9.1 FUEL STORAGE AND HANDLING

9.1.1 NEW FUEL STORAGE

9.1.1.1 Design Bases

9.1.1.1.1 Safety Design Bases

9.1.1.1.1.1 Safety Design Bases - Structural

a) The new fuel storage racks containing a full complement of fuel assemblies are designed to withstand all credible static and dynamic loadings to prevent damage to the structure of the racks, and therefore the contained fuel, and to minimize distortion of the racks arrangement. (See Table 3.9-2s.)

b) The racks are designed to protect the fuel assemblies from excessive physical damage which may cause the release of radioactive materials in excess of 10CFR20 requirements under normal conditions.

c) The racks are constructed in accordance with the Quality Assurance Requirements of 10CFR50, Appendix B.

d) The new fuel storage racks are categorized as Safety Class 2 and Seismic Category I.

9.1.1.1.1.2 Safety Design Bases - Nuclear

a) The new fuel storage racks are designed and maintained with sufficient spacing between new fuel assemblies to assure that the fully loaded array in dry storage or fully flooded conditions has a keff $\leq$0.95 including allowance for calculational biases and uncertainties.

b) The new fuel storage vault is covered by leak tight metal removable covers. These covers prevent an optimum moderator (e.g., fire-fighting foam) from reaching the new fuel. The movement of these covers is administratively controlled by approved plant procedures.

c) The new fuel storage vault criticality calculations assumed that the storage array was infinite in all directions. Since no credit is taken for leakage, the values reported as effective neutron multiplication factors are in reality infinite neutron multiplication factors.

d) The biases between the calculated results and experimental results as well as the uncertainty involved in the calculations are taken into account as part of the calculational procedure to assure that the specified keff limits are met. Also when fuel is in the new fuel storage vault two radiation monitors are utilized to detect criticality in the new fuel storage vault.

9.1.1.1.2 Power Generation Design Bases

a) New fuel storage racks are supplied for 30% of the full core fuel load in each unit.

b) New fuel storage racks are designed and arranged so that the fuel assemblies can be handled efficiently during refueling operations.

9.1.1.2 Facilities Description

The location of the new fuel storage facility within the station complex is shown in Section 1.2. Each new fuel storage rack (Figure 9.1-1) holds up to 10 channeled or unchanneled assemblies in a row. Fuel spacing (7 inches nominal center-to-center within a rack, 12 inches nominal center-to-center between adjacent racks) within the rack and from rack-to-rack, coupled with limits on fuel lattice reactivity, will limit the effective multiplication factor of the array (keff) to not more than 0.95. The fuel assemblies are loaded into the rack through the top. Each hole for a fuel assembly has adequate clearance for inserting or withdrawing the assembly channeled or unchanneled. Sufficient guidance is provided to preclude damage to the fuel assemblies. The upper tie plate of the fuel element rests against the rack to provide lateral support. The design of the racks prevents accidental insertion of the fuel assembly in a position not intended for the fuel. This is achieved by abutting the sides of each casting to the adjacently installed casting. In this way, the only spaces in the new fuel racks are those into which it is intended to insert fuel. The weight of the fuel assembly is supported by the lower tie plate which is seated in a chamfered hole in the base casting.

The floor of the new fuel storage vault is sloped to a drain located at the low point. This drain removes any water that may be accidentally and unknowingly introduced into the vault. The drain is part of the liquid radwaste collection system.

The area radiation monitoring equipment for the new fuel storage area is described in Subsection 12.3.4.

9.1.1.3 Safety Evaluation

9.1.1.3.1 Criticality Control

New Fuel Vault criticality analyses demonstrate that General Design Criterion 62 requirements (Prevention of Criticality in Fuel Storage and Handling) are met if fuel is stored in the normal dry condition or if the abnormal condition of flooding occurs (Reference 9.1-1).

The calculations of keff are based upon an infinite geometrical arrangement of the fuel array using FANP methods (Reference 9.1-1). The arrangement of fuel assemblies in the fuel storage racks results in keff $\leq$0.95 for both the dry storage condition and the fully flooded condition, assuming the most reactive fuel and moderator temperatures.

The New Fuel Storage Vault has not been designed to preclude criticality at optimum moderation between dry and flooded conditions (e.g., fire-fighting foam). Watertight covers are used as measures to prevent an inadvertent criticality. As an added precaution, criticality monitors have been installed. Administrative controls restrict the use of foam on the Refueling Floor and on the Reactor Building roof during those times when new fuel is being stored in the new fuel storage vault.

9.1.1.3.2 New Fuel Rack Design

a) The new fuel storage vault contains 23 sets of castings each of which may contain up to 10 fuel assemblies; therefore a maximum of 230 fuel assemblies may be stored in the fuel vault.

b) There are three tiers of castings which are positioned by fixed box beams. This holds the fuel assemblies in a vertical position and supported at the lower and upper tie plate with additional lateral support at the center of gravity of the fuel assembly.

c) The lower casting supports the weight of the fuel assembly and restricts the lateral movement; the center and top casting restricts lateral movement only of the fuel assembly.

d) The new fuel storage racks are made from aluminum. Materials used for construction are specified in accordance with ASTM specifications in effect in 1970. The material choice is based on a consideration of the susceptibility of various metal combinations to electrochemical reaction. When considering the susceptibility of metals to galvanic corrosion, aluminum and stainless steel are relatively close together insofar as their coupled potential is concerned. The use of stainless steel fasteners in aluminum to avoid detrimental galvanic corrosion in a predominantly air environment, is a recommended practice and has been used successfully for many years by the aluminum industry.

e) The minimum center-to-center spacing for the fuel assembly between rows is 11.875 inches. The minimum center-to-center spacing within the rows is 6.535 inches. Fuel assembly placement between rows is not possible.

f) Lead-in and lead-out of the casting, in the rack, provides guidance of the fuel assembly during insertion or withdrawal.

g) The rack is designed to withstand the impact force of 4000 ft-lbs while maintaining the safety design basis. This impact force could be generated by the vertical free fall of a fuel assembly from the height of 5.3 feet.

h) The storage rack is designed to withstand the pull-up force of 4000 lbs. and a horizontal force of 1000 lbs. There are no readily available forces in excess of 1000 lbs.

i) The storage rack is designed to withstand horizontal combined loads up to 222,000 lbs, well in excess of expected loads.

j) The maximum stress in the fully loaded rack in a faulted condition is 25.9 Kips. (See Table 3.9-2s.) This is lower than the allowable stress.

k) The fuel storage rack is designed to handle non-irradiated, low emission radioactive fuel assemblies. The expected radiation levels are well below the design levels.

l) The fuel storage rack is designed using non-combustible materials. Plant procedures and inspections assure that combustible materials are restricted from this area. Fire prevention by elimination of combustible materials and fluids is regarded as the prudent approach rather than fire accommodation and the need for fire suppressant materials which could negate criticality control assurances. Therefore, fire accommodation is not considered necessary.

m) The new fuel vault covers, which are carbon steel, are illustrated in Figure 9.1-2. The covers overlap the curb and have a protective lip that prevents direct impingement of water into the vault. The modified I-beams that span the vault provide mechanical support and direct water run-off from the covers.

9.1.2 SPENT FUEL STORAGE

Spent fuel is stored both in the Reactor Building Spent Fuel Storage Pools and at the Independent Spent Fuel Storage Installation (ISFSI). This Section applies only to spent fuel storage in the Reactor Building. Spent fuel storage in the ISFSI is described in Section 11.7.

9.1.2.1 Design Bases

9.1.2.1.1 Safety Design Bases

9.1.2.1.1.1 Safety Design Bases - Structural

a) The high density spent fuel storage racks containing a storage space sufficient for approximately 372% of one full core of fuel assemblies are designed to withstand all credible static and dynamic loadings to prevent excessive damage to the structure of the racks, and therefore the contained fuel. (See Table 3.9-2(af).)

b) The racks are designed to protect the fuel assemblies from excessive physical damage which may cause the release of radioactive materials in excess of 10CFR20 requirements under normal or abnormal conditions.

c) The racks are constructed in accordance with the Quality Assurance Requirements of 10CFR50, Appendix B.

d) The spent fuel storage racks are categorized as Safety Class 2 and Seismic Category I.

e) The spent fuel pool structure and the anchorage system to the fuel storage racks are categorized as Seismic Category I.

9.1.2.1.1.2 Safety Design Bases - Nuclear

The effective neutron multiplication factor (Keff) of the fuel array in any combination of any stored positions up to and including the fully loaded condition is less than or equal to 0.95. The positioning of the neutron poisoning material (boral) between adjoining fuel assemblies assures subcriticality by at least 5% ΔK under all normal and abnormal conditions. Consideration has been given to the geometry of the racks, possible abnormal loading, and the density of the coolant/moderator. As an additional precaution, two radiation monitors will detect a criticality event in the spent fuel pool.

9.1.2.1.2. Power Generation Design Bases

The spent fuel storage pool and fuel storage racks are designed to assure:

a) subcriticality, by at least 5% ΔK

b) decay heat from fuel assemblies/bundles will not adversely affect the fuel, racks, or pool walls.

c) radiation levels will be "As Low As Reasonably Achievable."

9.1.2.1.3 Storage Capacity Design Bases

Each reactor unit has a spent fuel pool which has high density fuel storage racks providing a maximum storage capacity of 2840 fuel assemblies. These fuel locations also provide storage of used fuel channels, if needed. In addition, the fuel storage rack design provides storage of 10 various reactor internal components, such as:

a) control rods
b) control rod guide tubes
c) defective fuel storage containers
d) "out-of-core" sipping containers

This capacity provides each reactor unit storage space for off loading one-quarter (1/4) of a core for approximately ten (10) years, plus one complete core load of fuel.

Each reactor unit's spent fuel pool is interconnected, via a transfer canal. Spent fuel may be transferred safely, through this transfer canal, to the other pool. This capability provides greater flexibility for the stations storage of spent fuel, if the need ever arises.

Each reactor unit's spent fuel pool walls also have storage hangers for one hundred and thirty control rods. These hangers, empty or full of control rods, do not interfere with the storage of fuel or the other mentioned reactor internal components in this section. Extended sling assemblies may be used in conjunction with the hangers to store the control rods at a lower depth in the pool.

9.1.2.2 Facilities Description

The location of the spent fuel storage facility within the station complex is shown in Dwgs. M-246, Sh. 1 and M-256, Sh. 1. The racks are connected to wall embedments on the pool walls and shown in Figure 9.1-4. Each pool has 24 racks for a storage capacity of 2840 fuel assemblies plus 10 multipurpose cavities for storage of control rods, control rod guide tubes, and defective fuel containers, and out-of-core sipping containers.

The spent fuel liner plate is not a structural element (i.e., it is not load bearing). The fuel racks are attached to the pool walls by embeds and anchors, which are designed for all credible loads (see Table 9.1-7a). The liner plate is welded to these embeds. In addition, the liner plate is attached to the pool walls by a system of stiffeners and anchors. The racks, embeds and fuel pool walls and liner plate (including anchor system) are designed for all credible loads.

A leak detection system is provided for the collection of possible leakage through the pools' liner plate. The liner leakage detection system is segregated into sections that collect leakage at independent locations below the pools. Drainage paths are formed by welded channels behind the liner weld joints and are designed to permit free gravity flow to manual telltale valves.

This system is provided to:

a) Prevent pressure buildup behind the liner plate

b) Prevent the uncontrolled loss of contaminated pool water to other cleaner locations within the secondary containment, and

c) Provide expedient liner leak detection and measurement.

Both Units 1 and 2 share a common cask pit that accepts the spent fuel shipping cask and accommodates underwater fuel transfer to the cask from either unit through its respective transfer canals. Movements of the cask on the refueling floor are restricted as shown on Drawing C-1807, Shts. 1 & 2.

The evaluations of the consequences of a postulated accidental drop of a spent fuel assembly and the shipping cask are discussed in Chapter 15. The capability of the spent fuel pool storage facility to prevent missiles generated by high winds from contacting the fuel is discussed in Subsection 3.5.2.

The rack arrangement is designed to prevent accidental insertion of fuel bundles between adjacent racks.

The five (5) foot to six (6) foot thick spent fuel pool walls provide radiation shielding to 2.5 Mrem/Hr measured on the outside of the spent fuel pool walls. Normal water shielding over the stored fuel in the racks is approximately 23 feet and is sufficient to provide shielding for required building occupancy. Under the normal water level conditions, about 8.5' of water is above the active fuel when moved through the refueling channel. This depth of water provides shielding to assure less than 2.5 Mrem/Hr to the operators on the refueling platform.

Accidental droppage of heavy objects into the fuel pool is precluded by the use of administrative procedures, electrical interlocks to limit the reactor building crane travel over the spent fuel pool, and the use of guardrails and curbs around all pools and the reactor wells to prevent fuel handling and servicing equipment from falling into the pools.

The spent fuel pools, reactor wells, dryer-separator storage pools, and common shipping cask pool including all gates are designed to Seismic Category I requirements. All pools and wells are lined with stainless steel to minimize leakage and reduce corrosion product formation. The spent fuel pools are further designed so that they cannot be drained to a level that uncovers the top of the stored fuel. The normal water shielding over the stored fuel in the racks is approximately 23 ft. However, in the unlikely event that the pool gates fail to contain the pool water, the fuel racks and their contained fuel are assured of maintaining water coverage at all times.
Cooling water supply lines enter the spent fuel pool from above the normal water level and are provided with high point siphon breaking vent lines to prevent siphoning of water from the pools.

The superstructure of the reactor building serves as a low leakage barrier to provide atmospheric isolation of the spent fuel storage pool and associated fuel handling area.
The superstructure is composed of structural steel framing, metal siding and metal roof decking.
The superstructure is designed to Seismic Category I criteria.

Features to limit potential offsite exposures in the event of significant release of radioactivity from the spent fuel have been provided.

These include a ventilation exhaust system, isolation of the secondary containment on high radiation, air mixing, and a standby gas treatment system capable of maintaining the secondary containment at 1/4-in. water column negative pressure with respect to the outside ambient pressure. These features are discussed in Subsection 9.4.2.

The radiological considerations for the spent fuel storage arrangement are described in Chapter 12.

9.1.2.3 Safety Evaluation

9.1.2.3.1 Criticality Control

Critically analyses have been performed for each fuel design (i.e., GE 8x8, FANP 8x8, FANP 9x9-2, and FANP ATRIUM™-10) to demonstrate that storage of fuel assemblies of each design in the spent fuel pool high density racks results in a keff $\leq$0.95 (References 9.1-2, 9.1-3, and 9.1-13). Storage of ABB SVEA 96+ and GE-12 Lead Use Assemblies in the spent fuel racks has been evaluated and is acceptable since these assemblies are designed to be neutronically similar to 9x9-2 fuel assemblies (References 9.1-11 and 9.1-12).

The calculations of keff for the 8x8 fuel were performed by Nuclear Associates International using a combination of diffusion theory and Monte Carlo techniques. Revised calculations of keff for FANP 9x9-2 fuel were performed using the Monte Carlo computer program KENO ATRIUM™-10 fuel criticality calculations were performed by FANP using a combination of the KENO Monte Carlo code and the CASMO-3G lattice physics code.

Each analysis is based upon an infinite array of fuel assemblies loaded in the spent fuel pool rack cell geometry. The reference temperature assumed in the 8x8 analysis was 68°F, and temperature effects on reactivity were evaluated for temperatures ranging from 212°F to 32°F. The 9x9-2 analysis performed by FANP supported spent fuel pool temperatures as low as 68°F. PPL subsequently reevaluated the spent fuel pool criticality analysis to assure sufficient margin to criticality for a moderator temperature as low as 32°F (Reference 9.1-12). For ATRIUM™-10 fuel, the analysis was performed at 40°F, the temperature at which the fuel is most reactive. Each analysis addresses the effects of water density (voids), calculational and manufacturing uncertainties, storage of assemblies with or without fuel channels, and bundle orientation within the racks.

The spent fuel storage pool has also been analyzed under abnormal and accident conditions. These conditions included a fuel bundle placed vertically along the edge of the spent fuel pool, a fuel bundle laid horizontally on the top of the spent fuel pool racks, and a single missing Boral panel from the storage array. For all normal, abnormal, and accident conditions, the spent fuel pool rack keff remained less than 0.95.

9.1.2.3.2 High Density Fuel Storage Rack Design

Spent fuel storage racks provide a place in the spent fuel pool for storing new and spent fuel. The high density spent fuel racks contain a neutron-absorbing medium of natural boron carbide (B4C) in an aluminum matrix core clad with 1100 series aluminum. This neutron absorber is marketed under the trade name of Boral.

Boral slabs are manufactured under a proprietary qualified process. This process assures a uniform minimum B-10 areal density of 0.0233 gm/cm^2 in the Boral slabs utilized in the construction of the Susquehanna Racks. Benchmark measurements of those slabs yield a neutron attenuation factor of 0.963 minimum.

The rack manufacturer assured that correct Boral locations and quantities were present in accordance with the design and procurement documents through a rigorous quality assurance program that was evaluated and approved by the AE. The construction of the rack assures that all adjacent storage cavities are separated by a Boral slab. The Boral is sealed within two concentric square aluminum tubes referred to as poison cans.

Boral panel placement in a rack cell is shown in Figure 9.1-5. Nominal dimensions for a fuel storage cell poison can are shown in Figure 9.1-6.

Figure 9.1-3 shows the structural design. Each rack module consists of six basic components:

1) top grid casting
2) bottom grid casting
3) poison cans
4) side plates
5) corner angle clips
6) adjustable foot assemblies

Each component is anodized separately.

The top and bottom grid casting are machined to maintain a nominal fuel pitch (center-to-center spacing) of 6.625 inches. Within these machined areas, in a checkerboard pattern, Boral poison cans are nested. This ensures smooth entry and removal of fuel assemblies in each fuel cavity. This design also assures Boral is located between adjacent fuel assemblies. To complete the module, the grids are bolted and/or riveted together by four corner angles and four side shear panels. Adjustable foot assemblies are located at the four corners of each module to allow adjustment for variations of the pool floor level of ±0.75 inches. To maintain a flat, uniform contact area, the leveling screw bearing pads are free to pivot.

Each module is level with each other module at the top. There is nominally seven inches of clearance from the bottom of the module to the pool floor. This assures adequate clearance for cooling water to enter each fuel cell and keep each fuel assembly cool through natural convection.

The modules are bolted together into four super modules. The perimeter modules have seismic bracing to embedments in the pool wall assuring structural integrity through all anticipated dynamic loads. The weight of the fuel assembly is supported in the chamfered hole in the bottom casting. Nominal center-to-center fuel spacing between modules is 9.375 inches.

a) The square poison cans are positioned in a top and bottom grid in a checkerboard pattern. Each poison can is pressure and vacuum leak tested for integrity.

b) The seismic restraints from the racks to the wall embedments consist entirely of a welded stainless steel construction. To reduce any galvanic corrosion, inconel pins are used between the wall seismic restraints and racks. The only interface of each module with the pool floor are four stainless steel pads attached to the rack leveling screws. A 1/4 inch ABS plastic material is volumetrically captured between this pad and the aluminum leveling screw to prevent galvanic corrosion with the pool floor stainless steel liner plate.

c) All materials used for construction are specified in accordance with the ASTM specifications, as applicable. The ASTM Standards used for stainless steel were A240-72b, A276-71 and A312-72a and for aluminum were B209-73, B26-74 and B211-74.

Traceability of major rack components to a heat lot are maintained.

In addition, the suppliers' quality assurance-quality are control program audited by the AE and user, in effect to ensure that the Boral has the required minimum B4C density and uniform B4C distribution in each sheet. Boral traceability is maintained.

d) A dimensional, visual, and functional (including testing with a dummy fuel assembly) inspection of the racks is performed prior to shipment by the rack manufacturer.

e) The rack materials have no significant degradation due to the total radiation doses expected in the spent fuel pool over the design life.

f) The minimum center-to-center fuel spacing within a rack assembly is 6.500". The minimum center-to-center fuel spacing between racks is 9.125". Fuel assembly placement between modules or cavities of a module are not possible.

g) The racks are designed to withstand the loading under the following loading conditions: dead, live, jammed fuel assembly, dropped fuel assembly, thermal, OBE and DBE seismic, SRV, and LOCA or Chugging.

h) The racks are installed in the pool on four tension and compression quadrants to eliminate thermal loads resulting from confined expansion.

i) An inservice inspection (ISI) program will be in effect throughout the life of the racks to assure quality of the poisoned racks is maintained, as described in Subsection 9.1.2.3.3.

9.1.2.3.3 Inservice Inspection

Sixteen test coupons are to be provided for an on-going in-service inspection program. Two coupons, one of which is vented and the other sealed, would be removed and analyzed at intervals of 1, 3, 5, 10, 15, 20, 30, and 40 years after installation. One set of coupons will be tested during the tenth or eleventh year after Unit 1 enters the Period of Extended Operation.

9.1.2.3.3.1 Test Coupon Description and Installation

A typical test coupon is a shortened production-type can similar to the spent fuel rack. Four sheets of BORAL neutron poison are encapsulated between the inner and outer cans. After assembly, the entire coupon is anodized.

The sealed cans are pressure-checked through a hole in the outer can. This hole is then welded to prevent water from contacting the BORAL. The unsealed cans will also have a 13/64 inch hole which will not be welded closed.

Two test coupons, one vented and the other unvented, are tied together with a hanger. This hanger contains a handling eye so that they can be hung on the perimeter of the spent fuel rack.

9.1.2.3.3.2 Test Coupon Inspection

a) The test coupon assembly will be removed from the spent fuel pool.

b) The test coupon will be drained of the entrapped water from the vented coupon and the pH of the water in the fuel pool will be determined.

c) The vented coupon will be disassembled sufficiently so that the neutron absorber can be extracted.

d) Upon disassembly, note whether there is water in the sealed coupon. If so, perform step #b above.

e) Visual inspection of the neutron absorber plates will be noted and any discoloration, corrosion damage or physical damage will be recorded. If corrosion or physical damage is noted, record depth and extent of damage.

f) The plates will be washed in a mild abrasive and detergent solution, then rinsed in clean water and/or acetone. The plates will be dried in a 175°F oven for ≥4 hours, followed by 4 hours in a 300°F oven and 4 additional hours in a 500°F oven. The plate weight will be determined, at room temperature, following each drying interval. Drying may be discontinued when no further weight loss occurs.

g) Each plate will be weighed and determine weight change.

h) Reperform step #e.

i) Perform neutron attenuation testing on each plate.

j) All data will be recorded, including pH values, for future comparison.

9.1.3 SPENT FUEL POOL COOLING AND CLEANUP SYSTEM

9.1.3.1 Design Bases

The Fuel Pool Cooling and Cleanup System (FPCCS) is designed and operated with the following considerations:

a) The FPCCS is designed to maintain the fuel pool water temperature below 125°F.

START HISTORICAL

The heat load which served as the basis for the FPCCS design is based upon filling the pool with 2840 fuel assemblies from normal refueling discharges and transferred to the fuel pool within 160 hours after shutdown. Tables 9.1-2a and 9.1-2b show the originally assumed discharge schedule and heat load.

END HISTORICAL

Table 9.1-2e shows an updated discharge schedule which was used as the basis for the Appendix 9A analysis only. This analysis was based upon filling the pool with 2850 fuel assemblies from normal refueling discharge and transferred to the fuel pool within 144 hours after shutdown.

b) During an emergency heat load (EHL) condition one RHR pump and heat exchanger are available for fuel pool cooling. The EHL condition occurs when one fuel pool is full including a full core unloaded.

START HISTORICAL

The original design bases for full core unloaded conditions occurred when the spent fuel racks of one spent fuel pool were filled with 2840 fuel assemblies including a full core discharged to the pool within 250 hours after shutdown (control rods inserted).
Tables 9.1-2c and 9.1-2d show the original discharge schedule and heat load that was assumed for the system's design for this condition for Units 1 and 2.

END HISTORICAL

Table 9.1-2f shows an updated discharge schedule. This updated schedule for full core unload conditions is based upon filling the pool with 2850 fuel assemblies including a full core discharge to the pool within 250 hours after shutdown.
The RHR Fuel Pool Cooling mode (RHRFPC) will maintain the isolated fuel pool water temperature, (with the heat load of 4.02×10^7 BTU/hr) at or below 125°F with or without assistance from the FPCCS under normal refueling conditions. When the decay heat load of the spent fuel drops to the level for which the FPCCS is designed, the RHR system may be disengaged. For crosstied spent fuel pools, the RHRFPC mode in one unit in combination with the normal Fuel Pool Cooling system of the other unit will maintain the crosstied fuel pools at or below 125°F with the EHL in one pool and fuel at the normal scheduled off load rate in the other pool.

c) Following a seismic event, the normal Fuel Pool Cooling system is postulated to be unavailable due to its Non-Seismic Category I, Non-Class 1E power design. If such an event were to occur the RHR Fuel Pool Cooling (RHRFPC) mode would be used to provide cooling to the spent fuel pools to prevent boiling.

All piping and components of the RHRFPC mode are Seismic Category I, Quality Group B or C constructed to ASME Section III standards. The RHR System is Class 1E powered and both loops have separate power supplies. The RHRFPC system is hardpiped and requires operation of several manual valves (which are accessible following a seismic event) to establish the flowpath. In addition, other manual and motor operated valves must be operated in order to assure proper operation of the RHRFPC mode. Proper operation of all active components in the RHRFPC mode is confirmed on a periodic basis in accordance with plant procedures.

The RHR pump suction path for the Fuel Pool Cooling mode is shared with the Shutdown Cooling mode of RHR. Consequently, Shutdown Cooling and Fuel Pool Cooling cannot be performed concurrently on a given unit. However, Alternate Shutdown Cooling and Fuel Pool Cooling can be performed concurrently since different suction sources are used.

Appendix 9A contains an evaluation of a boiling spent fuel pool for a Non-Seismic Category I Fuel Pool Cooling system. Boiling of the spent fuel pool(s) would not occur during a seismic event due to use of the RHR Fuel Pool Cooling system as a backup Seismic Category I Fuel Pool Cooling system. The RHRFPC mode can be placed into service well in advance of the postulated time to boil of 25 hours (see Subsection 9.1.3.3).

d) The FPCCS is designed to maintain the water clarity and quality in the pools as follows to facilitate underwater handling of fuel assemblies and to minimize fission and corrosion product buildup that pose a radiological hazard to operating personnel:

Conductivity	≤3 micromho/cm at 25°C
pH	5.3 - 7.5 at 25°C
Chloride (as CL^-)	≤0.5 ppm
Heavy elements (Fe,Cu,Hg,Ni)	<0.1 ppm
Total insolubles	<1 ppm

9.1.3.2 System Description

Each reactor unit is provided with its own FPCCS as shown on Dwgs. M-153, Sh. 1, M-153, Sh. 2, and M-154, Sh. 1.

The system cools the fuel storage pool water by transferring the decay heat of the irradiated fuel through heat exchangers to the service water system. During Refueling Outages, when the service water system is shutdown the decay heat is transferred through the FPCCS heat exchangers to the temporary cooling towers/chillers located outside the units or by circulating river water through the heat exchangers. The River Water Make Up line tap provided at the special manhole near North Gate House supplies river water for this purpose and also returns this water back into the RWMU line. This RWMU line tap and the temporary cooling towers/chillers are connected to the heat exchangers through temporary pumping equipment and Supplemental Decay Heat Removal piping.

Water clarity and quality in the fuel storage pools, transfer canals, reactor wells, dryer-separator pools, and shipping cask pit are maintained by filtering and demineralizing.

The FPCCS consists of fuel pool cooling pumps, heat exchangers, skimmer surge tanks, filter demineralizers, associated piping, valves, and instrumentation.

Equipment Description

Table 9.1-1 shows the design parameters of the FPCCS equipment. The seismic and quality group classifications of the FPCCS components are listed in Section 3.2.

One skimmer surge tank for each unit collects overflow water from skimmer drain openings with adjustable weirs at the water surface elevation of each pool and well. The common shipping cask pit water overflows to both units' skimmer surge tanks.

Wave suppression scuppers along the working side of the fuel pools also drain to the skimmer surge tanks. The skimmer openings in the pool liners are protected with a wire mesh screen to prevent floating objects such as the surface breaker viewing aids from entering the surge tanks. The adjustable weir plates are set according to the required cooling flow, desired flow pattern, and water shielding needs.

The skimmer surge tank provides a suction head for the fuel pool cooling pumps and a buffer volume during transient flows in the normally closed loop FPCCS. It provides sufficient live capacity for three days' normal evaporative loss from the fuel pool without makeup from the condensate transfer system. A removable object retention screen in the tank is accessible through the flanged tank top. Tank level indication and alarms on a control panel on the refueling floor and/or the vicinity of the fuel pool cooling pumps announce when the remote manual makeup valves must be opened or water drained from the system.

The fuel pool cooling pumps are stopped upon a low tank level signal.

Three fuel pool heat exchangers piped in parallel are located in the reactor building below the surge tank bottom elevation. The shell side is subjected to the static head of the skimmer surge tank level only. This is a minimum of 5 psi lower than the tube side service water pressure, thus minimizing the possibility of radioactive contamination of the service water system (see Subsection 9.2.1) from a tube leak.

The number of heat exchangers in service depends on the decay heat load from irradiated fuel in the spent fuel pool. The common inlet and each heat exchanger outlet temperature are recorded and high temperature alarmed on a local control panel.

Three fuel pool cooling pumps piped in parallel are placed in service in conjunction with the heat exchangers. They take suction from the heat exchangers and develop sufficient head to process a partial system flow through the filter demineralizers and transfer it combined with the bypass flow to the diffuser pipes at the bottom of the pools.
The pump controls, discharge pressure indicators, flow indicator, and alarms for low flow and low discharge pressure are provided on a local control panel.

The pumps trip individually upon low NPSH. Three fuel pool filter demineralizers are piped in parallel. One fuel pool filter demineralizer is designated for use with each unit with a spare filter demineralizer shared by both units. The design flow per filter demineralizer is less than the total system flow. Part of the cooled water is therefore bypassing at a manually adjustable rate.

If the inlet temperature should exceed 150°F, the filter demineralizer must be manually bypassed to prevent degradation of the ion exchange resin.

The filter demineralizer units are designed to operate with water flowing at nominal 2 gpm/sq. ft. filter area. Powdered ion-exchange resin or resin mixed with Solka-Floc (or other filtering aid) is used as a filter medium. The filter elements are stainless steel mesh, mounted vertically in a tube sheet and replaceable as a unit. Venting is possible from the upper head of the filter vessel to the reactor building ventilation system. The upper head is removable for installation and replacement of the filter elements. The filter demineralizer units are located separately in shielded cells. Sufficient clearance is provided to permit removal of the filter elements from the vessels. Each cell contains only the filter demineralizer and connecting piping. All inlet, outlet, recycle, vent, drain valves, and the holding pumps are located in a separate shielded room, together with necessary piping and headers, instrument elements, and controls. Penetrations through shielding walls are located so that shielding requirements are not compromised.

A post-strainer is provided in the effluent stream of each filter demineralizer to limit the migration of the filter material. The post-strainer element is capable of withstanding a differential pressure greater than the shut-off head for the system.

The ion exchange resin is a mixture of finely ground, 300 mesh or less (average particle size), cation and anion resins in proportions determined by service. The cation resin is a strongly acidic polystyrene with a divinylbenzene cross-linkage. The resin is supplied in fully regenerated hydrogen form. The anion resin is a strongly basic, Type I, quaternary ammonium polystyrene with a divinylbenzene cross-linkage. The resin is supplied in a fully regenerated hydroxide form.

The resin is replaced when the pressure drop is excessive or the ion exchange resin is exhausted. Backwashing and precoating operations are controlled from a local control panel in the reactor building. The spent filter medium is backwashed from the elements with instrument air and condensate and transferred via a receiving tank to the RWCU sludge phase separator or to the reactor water clean-up phase separators in the radwaste building.
New ion exchange resin is mixed in a resin tank and transferred as a slurry by a precoat pump to the filter where it is deposited on the filter elements. A separate precoat tank is provided to allow precoating of the filter elements with Solka-Floc (or other filtering aid) only or prior to depositing ion exchange resins. Both tanks are furnished with an agitator for mixing the filter medium slurries. The precoat subsystem is common to both FPCCS and may also be used for chemical cleaning of the filter demineralizers.

The holding pump associated with each filter demineralizer maintains circulation through the filter in the interval between the precoating operation and the return to normal system operation, or upon decrease in process flow below a point where the precoating may fall off the filter elements.

The filter demineralizers are controlled from a panel in the reactor building of Unit 1. Differential pressure and inlet and outlet pressure instrumentation are provided for each filter demineralizer unit to indicate when backwash is required. Suitable alarms, differential pressure indicators, and flow indicating controllers are provided to monitor the condition of the filter demineralizer and the post effluent strainers.

The backwash and precoat operations are push-button initiated, automatically sequenced operations. The filter demineralizer inlet and outlet conductivity is recorded and 1.2 micromho/cm in the outlet is alarmed on the reactor building sample station cabinet via an alarm light and the process value recorded on the water chemistry data acquisition system.

Fuel pool high and low level alarms, temperature indication and high temperature alarms are provided on a refueling floor control panel. Level set points are adjustable over the skimmer weir range. In addition, independent instruments provide both fuel pool level and temperature indication on a recorder in the Control Room. The span of these independent instruments bounds the range of the alarm setpoints.

A high rate of leakage through the refueling bellows assemblies, drywell to reactor well seals, or the fuel pool and shipping cask pit double gates is alarmed on a refueling floor control panel.

All local alarms are duplicated individually or as group alarms in the main control room.

Operational Description

During normal plant operation, the fuel pools are crosstied to the common shipping cask pit. The fuel pool cooling pumps circulate the pool water in a closed loop, taking suction from the skimmer surge tank through the heat exchangers and discharging a partial flow through the filter demineralizer, the balance passing through a bypass line back to the fuel pool diffusers.

After the reactor has been shut down, the vessel head and one refueling gate is removed. Two refueling water pumps (see Subsection 9.2.10) transfer condensate from the refueling water storage tank through diffusers into the reactor well and dryer-separator pool. The water level rises from the RPV flange elevation to the fuel pool water level in approximately 4 hr. The second refueling gate is then removed and refueling operations continued.

As the heat load increases with additional spent fuel elements being transferred from the reactor core to the spent fuel pool, additional pumps and heat exchangers of the FPCCS are put into service to meet the design objectives. Part of the cooled water can be diverted to the reactor well through the filling diffusers assisting the RHR system in removing decay heat rising from the core to the water surface. At this time two fuel pool filter demineralizers may be used in conjunction with the reactor water cleanup system to maintain required water quality in the reactor, reactor well, dryer-separator pool, and fuel pool.

Most outages include a period for maintenance on the cooling towers and the service water system. Since the fuel pool cooling heat exchangers are cooled by the service water system, the outage unit's fuel pool cooling system can be operated by circulating river water through the heat exchangers or by using temporary cooling towers/chillers located outside the unit. Supplemental decay heat removal piping can connect the tube side of the FPCC heat exchangers to either the temporary cooling towers/chillers or to the River Water Makeup line tap provided at the special manhole near North Gate House. During this period of the outage, the operating unit's fuel pool cooling system is also used to cool the pools. This in part, is accomplished by connecting the fuel pools via the cask storage pit. Prior to implementing this method of pool cooling, the shutdown unit's fuel pool temperature is monitored and calculations and tests are performed to assure that the capacity of the operating unit's fuel pool cooling system is adequate to maintain pool temperatures within acceptable limits. Once the shutdown unit's FPCCS becomes available, it is placed back into service.

After refueling has been completed, the refueling water pumps transfer the water from the reactor well and dryer-separator pool through a condensate demineralizer back to the refueling water storage tank. This is accomplished in approximately 4 hours. Gravity draining of the refueling water to the refueling water storage tank is possible.

As the decay heat from the spent fuel decreases with time, the number of operating pumps and heat exchangers may be reduced to keep the fuel pool below the maximum normal design temperature.

The shipping cask storage pit is filled and drained in the same manner as the reactor well with one refueling water transfer pump. The shipping cask storage pit is interconnected with the fuel pool during cask loading operations of spent fuel for offsite disposal. A small stream of fuel pool cooling water may be diverted from the fuel pool cooling pumps to the filling diffuser of the shipping cask pit to remove decay heat and water impurities during cask loading operations. This water returns over a skimmer weir to the skimmer surge tanks.

During periods when the heat in the pool is greater than the capacity of the fuel pool cooling system (such that acceptable fuel pool temperatures cannot be maintained), e.g., storing of a full core of irradiated fuel shortly after shutdown, the RHR system can be used to dissipate the decay heat. One RHR pump takes suction from an intertie line to the skimmer surge tank and discharges through one RHR heat exchanger to two independent diffusers at the fuel pool bottom. With the Spent Fuel Pool(s) filled to a height approximately 7.5 inches above the weirs, the skimmer surge tank provides sufficient suction head for an RHR pump in the RHR Fuel Pool Cooling (RHRFPC) mode.

Makeup water to replenish evaporative and small leakage losses from the pools is provided from the condensate transfer storage tank into the skimmer surge tank by opening a remote manual valve.

A Seismic Category I line from each of the two emergency service water loops is connected to the RHR intertie diffuser lines of each fuel pool, allowing for emergency makeup in support of RHRFPC or during postulated boiling of the pool water as described in Appendix 9A. The manual supply valves in these emergency makeup lines are accessible from elevations below the refueling floor.

9.1.3.3 Safety Evaluation

At FPCCS design conditions where the pool heat load is 12.6 MBTU/HR and service water temperature is 95°F the FPCCS will maintain the fuel pool water less than 125°F. At improved service water temperature conditions, the FPCCS can maintain the fuel pool water less than 125°F with larger heat loads in the pool. This condition occurs during refueling outages. When this condition exists the pool is monitored to assure adequate FPCCS capacity exists. When the FPCCS cannot maintain the pool temperature less than 125°F and low enough so that the calculated time to boil is greater than 25 hours, the RHR system in the Fuel Pool Cooling Mode (RHRFPC) can be connected to the pools to maintain pool temperatures below 125°F by the RHRFPC mode. AT EHL conditions (4.02 x 10^7 BTU/hr), RHRFPC can maintain the pool temperature below 125°F with spray pond water temperatures below Technical Specification limits. Pool configuration will be maintained during the outage sequence so that the calculated time to boil is greater than 25 hours. The exception to this are those periods of time when the spent fuel pools are connected to the reactor cavity and RHR Shutdown Cooling or RHRFPC is in operation. Under these circumstances Seismic Category I, Class 1E cooling is already in service, thereby eliminating the need to provide sufficient time to place RHR in service to prevent spent fuel pool boiling.

A Seismic Category I makeup is provided by a 2 in. line from each emergency service water (ESW) loop to the RHR fuel pool diffusers, thus providing redundant flow paths from a reliable source of water. The design makeup rate from each ESW loop is based on replenishing the postulated boil-off from the MNHL in each fuel pool for 30 days following the loss of the FPCCS capacity. This provides a capacity far in excess of what would be required by the RHRFPC mode in response to a loss of normal fuel pool cooling due to a seismic event.

All piping and equipment shared with or connecting to the RHR intertie loop are Seismic Category I, Quality Group C, or equivalent and can be isolated from any piping associated with the non-Seismic Category I Quality Group C fuel pool cooling system.

Due to its Non-Seismic Category I, Non-Class 1E power design, the consequences of a seismic event are required to be analyzed for the FPC system. In response to this event, the RHRFPC mode will be used to prevent boiling from occurring; however, a non-mechanistic evaluation of boiling of both spent fuel pools is contained in Appendix 9A in order to conservatively bound the radiological consequences.

The spent fuel pools are normally maintained in a crosstied configuration during dual unit operation and refueling outages. This assures that the time to boil following a loss of normal fuel pool cooling is a minimum of 25 hours; however, in this configuration the time to boil is typically much greater than the minimum 25 hours. The exception to this is shortly after a unit is shutdown for a refueling outage when the spent fuel pools are interconnected with the reactor vessel via the reactor cavity. During this time frame, the time to boil can be less than the 25 hour criteria, due to the combined decay heat load in the spent fuel pools and the reactor vessel. It should be noted that this is largely due to the decay heat resent in the reactor vessel at the time that the spent fuel pools are connected to the reactor vessel. However, a time to boil of less than 25 hours is not relevant, since RHR Shutdown cooling is required to be in service prior to interconnecting the spent fuel pools with the reactor cavity, thereby eliminating the need to provide sufficient time to place Seismic Category I, Class 1E cooling in service to prevent spent fuel pool boiling. The crosstied configuration allows use of either unit's systems (normal SFP Cooling or RHRFPC) to cool the pools, thus providing fuel pool cooling redundancy. Crosstied spent fuel pools also provide redundancy for the level instrumentation location in the control room. This instrumentation is designed to operate following an Operating Basis Earthquake under boiling spent fuel pool conditions, and is expected to remain functional. While not classified as Class 1E equipment, the instruments receive power from independent Class 1E power supplies that are Diesel Generator backed.

Should a seismic event occur during dual unit power operation with crosstied pools, adequate reactor core cooling will be provided and spent fuel pool boiling will be prevented. Only one loop of RHR is necessary to provide long term decay heat removal per reactor vessel. Similarly, only one loop of RHR is necessary to provide long-term decay heat removal to crosstied spent fuel pools. Since either unit's RHR system can provide cooling to both units spent fuel pools with the pools crosstied, a failure of one loop RHR in one of the units would still allow a sufficient number of loops to cool both reactors and the spent fuel pools. In this case, the unit providing spent fuel pool cooling would utilize Alternate Shutdown Cooling for long-term decay heat removal from reactor. The other unit would utilize the normal Shutdown Cooling mode.

Certain specific plant evolutions, will require the pools to be isolated. These evolutions will be procedurally controlled to ensure that sufficient cooling systems are available given the plant configuration at the time of the evolution.

An evaluation of the impacts of operating the RHRFPC mode on the Ultimate Heat Sink (UHS) was performed as a separate evaluation of the minimum heat transfer case discussed in Subsections 9.2.7.3.1 and 9.2.7.3.6. The results of this evaluation indicate that the Spray Pond (UHS) will be maintained below the design maximum temperature under worst case accident conditions.

Additional details on the design of the RHRFPC mode are provided in Sections 5.4.7.1.1.6, 5.4.7.2.6c, and 9.1.3.1c.

Provisions to minimize and monitor leakage from the fuel pool are described in Subsection 9.1.2.3.

Makeup for evaporative and small leakage losses from the fuel pool is normally supplied from the condensate transfer system to the skimmer surge tanks of each unit. The intermittent flow rate is approximately 50 gpm to each surge tank.

The water level in the spent fuel storage pool is maintained at a height which is sufficient to provide shielding for required building occupancy. Radioactive particulates removed from the fuel pool are collected in filter demineralizer units in shielded cells. For these reasons, the exposure of station personnel to radiation from the spent fuel pool cooling and cleanup system is normally minimal. Further details of radiological considerations are described in Chapter 12.

An evaluation of the radiological effect of a boiling fuel pool is presented in Appendix 9A.

9.1.3.4 Inspection and Testing Requirements

No special tests are required because at least one pump, heat exchanger, and filter demineralizer are continuously in operation while fuel is stored in the pool. The remaining components are periodically operated to handle increased heat loads during refueling.

The pool liner leak detection drain valves are periodically opened and the leak rate estimated by the volumetric method. Gas or dye pressure testing from behind the liner plate may be performed to locate a liner plate leak.

Routine visual inspection of the system components, instrumentation, and trouble alarms is provided to verify system operability. Components and piping of the FPCCS designed per ASME Boiler and Pressure Vessel Code, Section III, Class 3 are in-service inspected as described in Section 6.6.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.1.4 FUEL HANDLING SYSTEM AND REACTOR SERVICING EQUIPMENT

9.1.4.1 Design Bases

The fuel-handling system is designed to provide a safe and effective means for transporting and handling fuel from the time it reaches the plant until it leaves the plant after post-irradiation cooling. Safe handling of fuel includes design considerations for maintaining occupational radiation exposures as low as practicable during transportation and handling.

Design criteria for major fuel handling system equipment is provided in Tables 9.1-2 through 9.1-4 which list the safety class, quality group, and seismic category. Where applicable, the appropriate ASME, ANSI, Industrial and Electrical Codes are identified. Additional design criteria is shown below and expanded further in Subsection 9.1.4.2.

The transfer of new fuel assemblies between the railroad/truck bay and the new fuel inspection stand and/or the new fuel storage vault is accomplished using the Unit 1 or Unit 2 reactor building cranes or the refueling floor jib cranes equipped with a general purpose grapple, or nylon sling (1" minimum).

The Unit 1 or Unit 2 reactor building crane auxiliary hoist or a refueling floor jib crane is used with a general purpose grapple or nylon sling to transfer new fuel from the fuel inspection stand or the new fuel vault to the fuel pool. From this point on, fuel bundles will be handled by the telescoping grapple on the refueling platform. Individual fuel rods may be handled by the auxiliary hoists on the bridge.

The refueling platform including refueling platform rails, clamps, and clips are Safety Class 2 and Seismic Class 1 from a structural standpoint in accordance with 10CFR50, Appendix A and B. Allowable stress due to safe shutdown earthquake loading is 120 percent of yield or 70 percent of ultimate, whichever is least. A dynamic analysis is performed on the structures using the response spectrum method with load contributions being combined by the square root sum of the squares (SRSS) method.

The refueling platform structures are designed in accordance with the AISC Manual of Steel Construction. All parts of the hoist systems are designed to have a safety factor of five based on the ultimate strength of the material. The design of the fuel (main) hoist includes some redundant components such that no single probable event shall result in fuel bundle drop. Maximum deflection limitations are imposed on the main structures to maintain relative stiffness of the platform. Welding of the platform is in accordance with AWS D14-1 or ASME Boiler and Pressure Vessel Code Section 9. Gears and bearings meet AGMA Gear Classification Manual and ANSI B3.5. Materials used in construction of load bearing members are to ASTM specifications. For personnel safety, OSHA Part 1910-179 is applied. Electrical equipment and controls meet ANSI CI, National Electric Code, and NEMA Publication No. IC1, MG1.

The general purpose grapple and the main telescoping fuel grapple have redundant hooks. The fuel grapple has an indicator which confirms that the hooks are in the closed position.

The fuel grapple is used for lifting and transporting fuel bundles. It is designed as a telescoping grapple that can extend to the proper work level and in its normal up position state still maintains adequate shielding over fuel.

To preclude the possibility of raising radioactive material out of the water, the cables on the auxiliary hoists incorporate an adjustable, removable stop that will actuate a limit switch to prevent hoisting when the free end of the cable is at a preset distance below water level. In the event of limit switch failure, the stops are intended to jam the hoist. In addition, redundant electrical interlocks are a part of the grapple.

Provision of a separate cask loading pool, capable of being isolated from the fuel storage pool, will eliminate the potential accident of dropping the cask and rupturing the fuel storage pool. Refer to Chapter 15 for accident considerations.

Refuel Floor Auxiliary Platform (RFAP) is used to perform ISI work on the Reactor Vessel and its components and to perform other work during refueling outages. RFAP is designed to maintain it’s structural integrity during and after a dynamic/seismic event. Design/Analysis of RFAP meets the Quality Assurance requirements of 10CFR50, Appendix B.

The 360 Degree Refuel Work Platform is another reactor cavity platform which enables personnel to perform ISI Work (and other activities) on the reactor vessel in parallel with fuel movements by the Refueling Platform. The 360 Degree Refuel Work Platform is designed to maintain its structural integrity during and after a SSE. Design/Analysis of the 360 Degree Refuel Work Platform meets the Quality Assurance requirements of 10CFR50, Appendix B.

9.1.4.2 System Description

Table 9.1-5 is a listing of typical tools and servicing equipment supplied with the nuclear system. The following paragraphs describe the use of some of the major tools and servicing equipment and address safety aspects of the design where applicable.

Table 9.1-5 also includes a listing of tools provided for the Refuel Floor Wetlift System. The Refuel Floor Wetlift System allows reactor vessel disassembly and reassembly work activities to be performed from the Refueling Platform. The Refuel Floor Wetlift System consists of subsystems, related to MSL Plugs with MSL Plugs Restraint Ring and Rigid Pole Handling System. These subsystems are described in the following Sections.

9.1.4.2.1 Spent Fuel Cask

This Section applies to a spent fuel cask used to transfer spent fuel to an off-site storage or reprocessing facility. The On-Site Transfer Cask used to transfer spent fuel to the on-site Independent Spent Fuel Storage Installation (ISFSI) is described in Section 11.7.6.1.

The spent fuel cask is used to transfer spent reactor fuel assemblies from the spent fuel pool via the cask pit to a fuel storage or fuel reprocessing facility. The cask may also be used for offsite shipment of irradiated reactor components such as control rod blades, in-core monitors, etc.

The maximum loaded weight and, hence, the capacity of the cask is determined by the 125 tons lifting capacity of a reactor building crane. The maximum loading height, i.e., height of the open cask in the storage pit, is determined by the depth of the shipping cask pit from the gate bottom. This allows for a constant water depth over the fuel in transit from the reactor to the fuel pool and into the shipping cask.

The cask is designed to dissipate the maximum allowable heat load from contained irradiated fuel by natural convection at least from the time the cask pit is drained until the cooling system on the transport vehicle is connected.

It further allows underwater replacement of the lid and other operations that may pose unacceptable radiation hazards to personnel. Considerations facilitating decontamination of the cask are given in the design. The design of the cask meets all applicable regulations of the Department of Transportation and 10CFR71 with respect to shipping of large quantities of fissile materials.

At present, no specific type of cask has been chosen. Over the lifetime of the plant, several different sizes and models may be used which the fuel handling facilities can accommodate.

9.1.4.2.2 Cask Crane

See Subsection 9.1.5 for discussion of reactor building cranes.

9.1.4.2.3 Fuel Servicing Equipment

The fuel servicing equipment described below has been designed in accordance with the criteria listed in Table 9.1-2.

9.1.4.2.3.1 Fuel Prep Machine

The fuel preparation machine, generally represented in Figure 9.1-9, is mounted on the wall of the fuel pool and can be used for stripping reusable channels from the spent fuel and for channeling or rechanneling of fuel. The machine is also used with the fuel inspection fixture to provide an underwater inspection capability, and with the defective fuel storage container to contain a defective fuel assembly for stripping of the channel.

The fuel preparation machine consists of a work platform, a frame, and a moveable carriage. The frame and moveable carriage are located below the normal water level in the fuel storage pool, thus providing a water shield for the fuel assemblies being handled. The fuel preparation machine carriage has an up-travel-stop to prevent raising irradiated fuel above the safe water shield level. The up-travel-stop may be relocated for the purpose of new fuel handling in the fuel preparation machine. The moveable carriage is operated by a foot pedal controlled air hoist.

9.1.4.2.3.2 New Fuel Inspection Stand

The new fuel inspection stand, generally represented in Figure 9.1-10, serves as a support for the new fuel bundles undergoing receiving inspection and provides a working platform for technicians engaged in performing the inspection.

The new fuel inspection stand consists of a vertical guide column, a lift unit to position the work platform at any desired level, bearing seats and upper clamps to hold the fuel bundles in position.

This inspection stand has been modified to include a mast guide assembly and jib arm to transfer channels from the new fuel channel up ender onto the fuel bundles.

9.1.4.2.3.3 Channel Bolt Wrench

The channel bolt wrench, generally represented in Figure 9.1-11, is a manually operated device approximately 12 feet in overall length. The wrench is used for removing and installing the channel fastener assembly while the fuel assembly is held in the fuel preparation machine.

The channel bolt wrench has a socket which mates and captures the channel fastener capscrew.

9.1.4.2.3.4 Channel Handling Tool

The channel handling tool, generally represented in Figure 9.1-12, is used in conjunction with the fuel preparation machine to remove, install, and transport fuel channels in the fuel storage pool.

The tool is composed of a handling bail, a lock/release knob, extension shaft, angle guides, and clamp arms which engage the fuel channel. The clamps are actuated (extended or retracted) by manually rotating lock/release knob.

The channel handling tool is suspended by its bail from a spring balancer on the channel handling boom located on the fuel pool periphery.

9.1.4.2.3.5 Fuel Pool Sipper

The fuel pool sipper, generally represented in Figure 9.1-13, provides a means of isolating a fuel assembly to concentrate fission products for detection of defective fuel assemblies.

The fuel sipper head isolates individual fuel assemblies by sealing the top of the fuel channel and pumping water from the bottom of the fuel assembly, through the fuel channel, to a sampling station, and return to the primary coolant system. After a “soaking” period, a water sample is obtained and is radio-chemically analyzed.

9.1.4.2.3.6 Fuel Inspection Fixture

The fuel inspection fixture, generally represented in Figure 9.1-14, is used in conjunction with the fuel preparation machine to permit remote inspection of fuel elements. The fixture consists of two parts: (1) a lower bearing assembly, and (2) a guide assembly at the upper end of the carriage. The fuel inspection fixture permits the rotation of the fuel assembly in the carriage, and, in conjunction with the vertical movement of the carriage, provides complete access for inspection.

9.1.4.2.3.7 Channel Gauging Fixture

The channel gauging fixture, generally represented in Figure 9.1-15, is a go/no-go gauge used to evaluate the condition of a fuel channel, prior to rechanneling or when one is difficult to install.

The channel gauging fixture consists basically of a frame, gauging plate and gauging block. The gauging plate is shimmed to correspond to the outside dimension of a usable fuel channel. The gauging block conforms to the inside dimension of lower end of a usable fuel channel.

The channel gauging fixture is installed in the vertical position, between the two fuel preparation machines and hangs from the fuel pool curb.

9.1.4.2.3.8 General Purpose Grapple

The general purpose grapple is a handling tool used generally with the fuel. The grapple can be attached to the reactor building auxiliary hoist, jib crane, and the auxiliary hoists on the refueling platforms. The general purpose grapple is used to remove new fuel from the vault, place it in the inspection stand, and transfer it to the fuel pool. It can be used to handle new fuel during channeling. Either a manually operated or air operated general purpose grapple can be used for this fuel handling. The manually operated and air operated general purpose grapples are generally represented in Figures 9.1-16 and 9.1-25, respectively. A nylon sling (1" minimum) may also be used to handle new fuel assemblies.

9.1.4.2.3.9 Fuel Grapple

The fuel grapple on the Unit 1 Refueling Platform is a telescopic mast with a grapple head used to lift and orient fuel bundles for core and storage rack placement. The telescopic portion of the mast is made up of cylindrical stainless steel tube assemblies. The outer tube assembly is suspended from the platform at its upper end by means of a pin and hanger joint. The upper end of the inner tube assembly is suspended from the dual-cable of the platform's main hoist. The grapple head is attached to the lower end of the inner tube assembly and has dual hooks, fail safe (closed) operation and sealed magnetic switches for grapple open and closed indication. The grapple head also has an internally mounted camera that provides the operator with a clear view directly through the open grapple. This allows a close-up verification of serial numbers, orientation, channel fastener condition, seating and grapple alignment.

The fuel grapple on Unit 2 refueling platform is a telescoping mast with a double hook grapple head used to lift and orient fuel bundles for core and storage rack placement. It is a triangular, open sectioned mast constructed of tubular stainless steel.

Unit 2 Fuel Grapple Mast section-to-section guidance is provided by nylon bearing pads. Vertical motion is supplied by a dual wire rope cable hoist, which provides a redundant load path, and is mounted on the Refueling Platform Main Trolley. Hoist cable attachment to the inner-most grapple section is achieved through a rocker arm/clevis assembly which allows for load equalization in the hoist wire ropes. A redundant hook grapple head featuring individual hook engage switches and air cylinders consists of engage switches wired in series and interlocked with the main hoist load cell in a manner to prevent raising a fuel bundle with either hook disengaged. Figure 9.1-23 outlines the main fuel grapple.

9.1.4.2.3.10 Fuel Transfer Stand

The fuel transfer stand, generally represented in Figure 9.1-24, is a passive device constructed using aluminum structural members. The transfer stand provides three positions for landing metal fuel shipping containers in a near vertical position to facilitate lifting the bundles without tilting more than 5 degrees from vertical. The transfer stand is equipped with ladders to allow easy access by refueling personnel for rigging the fuel bundles for removal from the shipping containers.

9.1.4.2.3.11 New Fuel Channel Up Ender

The new fuel channel up ender, generally represented in figure 9.1-26, serves as a hydraulic holder to upend each fuel channel from a horizontal to a vertical position in preparation for channeling of new fuel.

9.1.4.2.3.12 New Fuel Up Ending Stand

The new fuel up ending stand, generally represented in figure 9.1-27, serves as a work platform for refueling personnel and a frame for metal fuel shipping containers to be placed in a near vertical position. The stand is equipped with numerous platform levels to allow easy access by refueling personnel for rigging the fuel bundles for removal from the shipping containers.

9.1.4.2.4 Servicing Aids

General area underwater lights are provided with a suitable reflector for illumination. Suitable light support brackets are furnished to support the lights in the reactor vessel to allow the light to be positioned over the area being serviced independent of the platform. Local area underwater lights and drop lights are used for illumination where needed.

Portable underwater closed circuit television cameras are provided. The cameras may be lowered into the reactor vessel and/or fuel pool to assist in the inspection and/or maintenance of these areas.

A general purpose, plastic viewing aid is provided to float on the water surface to provide better visibility. The viewing aid contains colored components, or is appropriately marked, to allow the operator to observe it in the event of filling with water and sinking. Portable, submersible type, underwater vacuum cleaners are provided to assist in removing crud and miscellaneous particulate matter from the pool floors, or the reactor vessel. The pump and the filter unit are completely submersible for extended periods. The filter "package" is capable of being remotely changed, and the filters will fit into a standard shipping container for off-site burial. Fuel pool tool accessories are also provided to meet servicing requirements.

9.1.4.2.5 Reactor Vessel Servicing Equipment

The essentiality and safety classifications, the quality group, and the seismic category for this equipment are listed in Table 9.1-3. Following is a description of the equipment designs in reference to that table.

9.1.4.2.5.1 Reactor Vessel Service Tools

These tools are used when the reactor is shut down and the reactor vessel head is being removed or reinstalled. Tools in this group are:

- Stud Handling Tool
- Stud Wrench
- Nut Runner
- Stud Thread Protector
- Thread Protector Mandrel
- Seal Surface Protector
- Stud Elongation Measuring Rod
- Dial Indicator Elongation Measuring Device
- Head Guide Cap

These tools are designed for a 40 year life in the specified environment. Lifting tools are designed for a safety factor of 5 or better with respect to the ultimate strength of the material used. When carbon steel is used, it is either hard chrome plated, parkerized, or coated with an acceptable paint.

9.1.4.2.5.2 Steam Line Plug

9.1.4.2.5.2.1 Steam Line Plug (REM*Light Model)

The steam line plugs are used during reactor refueling or servicing; they are inserted in the steam outlet nozzles from inside of the reactor vessel to prevent a flow of water from the reactor well into the main steam lines during servicing of safety relief valves, main isolation valves, or other components of the main steam lines, while the reactor water level is raised to the refueling level. The main steam line plugs are designed to withstand a differential pressure of 60 psid without ejecting from the main steam line nozzle, and have been tested to hold at 90 psid. The plug is equipped with a wire rope tether designed to limit the distance the plug can fall and prevent the plug from reaching the core support top guide.

The steam line plug design provides two seals of different types. Each one is independently capable of holding full head pressure. The equipment is constructed of non-corrosive materials. The plug body is designed in accordance with the "Aluminum Design Manual" by the Aluminum Association.

9.1.4.2.5.2.2 Main Steam Line (MSL) Plugs (Spring Disk Model) and MSL Plugs Restraint Ring [Refuel Floor Wetlift System]

The Main Steam Line (MSL) Plugs are used during the reactor refueling or servicing; they are inserted in the steam outlet nozzles from inside the reactor vessel to prevent flow of water from the reactor into the main steam lines during servicing of the safety relief valves, main isolation valves or other components of the main steam lines, while Reactor Cavity is flooded. The MSL plugs are designed to withstand a differential pressure of 50 psi without ejecting from the main steam line nozzle. The MSL Plugs Restraint Ring provides a backup mechanical means to prevent ejection of the MSL Plugs.

9.1.4.2.5.3 Shroud Head Bolt Wrench

9.1.4.2.5.3.1 Shroud Head Bolt Wrench (Supplied with Nuclear System)

This is a hand held tool for operation of shroud head bolts. It is deigned for a 40 year life, it is made of aluminum to be easy to handle and to resist corrosion. Testing has been performed to confirm the design.

9.1.4.2.5.3.2 Shroud Head Bolt Wrench (Refuel Floor Wetlift System)

This tool is used for operation of the shroud head bolts. The shroud head bolt wrench is attached to the rigid poles supplied with the Rigid Pole Handling System and can be manipulated from either the Rigid Pole Handling System hoist, or the Reactor Building Cranes' auxiliary hoists, or the Refueling Platforms' auxiliary hoists.

9.1.4.2.5.3.3 Shroud Head Bolt Wrench (Lightweight supplied by Vendor)

This is a long extension wrench that is used to remotely loosen or tighten the shroud head bolts from the Refueling Platform. The wrench is operated manually and is supported on a bracket which is mounted on the Refueling Platform handrails. It is made of aluminum to be easy to handle and to resists corrosion. Testing has been performed to confirm the design.

9.1.4.2.5.4 Head Holding Pedestal

Three pedestals are provided for mounting on the refueling floor for supporting the reactor vessel head. The pedestals have studs which engage three evenly spaced stud holes in the head flange. The flange surface rests on replaceable wear pads made of aluminum. When resting on the pedestals, the head flange is approximately 3 feet above the floor to allow access to the seal surface for inspection and O-ring replacement.

The pedestal structure is a carbon steel weldment, coated with an approved paint. It has a base with bolt holes for mounting it to the concrete floor. The structure is designed in accordance with "The Manual of Steel Construction" by AISC.

9.1.4.2.5.5 Head Nut and Washer Rack

The RPV head nut and washer rack is used for transporting and storing up to 6 nuts and washers. The rack is a box shaped aluminum structure with dividers to provide individual compartments for each nut and washer. Each corner has a lug and shackle for attaching a 4-leg lifting sling.

The rack is designed in accordance with the "Aluminum Construction Manual" by the Aluminum Association, and for a safety factor of 5.

9.1.4.2.5.6 Head Stud Rack

The head stud rack is used for transporting and storage of up to 6 reactor pressure vessel studs. It is suspended from the auxiliary building crane hook when lifting studs from the reactor well to the operating floor.

The rack is made of aluminum to resist corrosion.

9.1.4.2.5.7 Dryer and Separator Strongback

The dryer and separator strongback is a lifting device used for transporting the steam dryer or the shroud head with the steam separators between the reactor vessel and the storage pools. The strongback consists of a cruciform shaped structure which is suspended from a hook pin assembly. On the end of each arm of the cruciform is a socket with a pneumatically operated pin for engaging the four lift eyes on the steam dryer or shroud head. Also, it is used for installation and removal of the MSL Plugs Restraint Ring when required.

9.1.4.2.5.8 RPV Head Strongback-Carousel and Adapter

The RPV Head Strongback-Carousel is an integrated piece of equipment consisting of a cruciform-shaped strongback, a circular monorail, and a circular storage tray. It is designed to perform functions formerly performed separately by Head Nut and Washer Racks, Head Strongback, and Stud Tensioner Monorail.

The strongback is a box beam structure with four (4) arms and a hook box in the center. An adapter is used as an interface between the hook box and the Reactor Building crane sister hook. Two (2) hook pins are used for hook box to adapter engagement, and two (2) more hook pins are used for adapter to crane sister hook engagement. On each of the four (4) arms, the strongback has a lift rod for engagement to the lift lugs on the RPV head. The circular monorail is mounted on the extensions of the strongback arms and four (4) additional arms equally spaced between the strongback arms. The monorail circle matches the stud circle of the reactor vessel and serves to suspend stud tensioners. The storage tray is suspended from the ends of the same eight (8) arms and surrounds the RPV head flange. It has provision for storage of nuts, washers and stud thread protectors.

All steel structure is designed in accordance with "The Manual of Steel Construction" by AISC or Crane Manufacturers Association of America (CMAA) Specification No. 70 as applicable. The welding is in accordance with the ASME Boiler and Pressure Vessel Code Section IX. A safety factor of 5 or greater with reference to the ultimate strength is used for the design. In addition, the strongback is designed such that one leg of the cruciform will support the maximum applied load without exceeding the stresses allowed by the specifications noted above (AISC or CMAA as applicable). The strongback lifting assembly is proof load tested to 125 (±2%) percent of the rated load. After the load test, all structural welds are magnetic particle tested. The aluminum structure for the nut rack is designed in accordance with the "Aluminum Construction Manual" by the Aluminum Association and for a minimum safety factor of 5 with reference to the ultimate strength.

9.1.4.2.5.9 Service Platform

The service platform is not used and has been eliminated.

The service platform is non-Seismic Class I equipment, and it has been designed for 0.75 g horizontal and 0.00 g vertical. The physical size of the device is such that it cannot enter the reactor pressure vessel.

9.1.4.2.5.10 Service Platform Support

The service platform support is not used and has been eliminated. A segmented aluminum seal surface protector supplied by CBI Nuclear serves as a protector for the reactor vessel flange.

9.1.4.2.5.11 Steam Line Plug Installation Tool

9.1.4.2.5.11.1 Steam Line Plug Installation Tool [REM*Light Model]

The main steam line plug with its integral installation tool assembly are remotely installed one at a time from the refueling platform using the monorail auxiliary hoist and the jet pump grapple.

The installation tool assembly, which remains in place, acts as a redundant restraint preventing the plug from inadvertently exiting the nozzle.

9.1.4.2.5.11.2 MSL Plugs Installation and Removal (I/R) Tool (Spring Disk Model) [Refuel Floor Wetlift System]

The MSL Plugs I/R Tool is attached to the rigid poles and suspended from the hoist of the Rigid Pole Handling System or the Reactor Building Crane auxiliary hoist for transporting, installing and removing the MSL Plugs in the steam line nozzles of the reactor vessel. The MSL Plugs I/R Tool can handle two MSL Plugs at a time and is designed to a factor of safety of 5 or greater in reference to the ultimate tensile strength of its materials.

9.1.4.2.5.12 Refuel Fuel Floor Auxiliary Platform (RFAP)

The Refuel Pool Auxiliary Platform is an electrically operated with manual backup, lightweight work platform. This is an engineered tool and it is operated on the existing refueling platform rails. It is a fully engineered clear span bridge for use as a portable work platform for personnel access over the reactor cavity, the spent fuel storage pools and the equipment pools.

9.1.4.2.5.13 360 Degree Refuel Work Platform

The 360 Degree Refuel Work Platform is a steel structure platform with a trough (partially submerged in the reactor cavity) to allow personnel occupancy while fuel moves occur with the Refueling Platform overhead. It is engineered tool which is lifted in and out of the reactor cavity and its support feet rest on the cavity shield block support ledge. Designated removable work carriages and a jib hoist can be attached to the trough and used for vessel servicing/inspections.

9.1.4.2.5.14 Jet Pump Plugs

The Jet Pump Plugs are used during reactor refueling or servicing; they are inserted in the Jet Pump nozzles from inside the reactor vessel to prevent flow of water from the reactor well into the Reactor Recirculation discharge lines. The Jet Pump Plugs are designed to withstand a differential pressure of 100 psi without ejecting. The Jet Pump Plugs are dynamically qualified to maintain their integrity during a seismic event.

9.1.4.2.6 In-Vessel Servicing Equipment

The multiple LPRM strongback attached to the reactor building crane auxiliary hoist is used to support up to eight LPRM assemblies during transfer to the reactor vessel. The LPRM assemblies are then transferred one at a time to the instrument handling tool for insertion into the reactor vessel. Water Seal Caps are installed under vessel prior to removal of an LPRM assembly to prevent loss of reactor coolant water during LPRM replacement.

The instrument strongback attached to the Reactor Building crane auxiliary hoist is used for servicing neutron monitor dry tubes should they require replacement. The strongback supports the dry tube during transfer to the vessel. The in-core dry tube is then decoupled from the strongback and is guided into place while being supported by the Instrument Handling Tool. Final in-core insertion is accomplished from below the reactor vessel. The instrument handling tool is attached to the refueling platform auxiliary hoist and is used for removing and installing fixed in-core dry tubes as well as handling neutrons source holders and the Source Range Monitor/Intermediate Range Monitor dry tubes.

Each in-core instrumentation guide tube is sealed by an O-ring on the flange and in the event that the seal needs replacing, an in-core guide tube sealing tool is provided. The tool is inserted into an empty guide tube and sits on the beveled guide tube entry in the vessel. When the drain on the Water Seal Cap is opened, hydrostatic pressure seats the tool. The flange can then be removed for seal replacement.

The auxiliary hoist on the refueling platform is used with appropriate grapples to handle control rods, flux monitor dry tubes, sources, and other internals of the reactor.

9.1.4.2.7 Refueling Equipment

Fuel movement and reactor servicing operations are performed from a platform which spans the refueling, servicing, and storage cavities.

Following description of refueling platform applies to both Unit 1 and Unit 2 except where indicated otherwise.

Either platform can be operated over either unit's reactor cavity. However, Unit 1 Refueling Platform is usually used for refueling of both units since this platform has enhanced operational capabilities.

9.1.4.2.7.1 Refueling Platform

The refueling platform is a gantry crane which is used to transport fuel and reactor components to and from pool storage and the reactor vessel (including pool to pool and core to core movements). The platform spans the fuel storage and vessel pools on rails bedded in the refueling floor. A telescoping mast and grapple suspended from a trolley system is used to transport and orient fuel bundles, for core, storage rack, or shipping cask placement. Control of the platform is from an operator station on the main trolley with a position indicating system provided to position the grapple over core locations. The platform control system includes indication to verify hook closed and grapple load and interlocks to prevent unsafe operation over the vessel during control rod movements, and limit vertical travel of the grapple. Two 1000 pound capacity auxiliary hoists, one main trolley mounted and one auxiliary trolley mounted, are provided for servicing such as LPRM replacement, fuel support replacement, jet pump servicing, and control rod replacement. The grapple in its normal up position provides about 8 feet 6 inches minimum water shielding over the active fuel of the bundle during transit.

The Unit 1 Refueling Platform has a computer based control system. This provides the capability to operate in Manual Control Mode, Semi-Automatic Mode, or Automatic Mode. The system also provides Boundary Zone Integration/Checking capability thereby preventing Refueling Mast interference with reactor vessel walls, reactor cavity walls, reactor core shroud, fuel pool walls, cattle chute, cask loading area, control rod brackets, or any other equipment programmed into the exclusion zone. All Boundary Zone controls and interlocks are active during automatic, semi-automatic and manual operations.

When using the opposite unit’s refueling platform on the refuel unit for fuel handling activities (U1 platform refueling U2 reactor and vice versa), the refuel unit’s idle platform may be powered from an alternate source which does not have the RMCS refuel interlock interface. When powered from the alternate source the refuel unit’s platform becomes an auxiliary work platform over the dryer-separator storage pool or reactor vessel. In this configuration, the Main Hoist on this work platform will be in a stowed position and therefore physically disabled from handling fuel. The Auxiliary Hoists (i.e., Frame and Monorail Hoists) on the work platform will be administratively controlled from operation in the vessel if the Steam Separator is removed. In addition to the RMCS refueling interlocks, any boundary zone or travel interlocks may also be defeated for the platform functioning as an auxiliary work platform.

The Refuel Floor Wetlift System's Rigid Pole Handling System is mounted on the monorail portion of either units Refueling Platforms and is a general purpose underwater pole system for use in the Refuel Floor Pools and Reactor Cavities. The Rigid Pole Handling System is based on a sectionally assembled, long handle tool for reactor vessel servicing that consists of a hoist, assembly work station, pole storage station, pole section and tools. The Rigid Pole Handling System provides the means for unlatching and latching of the Separator and supports the installation and removal of the MSL Plugs from the Refueling Platform with the Reactor Cavity flooded. The Rigid Pole Handling System is designed for a 2000 pounds load rating. The Rigid Pole Handling System is designed so that the assembly and its components retain structural integrity during seismic events to prevent its collapse into the Reactor Cavity or Refuel Floor Pools or dropping of suspended load. The Rigid Pole Handling System is designed to a factor of safety of 10 or greater in reference to the ultimate tensile strength of its materials.

9.1.4.2.8 Storage Equipment

Specially designed equipment storage racks are provided. Additional storage equipment is listed on Table 9.1-5. For fuel storage racks description and fuel arrangement, see Subsections 9.1.1 and 9.1.2.

Defective fuel rods may be stored in a fuel rod storage basket. The storage basket has physical dimensions similar to a fuel assembly, stainless steel tubes for storing individual fuel rods, and a handle for transporting. The fuel rod basket storage is stored in the spent fuel storage pool racks.

Defective fuel assemblies are placed in defective fuel storage containers, as necessary. These containers are stored in the multi-purpose storage container which is a part of the high density spent fuel racks.

Defective fuel storage containers can be picked up and moved with a fuel bundle in them. Channels can also be removed from the fuel bundle while in a defective fuel storage container. Defective individual fuel rods may be stored in a failed fuel rod holder.

The Fuel Pool Sipper may be used for out-of-core wet sipping at any time. They are used to detect a defective fuel bundle. The containers cannot be used for transporting a fuel bundle. The bail on the container head is designed not to fit into the fuel grapple.

9.1.4.2.9 Under Reactor Vessel Servicing Equipment

The primary functions of the under reactor vessel servicing equipment are to: (1) remove and install control rod drives, (2) service thermal sleeve and control rod guide tube, (3) install and remove the neutron detectors. Table 9.1-4 lists the equipment and tools required for servicing.

The control rod drive handling system (CRDHS) is a pneumatically powered device, designed for use in the under vessel gallery for the purpose of exchanging control rod drives. The capabilities of this system include: transport of the control rod drive (CRD) into the under vessel gallery, erection to the vertical position and installation of the CRD, removal of a CRD and reposition to horizontal, and transport out of the under vessel gallery. The system will also accept a spud end shield sleeve to be installed directly after withdrawal of the CRD from the housing. The system consists of two primary parts, the carriage and the winch cart. A pneumatic control stand is separate from these two parts and is attached only by hoses to the other two parts. No electrical systems are incorporated into this design.

The winch cart is the heart of the motive forces of the system. Twin stainless steel aircraft cables are wound on and off twin cable drums. The cable drums are driven by an air motor through a self-locking worm gear box. These cables perform two functions: (1) raise/lower the elevator and (2) rotate the carriage from horizontal to vertical and back. The two cables provide a redundant safety feature; either cable can safely support the CRD in the unlikely event of a cable failure. The cables are retained in the grooves of the drums by the pressure of spring-loaded rollers. This prevents the cables from disengaging from the drums should they become slack. Thus the lifting components are equipped with adequate features to prevent uncontrolled movement upon loss of air or component failure.

The CRDHS was designed as non-safety related equipment in accordance with NES, inc. Quality Assurance requirements as spelled out in NES Proposal 8660-283, dated 2/4/87. There were no specific industry codes or standards identified in design and construction of this system.

The equipment handling platform is powered electrically and provides a working surface for equipment and personnel performing work in the under vessel area. It is a polar platform capable of 360° rotation. This equipment is designed in accordance with the applicable requirements of OSHA (Vol. 37, No. 202, Part 191 ON), AISC, ANSI-C-1, (National Electric Code).

The thermal sleeve installation tool locks, unlocks, and lowers the thermal sleeve from the control rod drive guide tube. The key bender is designed to install and remove the anti-rotation key that is used on the thermal sleeve.

The in-core flange seal test plug is used to determine the pressure integrity of the in-core flange O-ring seal. It is constructed of non-corrosive material.

9.1.4.2.10 Fuel Transfer Description

9.1.4.2.10.1 Arrival of Fuel on Site

New fuel arrives in the railway bay of the reactor building Unit 1 either by railcar or truck or the reactor building Unit 2 by truck in the truck bay. The access doors are closed to maintain the secondary containment as required by Technical Specifications. Unloading of the shipping containers is done by the auxiliary hoist of the Unit 1 or Unit 2 reactor building cranes.

9.1.4.2.10.2 Refueling Procedure

Fuel handling procedures are described below and shown visually in Figures 9.1-20, 9.1-21, and 9.1-22. The Refueling Floor Layout is shown on Drawing C-1807, Shts. 1 & 2, and component drawings of the principal fuel handling equipment are shown in Figures 9.1-9 through 9.1-16 and Figure 9.1-23.

The fuel handling process takes place primarily on the refueling floor above the reactor. The principal locations and equipment are shown on Drawing C-1807, Shts. 1 & 2. The reactor, fuel pool, and shipping cask pool are connected to each other by transfer slots.

The reactor cavity/fuel pool slot is opened to allow for vessel refueling. The fuel pool/cask storage pit slot is normally open to allow transfer of spent fuel bundles and other irradiated components from the fuel pool to a shipping cask or to the other fuel pool. At other times, the fuel pool slot is closed to hydraulically isolate the fuel pools from the reactor cavity via watertight gates. Additionally, radiological shielding from the spent fuel may be provided via the installation of removable blocks in the slots.

The handling of new fuel on the refueling floor is illustrated in Figure 9.1-20. The transfer of the bundles between the shipping container (C) and the new fuel inspection stand (D) and/or the new fuel storage vault (E) is accomplished using 5-ton auxiliary hoist of the Unit 1 or Unit 2 reactor building crane or a half-ton floor mounted refueling jib crane equipped with a general-purpose grapple or nylon sling. The fuel bundle cannot be handled horizontally without support, so the shipping container is placed in an almost vertical position before being opened. The container is opened, and the bundles removed in a vertical position.

The auxiliary hoist of the Unit 1 or Unit 2 reactor building crane or the jib crane are also used with a general-purpose grapple or nylon sling to transfer new fuel from the new fuel vault or inspection stand to the fuel pool. From this point on, fuel bundles are handled by the telescoping grapple on the refueling platform.

The storage racks in both the vault and the fuel pool hold the fuel bundles or assemblies in a vertical position.

The new fuel inspection stand holds one or two bundles in vertical position. The Inspector(s) ride up and down on a platform, and the bundles are manually rotated on their axes. Thus the inspectors can see all visible surfaces on the bundles. The general-purpose grapples and the fuel grapple of the refueling platform have redundant hooks, and an indicator which confirms that the grapple hooks are in the closed position.

The refueling platform uses a grapple on a telescoping mast for lifting and transporting fuel bundles or assemblies. The telescoping mast can extend to the proper work level; and, in its normal up position state, maintains adequate water shielding over the fuel being handled.

The reactor refueling procedure is shown schematically in Figure 9.1-21. The refueling platform (G) moves into position over a fuel assembly, lowers the grapple on the telescoping mast (H) and engages the bail on a fuel assembly. The assembly is lifted clear of the interferences and moved into position over its new location. The mast then lowers the assembly into the selected location and the grapple releases the bail. This same process is repeated to complete all required fuel moves. Fuel assemblies can be moved in this manner from one core (J) location to another if an in-core shuffle is being performed, between the core and a fuel pool location (F, K) or between the Unit 1 and Unit 2 fuel pools.

If the fuel assembly is to be dechanneled from the fuel prep machine, an operator, using a long-handled wrench, removes the screw(s) and springs from the top of the channel. The channel is then held, while a carriage lowers the fuel bundle out of the channel. The channel is then moved aside and stored. If required, the refueling platform grapple can carry the unchanneled bundle and place it in a storage rack. The channel handling boom hoist, (L) moves the channel to storage, if appropriate.

A channel rack is conveniently located near to the fuel prep machines, for storage of channels. Refer to Section 9.1.4.2.10.2.12 for discussion on new fuel channeling.

To preclude the possibility of raising radioactive material out of the water, redundant electrical limit switches are incorporated in the auxiliary hoists of the refueling platform and the jib crane hoist, and interlocked to prevent hoisting above the preset limit. In addition, the cables on the hoists incorporate adjustable stops that are intended to jam the hoist in the event of limit switch failure.

When spent fuel is to be shipped, it is placed in a cask, as shown in Figure 9.1-22. The refueling platform grapples a fuel bundle from the storage rack in the fuel pools, lifts it, carries it through slot (B) into the shipping cask pool, and lowers it into the cask, (M). When the cask is loaded, the Unit 1 single failure proof reactor building crane sets the cask cover (N) on the cask. After partially draining the shipping cask pool, the cask is lifted onto the refueling floor, decontaminated and lowered through the open hatchways, (P), onto the truck or railcar in the railway bay at grade level by the Unit 1 single failure proof reactor building crane only.

Provision of a separate cask loading pool, capable of being isolated from the fuel storage pool, eliminates the potential accident of dropping the cask and rupturing the fuel storage pool.

Additional detailed information is provided below.

9.1.4.2.10.2.1 New Fuel Preparation

9.1.4.2.10.2.1.1 Receipt and Inspection of New Fuel

The incoming new fuel will be delivered to the site. The shipping containers should be unloaded from the transport vehicle and examined for damage during shipment. Each outer shipping container contains two fuel bundles supported by an inner metal container. The metal inner containers are removed from the outer shipping containers. The metal inner containers are then moved to the reactor building where they are lifted to the refueling floor. Both inner and outer shipping containers are reusable. Lifting of the metal inner containers to the refuel floor is to be accomplished by use of the reactor building crane extending down from the refueling floor through the appropriate equipment hatch.

9.1.4.2.10.2.1.2 Channeling New Fuel

Typically new fuel is channeled in the inspection stand. If desired, new fuel can be channeled in the fuel pool using the fuel prep machine. Also, prior to shipment, fuel assemblies may have been channeled by the fuel manufacturer. The channeled new fuel is then stored in the new fuel vault or in the pool storage racks ready for insertion into the reactor.

9.1.4.2.10.2.1.3 Equipment Preparation

Prior to use for refueling, all equipment must be placed in readiness. All tools, grapples, slings, strongbacks, stud tensioners, etc., should be given a thorough check and any defective (or well worn) parts should be replaced. Air hoses on grapples should be routinely leak tested. Crane cables should be routinely inspected. All necessary maintenance and interlock checks should be performed to assure no extended outage due to equipment failure.

The in-core flux monitors, in their shipping container, should be on the refueling floor. The channeled new fuel and the replacement control rods should be ready.

9.1.4.2.10.2.2 Reactor Shutdown

The evolutions and sequence for reactor shutdown are controlled via appropriate plant procedure(s). Generally, the reactor sequence is as follows (Note: The following evolutions can be performed as required (i.e., series or parallel evolutions) as directed via the appropriate procedures):

a) Reactor shutdown with all control rods inserted (controlled shutdown and/or scram).

b) De-inert the Drywell and Suppression Chamber.

c) Remove reactor well shield plugs (2 layers) when plant conditions allow. (The layers do not have to be removed at the same time). The eight reactor well shield plugs are removed via the reactor building crane.

This operation can be immediately followed by removal of the three canal plugs and the three slot plugs. Thus, a total of 14 separate plugs must be removed and placed on the refueling floor. Refer to Drawing C-1807, Shts. 1 & 2 for placement of these plugs on the refueling floor.

9.1.4.2.10.2.2.1 Drywell Head Removal

Immediately after removal of the reactor well shield plugs, the work to unbolt the drywell head can begin. The drywell head is attached by removable bolts protruding from the lower drywell flange. The nuts on top are merely loosened and the bolt heads swing outward. The bolts are then pulled upwards and supported with the nuts on a slotted lip of the head.

The main hoist hook of the Unit 1 or Unit 2 reactor building crane is attached to the hook box on top of the unbolted drywell head which is lifted to its appointed storage space on the refueling floor.

9.1.4.2.10.2.2.2 Reactor Well Servicing

When the drywell head has been removed, an array of piping is exposed that must be serviced. Various vent piping penetrations through the reactor well must be removed and the penetrations made water tight.

Vessel head piping and head insulation must be removed and transported to storage on the refueling floor. Water level in the reactor vessel is now brought to flange level in preparation for head removal.

9.1.4.2.10.2.3 Reactor Vessel Opening

9.1.4.2.10.2.3.1 Vessel Head Removal

9.1.4.2.10.2.3.1.1 Vessel Head Removal Using RPV Head Strongback/Carousel

The RPV head strongback/carousel is transported by the Unit 1 or Unit 2 reactor building crane and positioned on the reactor vessel head. Each stud is detensioned and its nut loosened. When the nuts are loose, they are backed off using a nut runner. The nuts and washers are placed in the integral nut rack on the strongback/carousel. With the nuts and washers removed, the vessel stud protectors and vessel head guide caps are installed. The four to six studs in line with the fuel transfer canal are removed from the vessel flange. The removed studs may be placed in the racks and transported to the refueling floor for storage. As an alternative, they may be stored in the vessel head and transported with the head.

The Unit 1 reactor building crane is used to lift the head and transport it to the head holding pedestals on the refueling floor. The head holding pedestals keep the vessel head elevated to facilitate inspection and "0" ring replacement.

9.1.4.2.10.2.3.2 Dryer Removal

9.1.4.2.10.2.3.2.1 Dryer Removal

Dryer Removal Using Dryer and Separator Strongback

With the Reactor Cavity flooded, or while flooding the Reactor Cavity, the Dryer and Separator Strongback is lowered by the Unit 1 and Unit 2 Reactor Building Crane and attached to the Dryer lifting lugs. The Dryer is lifted from the reactor vessel and transported underwater to its storage location in the Dryer-Separator Storage Pool adjacent to the Reactor Cavity by the corresponding unit's Reactor Building Crane.

9.1.4.2.10.2.3.3 Separator Removal

9.1.4.2.10.2.3.3.1 Separator Removal Using Dryer and Separator Strongback

From the Refueling Platform, using the lightweight shroud head bolt wrench mounted on the handrail bracket, or shroud head bolt wrenches suspended from the Rigid Pole Handling System's hoist or Reactor Building Cranes' auxiliary hoists, the Separator is unlatched. With the reactor Cavity flooded, the Dryer and Separator Strongback is lowered by the Unit 1 and Unit 2 Reactor Building Crane and attached to the Separator lifting lugs. The Separator is lifted from the reactor vessel and transported underwater to its storage location in the Dryer-Separator Storage Pool adjacent to the Reactor Cavity by the corresponding unit's Reactor Building Crane.

9.1.4.2.10.2.3.4 Fuel Bundle Sampling

During reactor operation, the core off-gas radiation level is monitored. If an excessive rise in off-gas activity has been noted, the suspect assemblies can be sampled during shutdown to locate any leaking fuel assemblies. The fuel sampler or sipper rests on the channels of a four bundle array in the core. An air bubble is pumped into the top of the 4 fuel bundles and allowed to stay about 10 minutes. This stops water circulation through the bundles and allows fission products to concentrate if a bundle is defective. After 10 minutes, a water sample is taken for fission product analysis. If a defective bundle is found, it is taken to the fuel pool and if required, may be stored in a special defective fuel storage container to prevent the spread of contamination in the pool. Alternately, suspect assemblies can be sipped using the fuel pool sipper described in Section 9.1.4.2.3.5.

9.1.4.2.10.2.4 Refueling and Reactor Servicing

The two fuel pool gates isolating the fuel pool from the reactor well are now removed thereby interconnecting the fuel pool, the reactor well, and the dryer-separator storage pool. The gate strong back is attached to the gate lifting lugs and the Unit 1 or Unit 2 reactor building crane lifts the gate and places it on the fuel pool gate storage lugs. The actual refueling of the reactor can now begin.

9.1.4.2.10.2.4.1 Refueling

The actual fuel handling is done with the fuel grapple which is an integral part of the refueling platform. The platform runs on rails over the fuel pool and the reactor well. In addition to the fuel grapple, the refueling platform is equipped with two auxiliary hoists which can be used with various grapples to service other reactor internals.

To move fuel in the core, the fuel grapple is aligned over the fuel assembly, lowered and attached to the fuel bundle bail. The fuel bundle is raised out of the core, moved to another core location or moved through the refueling slot to the fuel pool, positioned over the storage rack and lowered to storage. Fuel is moved from the storage pool to the reactor vessel in the same manner. Although described sequentially, simultaneous movement in three axes is not prohibited (Unit 1 only).

9.1.4.2.10.2.5 Vessel Closure

The evolutions and sequence for reactor reassembly are controlled by appropriate plant procedure(s). Generally, the sequence is as follows.

Vessel closure is performed with the equipment described above. The service platform supplied with the Nuclear System is not used and has been eliminated.

The following steps are a typical sequence that will return the reactor to operating condition. The procedures are the reverse of those described in the preceding Sections. Many steps are performed in parallel.

a) Core verification. The core position of each fuel assembly must be verified to assure the desired core configuration has been attained.

b) Control rod drive tests. The control rod drive timing, friction and scram tests are performed.

c) Remove the MSL Plugs Restraint Ring.

d) Replace Separator with corresponding unit's Reactor Building Crane and latch Separator using Rigid Pole Handling System and a Refueling Platform or Reactor Building Crane hoist.

e) Remove MSL Plugs from reactor vessel using Rigid Pole Handling System.

f) Replace Dryer with corresponding unit's Reactor Building Crane.

g) Close Fuel Pool gates.

h) Drain Reactor Cavity and Dryer-Separator Storage Pool.

i) Decontaminate Reactor Cavity.

j) Remove seal surface protector from the vessel flange and remove refueling shield (cattle chute).

k) Decontaminate dryer-separator storage pool.

l) Replace vessel studs.

m) Install reactor vessel head with Unit 1 reactor building crane.

n) Install vessel head piping and insulation.

o) Replace equipment pool and refueling slot shield plugs.

p) Hydro-test vessel, if necessary.

q) Open drywell vents, install vent piping.

r) Install drywell head with Unit 1 or Unit 2 reactor building cranes.

s) Inert reactor drywell and suppression chamber.

t) Install reactor well shield plugs with Unit 1 or Unit 2 Reactor Building Cranes.

u) Startup tests. The reactor is returned to full power operation. Power is increased gradually in a series of steps until the reactor is operating at rated power. At specific steps during the approach to power, the in-core flux monitors are calibrated.

9.1.4.2.10.3 Departure of Spent Fuel from Site

This Section describes the departure of spent fuel from the site.

Departure of the spent fuel stored at the Independent Spent Fuel Storage Installation (ISFSI) from the site will require that the Dry Shielded Canister (DSC) be extracted from the ISFSI Horizontal Storage Module (HSM) and returned to the Reactor Building Spent Fuel Storage Pools. Subsequent departure of this spent fuel from the site is described below.

The spent fuel shipping cask arrives by railcar or truck in the railway bay of the reactor building Unit 1. It is lifted from there by the main hoist 125 ton hook of the Unit 1 single failure proof reactor building crane through the floor openings to the refueling floor and placed into the empty shipping cask pit between the fuel pools of the Unit 1 and Unit 2 Reactor Building.

The cask outside is decontaminated from road dirt and the lid removed by the Unit 1 single failure proof reactor building crane. If the cask pit gates are installed and the cask pit is not filled, one of the inner gates of the shipping cask pit is removed. After filling of the shipping cask pool, the second gate to one of the fuel pools is removed and loading of the cask with irradiated fuel commences. The refueling platform is used to transfer fuel bundles of sufficiently low decay heat level from the spent fuel storage racks underwater into the shipping cask.

Following replacement of the cask lid, the gates to the fuel pool are inserted, the shipping cask pit drained and the cask outside decontaminated. The Unit 1 single failure proof reactor building crane then transfers the cask from the storage pit onto the shipping vehicle where a cooling system dissipates the remaining decay heat of the fuel during transport.

9.1.4.3 Safety Evaluation

9.1.4.3.1 Spent Fuel Cask

This Section applies to a spent fuel cask used to transfer spent fuel to an off-site storage or reprocessing facility. The On-Site Transfer Cask used to transfer spent fuel to the on-site Independent Spent Fuel Storage Installation (ISFSI) is described in Section 11.7.6.1.

The spent fuel cask is equipped with dual sets of lifting lugs and yokes compatible with the Unit 1 reactor building crane redundant main hook, thus preventing a cask drop due to a single failure. An analysis of the spent fuel cask drop is therefore not required.

9.1.4.3.2 Reactor Building Crane

See Subsection 9.1.5.3 for the reactor building crane safety evaluation.

9.1.4.3.3 Fuel Servicing Equipment

Failure of any fuel servicing equipment listed in Table 9.1-2 poses no hazard beyond the effect of the refueling accident analyzed in Chapter 15.

Safety aspects (evaluation) of the fuel servicing equipment are discussed in Subsection 9.1.4.2.3.

9.1.4.3.4 Servicing Aids

The small manual devices listed in Table 9.1-5 facilitate underwater viewing and handling of fuel. Failure of any servicing aid does not pose any hazard beyond the effect of the refueling accident.

9.1.4.3.5 Reactor Vessel Servicing Equipment

The effects of postulated load drops of the steam dryer, steam separator and the vessel head have been analyzed in accordance with NUREG 0612. These analyses are documented in calculations which have been performed as part of the SSES Heavy Loads Program. The structural effects of the limiting postulated drops along the load paths utilized for these lifts were found to be within defined acceptance limits. The results of these evaluations conclude that the 4 general criteria identified in Section 5.1 of NUREG 0612 are satisfied. Use of the dryer/separator strongback, the vessel head strongback, and the head strongback/carousel is therefore in compliance with the NUREG.

The reactor vessel heads are transported as equivalent single failure proof lifts using the Unit 1 Reactor Building single failure proof crane. Refer to FSAR Section 9.1.6.4.2

The Refuel Floor Auxiliary Platform and the 360 Degree Refuel Work Platform are designed to preclude them from becoming Safety Impact Items. Lifting of the RFAP and the 360 Degree Refuel Work Platform to the Refuel Floor and on the Refuel Floor will be in accordance with the SSES Heavy Loads Program. Use of the jib hoist on the 360 Degree Refuel Platform is limited to loads less than 1000 pounds (not a Heavy Load) and does not pose any hazard beyond the effect of the refueling accident.

9.1.4.3.6 In-Vessel Servicing Equipment

Failure of any in-vessel servicing equipment listed in Table 9.1-5 poses no hazard beyond the effect of the refueling accident analyzed in Chapter 15.

9.1.4.3.7 Refueling Equipment

The most severe failure of the refueling platform and associated grapple and hoists results in the dropping of a fuel assembly onto the reactor core. This refueling accident is analyzed in Chapter 15.

Safety aspects of the refueling equipment are discussed in Subsection 9.1.4.2.7. A description of fuel transfer, including appropriate safety features, is provided in Subsection 9.1.4.2.10. In addition, the following summary safety evaluation of the fuel handling system is provided below.

The fuel prep machine can be used to remove and install channels with all parts remaining under water. Mechanical stops prevent the carriage from lifting an irradiated fuel bundle or assembly to a height where water shielding is less than 7 feet. Irradiated channels, as well as small parts such as bolts and springs, are stored underwater. The spaces in the channel storage rack have center posts which prevent the loading of fuel bundles into this rack.

There are no nuclear safety problems associated with the handling of new fuel bundles, singly or in pairs. Equipment and procedures prevent an accumulation of more than two bundles in any location.

The refueling platform and the Refuel Floor Wetlift System's Rigid Pole Handling System are designed to prevent them from toppling into the pools during a SSE.

The grapple utilized for fuel movement is on the end of a telescoping mast. At retraction of the mast to its normal hoist position for fuel transport, the top of the active fuel of the bundle is about 8.5' below the water surface, which provides water shielding consistent with radiation zone designations established in Chapter 12. The grapple is hoisted by redundant cables inside of the mast; and is lowered by gravity. A digital readout is displayed to the operator, showing him the exact coordinates of the grapple over the core.

The mast is suspended and gimbaled from the trolley, near its top, so that the mast can be swung about the axis of platform travel, in order to remove the grapple from the water for servicing and for storage.

The grapple has dual hooks designed for fail safe (closed) operation with hook closed position indicated to the operator. The mechanical design of the grapple hook is such that grapple disengagement is prevented until the fuel assembly is seated.

In addition to the main hoist on the trolley, there is an auxiliary hoist on the trolley, and another hoist on its own monorail. These three hoists are precluded from operating simultaneously, because control power is available to only one of them at a time.

The Refuel Floor Wetlift System's Rigid Pole Handling System hoist's power is supplied from the Refueling Platform's Monorail Auxiliary hoist. These two hoists can be operated at the same time if required.

The two auxiliary hoists have mechanically actuated electrical limit switches, which are set to maintain water shielding over irradiated loads consistent with radiation zone designations established in FSAR Chapter 12. Adjustable mechanical stops attached to the hoist cables are intended to jam the hoist in the event of limit switch failure.

In summary, the fuel handling system complies with Regulatory Guide 1.13 (12/75), General Design Criteria 2, 3, 4, 5, 61, 62, and 63, and applicable portions of 10CFR50.

A system-level, qualitative-type failure mode and effects analysis relative to this system is discussed in Subsection 15A.6.5.

9.1.4.3.8 Storage Equipment

The safety evaluation of the new and spent fuel storage is presented in Subsections 9.1.1.3 and 9.1.2.3.

9.1.4.3.9 Under Reactor Vessel Servicing Equipment

Failure of any under reactor vessel servicing equipment poses no hazard in excess of the effects of accidents analyzed in Chapter 15.

9.1.4.4 Inspection and Testing Requirements

9.1.4.4.1 Inspection

Much of the refueling and servicing equipment is subject to the strict controls of quality assurance, incorporating the requirements of federal regulation 10CFR50, Appendix B. Components defined as essential to safety, such as the fuel storage racks and refueling platform have an additional set of engineering specified, "quality requirements" that identify safety-related features which require specific QA verification of compliance to drawing requirements.
Prior to shipment, all quality requirements are reviewed by QA personnel and combined into a summary product quality checklist. The quality checklist provides confirmation of the quality requirements for each product.

9.1.4.4.2 Testing

Prior to multi-unit fabrication, major pieces of refueling or servicing equipment are fabricated and tested as prototype units. These units are tested to specifications defined by the responsible design engineer and implemented by a test engineering organization. In many cases, a full design review of the product is conducted before and after the testing cycle.

Any design changes affecting function, that are made after the design review of the qualification testing has been completed, are reverified by test or calculation.

When the unit is received at the site, it is inspected by quality assurance personnel to ensure that no damage has occurred during transit or storage. Prior to site operation, the refueling or servicing equipment must undergo a sequence of preoperational functional tests, as defined by a site preoperational test specification.

Fuel handling and vessel servicing equipment was preoperationally tested in accordance with Chapter 14.

Tools and servicing equipment used for refueling are inspected and preoperationally performance tested prior to use.

9.1.4.5 Instrumentation Requirements

The majority of the refueling and servicing equipment is manually operated and controlled by the operator's visual observations. This type of operation does not necessitate the need for a dynamic instrumentation system.

However, there are several components that are essential to prudent operation that do have instrumentation and control systems.

9.1.4.5.1 Refueling Platform

The refueling platform has a non-safety related X-Y-Z position indicator system that informs the operator which core fuel cell the fuel grapple is accessing. Refueling Platform interlocks and a control room operator monitoring fuel moves are used to prevent the fuel grapple from operating in a fuel cell where the control rod is not fully inserted. Refer to Subsection 7.6.1.1 for discussion of refueling interlocks.

Additionally, there are a series of mechanically activated switches that provide indications on the operator's console for grapple limits, hoist and cable load conditions, and confirmation that the grapple's hook is either open or closed.

A series of load cells are installed which provide interlocks that restrict hoist movements whenever threshold limits are exceeded on either the fuel grapple or the auxiliary hoist units and the Rigid Pole Handling System hoist.

9.1.4.5.2 Fuel Support Grapple

Although the Fuel Support Grapple is not essential to safety, it has an instrumentation system consisting of mechanical switches and indicator lights. This system provides the operator with a positive indication that the grapple is properly aligned and oriented and that the grappling mechanism is either extended or retracted. The control rod/fuel support piece (CR/FSP) combination grapple is similar to the fuel support grapple, with the exception that it uses mechanical indicators.

9.1.4.5.3 Other

Refer to Table 9.1-5 for additional refueling and servicing equipment not requiring instrumentation.

9.1.4.5.4 Radiation Monitoring

The area radiation monitoring equipment for the refueling area is described in Subsection 12.3.4.

9.1.5 REACTOR BUILDING CRANES

Two reactor building cranes are provided for the Susquehanna SES. Unit 1 crane is a single failure-proof crane and is designed to handle the spent fuel cask as well as refueling and vessel service load requirements for Unit 1 or Unit 2. The Unit 2 crane is not single failure-proof and is designed to handle construction loads as well as refueling and vessel service load requirements for Unit 1 or Unit 2 except the reactor vessel heads, spent fuel cask and On-Site Transfer Cask.

The Unit 2 reactor building crane, rated 125 tons (main hoist), 5 tons (auxiliary hoist) is capable of carrying any loads within its rated capacity. Load carrying over or within restricted areas of the refueling floor must be in accordance with the limits established for those areas. (Reference Drawing C-1807, Shts. 1 & 2.)

Administrative controls are used to preclude the Unit 2 reactor building crane from being used for handling the reactor vessel heads and the spent fuel cask and On-Site Transfer Cask when stored in the spent fuel shipping cask storage pit.

9.1.5.1 Design Bases

The main purpose of the Unit 1 single failure proof reactor building crane is to handle the reactor vessel heads and the spent fuel cask and On-Site Transfer Cask between the cask transport vehicle, the cask storage pit, and the wash-down area in the reactor building. Secondary purposes of the Unit 1 and Unit 2 reactor building cranes include:

a) Handling loads related to maintenance and replacement of equipment from the reactor building which are received or shipped through the railroad or truck bay access doors for either Unit 1 or Unit 2.

c) Handling of shield plugs, drywell heads, steam dryer and separator, etc, during refueling operations.

The reactor building crane is designed for the following ratings:

Main Hoist Capacity	125 tons	
Auxiliary Hoist Capacity	5 tons	
Speed of Main Hoist (Critical - at rated load)	5 fpm	
Speed of Main Hoist (Non-Critical)	7 fpm	(see Note 1)
Speed of Auxiliary Hoist (Critical - at rated load)	20 fpm	
Speed of Auxiliary Hoist (Non-Critical)	28 fpm	(see Note 1)
Speed of Trolley (Critical)	30 fpm	
Speed of Trolley (Non-Critical)	50 fpm	
Speed of Bridge	50 fpm	
Lift of Main Hook	173 ft (min.)	(see Note 2)
Lift of Auxiliary Hook	173 ft (min.)	
Crane Span	130 ft (approx.)	
Length of Runway (between stops)	323 ft (approx.)	
Uncontrolled Drop		
Main Hoist	0.5 in. (max.)	
Auxiliary Hoist	8.55 in. (max.)	

<u>Note 1</u>: The non-critical mode of operation provides the additional speed range of 5 to 7 fpm with administratively controlled load limits of 40 tons for the main hoist and 20 to 28 fpm and 2 tons for the auxiliary hoist.

<u>Note 2</u>: Unit 2 reactor building crane ratings are identical to those of the Unit 1 crane, except for the main hook lift, which is 68 ft. This, in addition to administrative controls, precludes inadvertent use of the Unit 2 crane for spent fuel cask handling, since the main hook cannot lower the spent fuel cask to the truck bay on Elevation 670.

The auxiliary hooks of both cranes are designed for use underwater, up to 50 ft. depth.

<u>9.1.5.2 Equipment Design</u>

a) <u>General</u>

The Unit 1 and Unit 2 reactor building cranes are designed, fabricated, installed, and tested in accordance with ANSI B30.2.0, CMAA-70, and OSHA regulations.

b) <u>Structural</u>

The structural portions of the crane bridge and trolley are designed for (1) dead load plus rated lift load plus impact load of 15 percent of the total dead plus rated live loads, not to exceed allowable stresses; (2) dead load plus rated lift load plus a lateral load of 10 percent of the total dead plus rated live loads, not to exceed allowable stresses; (3) the operating basis earthquake (OBE) while lifting the rated load, the working stresses not to exceed 125 percent of the allowable stress; (4) the design basis earthquake (DBE) while lifting the rated load, the allowable stresses to be less than 90 percent in bending, 85 percent in axial tension, and 50 percent in shear of the material minimum yield stresses; (5) a tornado loading of 300 psf, without live load, the allowable stresses to be the same as for (4) above.

The structure of the crane bridge consists of welded box type girders with truck saddles and truck frames of welded steel construction. The trolley side frames, sheave frames, and truck frames are of structural steelwelded construction.

c) <u>Mechanical-General</u>

The Unit 1 and Unit 2 reactor building cranes are of a single trolley top running electric overhead travelling bridge design.

d) <u>Mechanical-Unit 1</u>

The Unit 1 reactor building crane main hoist is provided with the following dual components preventing a single failure to result in a drop of the spent fuel shipping cask:

1) Dual sister hook (hook within a hook).

2) Dual reeving systems complete with redundant wire ropes, upper, lower, and equalizing sheaves.

3) Dual main hoist gear boxes with individual braking systems.

Each wire rope has a safety factor of five against breaking while lifting the rated capacity. In case of failure of one of the two reeving systems, the dynamic load transfer to the other system will not cause the rope load to exceed one-third of the rope breaking strength.

The following holding brakes are provided:

Main hoist	Three, rated for 150 percent of the motor torque, with provision for manual operation to allow lowering of the load after a power failure.
Trolley	Two, one rated at 100% and the other rated 150% of the trolley drive motor torque at the point of application.
Bridge	One, rated for 100 percent of motor torque for each of the two bridge motors.

All holding brakes are ac or dc magnet operated and must be energized to release them.

e) Controls-Unit 1

Trolley	AC Adjustable frequency scalar control (open loop) with inherent reversing plugging control.
Bridge	Adjustable frequency vector control (closed loop) with inherent reversing plugging control.
Hoists	AC Adjustable frequency vector control (closed loop) including dynamic braking, with minimum speed of less than 0.1% of rated speed.

Operation of the crane is from the bridge mounted cab or floor. The floor operation is by radio control. Control at any one time is from one point only.

f) Mechanical-Unit 2

The Unit 2 reactor building crane is provided with the following components and is not designed to any single failure criteria:

1) Single Hook.

2) One set of 6 part double reeving system composed of a single wire rope, upper and lower sheaves.

3) Single main hoist gear box with single braking system composed of a primary brake and a time delayed secondary brake.

The single wire rope has a safety factor of five against breaking while lifting the rated capacity. The wire rope type used for Unit 2 will be identical to that used for Unit 1.

The following holding brakes are provided:

Main Hoist	Two brakes rated for 150 percent of the motor torque, with provision for manual operation to allow lowering of the load after a power failure.
Trolley	Two, one rated at 100% and the other rated at 50% of the trolley drive motor torque at the point of application.
Bridge	One brake rated for 100 percent of motor torque for each of the two bridge motors.

All holding brakes are AC or DC magnet operated and must be energized to release them.

g) Controls-Unit 2

Trolley	AC Adjustable frequency scalar control (open loop) with inherent reversing plugging control.
Bridge	Adjustable frequency vector control (closed loop) with inherent reversing plugging control.
Hoists	AC Adjustable frequency vector control (closed loop) including Dynamic braking, with minimum speed of less than 0.1% of rated speed.

Operation of the crane is from the bridge mounted cab or floor. The floor operation is by radio. Control at any one time is from one point only.

9.1.5.3 Safety Evaluation

As described in Subsection 9.1.5.2, the Unit 1 Reactor Building Crane main hoist is provided with dual main hoist components capable of holding the load in the event of a single failure.

An overspeed switch activating all spring set motor brakes in the lowering direction holds the load in suspension in the Critical and Non-Critical modes of operation.

See Section 3.13 for discussion of compliance with Regulatory Guides 1.104 and 1.13.

See Appendix 9B for a discussion of compliance with BTP ASB9-1.

A dillon load switch is provided under the equalizer to prevent the Unit 1 Reactor Building Crane from lifting loads in excess of 110% of its rated capacity.

The Unit 1 and Unit 2 reactor building cranes are provided with limit switches to prevent overtravel of the bridge and trolley and stop the main and auxiliary hooks in their highest and lowest safe positions.

Two limit switches, each of different design, are provided to limit the upward movement of the main and auxiliary hoist.

Two geared limit switches are provided for the main hoist, and one for the auxiliary hoist to limit the downward movement of the respective hoists except that the Unit 2 reactor building crane has only one geared limit switch to limit downward movement of the main hoist and auxiliary hoist.

When the 125-ton hook is not in the parked upper position, movement of the crane bridge and/or trolley will be stopped when entering the Zone “B” restricted areas shown on Drawing C-1807, Shts. 1 & 2. It can be used in the Zone “A” areas of Drawing C-1807, Shts. 1 & 2 when the key-locked zone bypass switch is used in accordance with administrative guidance.

The trolley and bridge motion of the crane is equipped with non-contact distance sensor(s). Position information is obtained via measurement of the speed of light from the sensor head to a reflector and back to the sensor head. This information is serially input to a Programmable Logic Controller which in turn prevents entry into a controlled zone. The respective motion will be permitted to reverse out of the restricted zone.

Administrative controls prevent placing the hoist in the upper parked position with a load suspended.
A key locked bypass switch is provided in the cab, with an additional selector switch on the radio controller that is disabled or enabled by a locked bypass switch in the cab, to allow the use of the main hoist over the RPV area for handling shield plugs, RPV and drywell heads, steam dryer/separator, etc.

Crane motor overload protection is provided by an electrical cut-out on the hoist drive motor.

The results of a failure mode and effect analysis are presented in Tables 9.1-6a and 9.1-6b for the Unit 1 and Unit 2 reactor building cranes.

The Unit 1 and Unit 2 reactor building cranes are safety related and a quality assurance program has been established and implemented on their design, fabrication, erection, and testing.

The Unit 1 and Unit 2 reactor building cranes are designed to remain on the runway in a parked and restrained position (by tornado locks) with no load attached under the following tornado wind loadings:

a) 300 psf on the windward crane girder

b) ±200 psf on the leeward crane girder.

The Unit 1 and Unit 2 reactor building crane mechanical and structural components are qualified to Seismic Category I requirements. They may become and remain inoperative after the operating basis earthquake, but no parts or the load will dislodge or fall. Manual lowering of the main hoist load is provided.

9.1.5.4 Inspection and Testing Requirements

The following Unit 1 and Unit 2 reactor building crane components tests were performed during the crane fabrication as follows:

a)	Each hook:	Ultrasonic tests 200 percent load test followed by dimensional check Dry powder magnetic particle test.
b)	Wire rope:	Rope sample destructive breaking test.
c)	Gears, gear pinions, swivels, load block frames, hook trunnions, seismic restraints, and tornado locks:	Magnetic particle tests.
d)	Major structural welds:	100 percent magnetic particle testing.

The crane hoists, trolley, and bridge drives were operated in the shop to demonstrate their operability and the trolley tracking.

After the Unit 1 and Unit 2 Reactor Building Cranes were erected, they were thoroughly tested, including the crane rating test in accordance with ANSI B30.2.0.

After the Unit 1 and Unit 2 Reactor Building Crane retrofit all motions were thoroughly tested, including the crane rating test in accordance with ANSI B30.2. NOTE: The following exception applies: The load test was limited to the range of motion available in the access hatch.

The Unit 1 and Unit 2 Reactor Building crane periodic operational tests are performed in accordance with applicable OSHA regulations, local codes, and ANSI B30.2.0.

9.1.5.5 Instrumentation Requirements

The Unit 1 and Unit 2 Reactor Building cranes are furnished with devices and controls, as described in Subsection 9.1.5.3. The Unit 1 Reactor Building crane has dual devices and controls to prevent or detect a single crane failure and thus preclude dropping of the spent fuel cask.

9.1.6 Control of Heavy Loads

9.1.6.1 Introduction / Licensing Background

Heavy loads are typically defined as loads that weigh more than 1000 pounds in the vicinity of spent fuel and/or safety related equipment. The transport of heavy loads during maintenance activities and other evolutions is controlled to minimize risk.

The Heavy Loads Program ensures the safe handling of heavy loads at the Susquehanna Steam Electric Station (SSES). PPL is committed to NUREG 0612 Section 5.1.1 requirements (Phase I) for all areas of SSES where damage to safety related equipment is possible during the transfer of heavy loads. For SSES Reactor Pressure Vessel (RPV) disassembly and reassembly and for the movement of the On-Site Transfer Cask and spent fuel cask, PPL is committed to NUREG 0612 Sections 5.1.1 through 5.1.6 (Phase I and Phase II) requirements.

Based on the favorable implemented actions of licensees during Phase I effort, the NRC withdrew the requirement to complete Phase II in Generic Letter 85-11 and encouraged licensees to implement safety significant actions they deemed appropriate. PPL continued with its commitment to comply with the Phase II requirements of NUREG 0612 for RPV disassembly and reassembly and for the movement of the On-Site Transfer Cask and spent fuel casks.

NRC Bulletin 96-02 dealt with the movement of heavy loads over spent fuel, over fuel in the RPV, and over safety related equipment. PPL found the approach used to meet the Phase I requirements and the voluntary Phase II requirements for heavy loads is in accordance with the regulatory guidelines for the scope of NRC Bulletin 96-02. At SSES, the transfer of heavy loads immediately adjacent to or over irradiated fuel in the RPVs or spent fuel pools is generally prohibited; however there are a few exceptions that are simply unavoidable during RPV disassembly and reassembly. PPL performed load drop analysis calculations which demonstrated the acceptability of these exceptions.

Additional detail on the Heavy Loads Program is available in the referenced drawings, procedures, industry standards, specifications, NRC guidance documents, licensing documents, letters, etc. provided in FSAR Section 9.1.7*.*

9.1.6.2 Safety Basis

This section describes the safety basis that ensures that the risk associated with load handling failures is acceptably low.

9.1.6.2.1

The risk associated with load handling failures is acceptably low based on meeting the Phase I requirements of NUREG 0612 (Section 5.1.1) for the transport of all heavy loads.

9.1.6.2.2

The risk associated with handling of heavy loads for RPV disassembly and reassembly is acceptable since SSES meets the more stringent requirements of Phase II of NUREG 0612 (Sections 5.1.2 through 5.1.6). The RPV heads are transported as equivalent single failure proof lifts using the Unit 1 Reactor Building single failure proof crane. Load drop analyses exist for the transport of other heavy load associated with RPV disassembly and reassembly. Technical Requirements for Operation exist to control radiation releases while transferring heavy loads over irradiated fuel.

9.1.6.2.3

The On-Site Transfer Cask, which is used to transfer spent fuel to the Independent Spent Fuel Storage Installation, is single failure proof and is transported as a single failure proof lift using the Unit 1 Reactor Building single failure proof crane. Refer to the discussion presented in FSAR Section 15.7.5.

9.1.6.3 Scope of Heavy Load Handling Systems

The overhead cranes, monorails, and jib cranes included in the Heavy Loads Program are described in Specification M-1435.

9.1.6.4 Control of Heavy Loads Program

The control of Heavy Loads Program consists of 1) PPL's commitment to NUREG-0612, Phase I elements, 2) PPL's commitment to NUREG-0612, Phase II elements for RPV disassembly and reassembly, and 3) On-Site Transfer Cask and spent fuel cask lifts are performed as single failure proof lifts.

9.1.6.4.1 Commitments in Response to NUREG 0612, Phase I Elements

PPL is committed to complying with NUREG 0612 Phase I requirements. The seven elements associated with the Phase I requirements are incorporated into procedure NDAP-QA-0505 and are discussed in this section.

9.1.6.4.1.1 Safe Load Paths

Lifts associated with refuel floor activities have safe load paths presented on safe load path drawings. The drawings are based on heavy load drop analysis calculations. Per procedure NDAP-QA-0505, load paths shall be predetermined and discussed with work groups to minimize the height and length of travel.

9.1.6.4.1.2 Load Handling Procedures

Procedure NDAP-QA-0505 provides the controls for the implementation of the Heavy Loads Program. All heavy loads shall be lifted in accordance with a plant approved procedure or by an approved Heavy Loads Worksheet.

Prior to moving a heavy load in the proximity of irradiated fuel, the completion of a checklist is required to assure that the necessary plant systems are operable to mitigate and control radiological consequences associated with a postulated drop accident.

9.1.6.4.1.3 Crane Operator Qualifications

Rigger, Lifting Equipment Inspector, and Crane Operator qualification requirements are provided in procedure NDAP-QA-0505 and other station procedures.

9.1.6.4.1.4 Special Lifting Devices

To comply with Phase I requirements of NUREG 0612, procedure NDAP-QA-0505 implements industry standard ANSI N14.6 1978, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 Kg) or More for Nuclear Materials".

9.1.6.4.1.5 Other Lifting Devices

To comply with Phase I requirements of NUREG 0612, procedure NDAP-QA-0505 implements industry standard ASME B30.9 – 2003, "Slings" for lifting devices that are not specially designed.

9.1.6.4.1.6 Inspection and Testing

Inspection and testing requirements are presented in procedure NDAP-QA-0505. Non-installed lifting equipment (strongbacks, lifting beams, boxes/containers, chain hoists, come-alongs and other engineered components) shall be inspected, load tested and documented per the Work Order Program in accordance with station procedures. Load tests are performed on the Reactor Building cranes as specified in the ASME B30.2-2005, "Overhead and Gantry Cranes". Load tests were performed initially (when the crane was new). In addition, load tests are required when modifications are performed on the load carrying components to the crane.

9.1.6.4.1.7 Crane Design

To comply with Phase I requirements of NUREG 0612, procedure NDAP-QA-0505 implements industry standard ASME B30.2 – 2005, "Overhead and Gantry Cranes". Cranes are designed to Crane Manufacturers Association of America (CMAA) specification #70 and #74 depending on the type of crane.

9.1.6.4.2 Reactor Pressure Vessel Head Lifting Procedures

PPL is committed to complying with NUREG 0612 Phase II requirements for RPV disassembly and reassembly.

9.1.6.4.2.1

The transport of the RPV heads is controlled by RPV disassembly and reassembly procedures. These lifts are performed as “equivalent” single failure proof lifts using the Unit 1 Reactor Building single failure proof crane. These lifts are classified as “equivalent” single failure proof lifts rather than single failure proof lifts. The load transfer elements (adapter box, strong back, and lifting lugs) below the crane hook meet NUREG 0612 Phase I requirements and not NUREG 0612 Phase II requirements. The guidance for “equivalent” single failure proof lifts is provided in Section 3.2 of NEI 08-05 which states “The lifting devices used below the hook to make the reactor head lift are required to meet the Phase I requirements as delineated in NUREG-0612, Section 5.1.1.(4).”

9.1.6.4.2.2

Other heavy load lifts associated with RPV disassembly and reassembly meet NUREG-0612 Phase II requirements. The acceptability for performing the vast majority of these lifts has been demonstrated by performing load drop analyses. The load drop analyses resulted in restrictions on load height, load weight, load transfer boundaries, and medium under the loads. The restrictions are presented on the safe load path drawings. The Unit 1 Reactor Building single failure proof crane can not be used exclusively due to the presence of the Unit 2 Reactor Building crane, which utilizes the same rails, and a structural requirement to keep the cranes a certain distance apart.

9.1.6.4.3 Single Failure Proof Crane for the On-Site Transfer Cask

As discussed in FSAR Sections 9.1.4.3.1, 11.7.10, and 15.7.5, the On-Site Transfer Cask, which is used to transfer spent fuel to the Independent Spent Fuel Storage Installation, is transferred as a single failure proof lift using the Unit 1 Reactor Building single failure proof crane. The On-Site Transfer Cask is not lifted over the spent fuel pool and is transported in accordance with safe load path drawings and station procedures.

9.1.6.5 Safety Evaluation

The controls implemented by NUREG 0612 Phase I elements and the controls implemented by NUREG 0612 Phase II elements, for maintenance activities involving RPV disassembly and reassembly, make the risk of a load drop very unlikely.

Load drop analyses, performed for heavy load transfers associated with RPV disassembly and reassembly, have demonstrated that the consequences of postulated load drops are acceptable. Restrictions on load height, load weight, load transfer boundaries, and medium under the load are reflected in plant procedures and safe load path drawings.

The most critical lifts of RPV heads and the On-Site Transfer Cask and spent fuel cask are performed as “equivalent” single failure proof lifts and single failure proof lifts using the Unit 1 Reactor Building single failure proof crane. This approach makes the risk of a load drop extremely unlikely and acceptably low.

9.1.7 References

- Specification M-1435, "General Specification for Heavy Loads Review"
- Procedure NDAP-QA-0505, "Crane, Hoist, and Rigging Program"
- Procedure NDAP-QA-0507, "Conduct of Refuel Floor"
- Procedure NDAP-QA-0653, "Medical Testing Requirement For Other Than Licensed Operator (RO/SRO) Regulated Positions"
- Procedure MT-GM-014, "Rigging and Lifting Inspection"
- Procedure NTP-QA-46.1, "Susquehanna Crane Operator Certification Training Program"
- Procedure ME-0RF-023, "Dry Fuel Storage 61BT Dry Shielded Canister"
- Procedure ME-0RF-179, "Dry Fuel Storage Equipment List and Reference Information"
- Drawing C-2090 Reactor Building Units 1 and 2 Safe Load Paths for Transfer of Heavy Loads
- Drawing C-2586 Unit 2 Refuel Floor Laydown Plan and Safe Load Paths
- Drawing C-2592 Unit 1 Refuel Floor Laydown Plan and Safe Load Paths
- NUREG 0612, "Control of Heavy Loads at Nuclear Power Plants," issued in July 1980
- NUREG 0544, "Single-Failure Proof Cranes for Nuclear Power Plants"
- Generic Letter 80-113, "Control of Heavy Loads at Nuclear Power Plants" December 22, 1980
- Generic Letter 81-07, "Control of Heavy Loads" February 3, 1981
- Generic Letter 85-11, "Completion of Phase II of Control of Heavy Loads at Nuclear power Plants" June 28, 1985
- NRC Bulletin 96-02, "Movement of Heavy Loads Over Spent Fuel"
- NRC Regulatory Issue Summary 2005-25: Clarification of NRC Guidelines for Control of Heavy Loads, dated October 31, 2005
- NRC Regulatory Issue Summary 2005-25 Supplement 1: Clarification of NRC Guidelines for Control of Heavy Loads, dated May 29, 2007
- AR/CR 723370 Review of NRC Regulatory Issue Summary 2005-25.
- AR/CR 878992 Review of NRC Regulatory Issue Summary 2005-25 Supplement 1
- PLA-857, N. W. Curtis to NRC, dated 6/22/81, Unit 1 Phase-One Response
- PLA-937, N. W. Curtis to NRC, dated 9/24/81, Unit 1 Phase-Two Response
- PLA-1110, N. W. Curtis to NRC, dated 6/4/82, Unit 1 Phase-Two Response for Special Lifting Devices
- USNRC letter to N. W. Curtis, dated 5/7/82, Unit 1 Phase-One Draft Technical Evaluation Report
- PLA-1332, N. W. Curtis to NRC, dated 11/18/82, Unit 1 Phase-One Response to Draft Technical Evaluation Report
- USNRC letter to N. W. Curtis, dated 7/21/83, Unit 1 Phase-One Safety Evaluation Report
- PLA-1752, N. W. Curtis to NRC, dated 7/22/83, Unit 2 Phase-One Response
- PLA-1843, N. W. Curtis to NRC, dated 9/29/83, Unit 2 Phase-Two Response
- PLA-1988, N. W. Curtis to NRC, dated 12/13/83, Unit 2 Phase-Two Supplement
- PLA-2511, H. W. Keiser to NRC, dated 9/30/85, Proposed Amendment 24 to License NPF-22
- PLA-3521 H. W. Keiser to NRC, dated 2/27/91 Control of Heavy Loads
- USNRC letter to N. W. Curtis, dated 10/31/83, Unit 2 Phase One Safety Evaluation Report

- PLA-4460, RG Byram to NRC, dated 5/13/1996, 30 Day Response to Bulletin 96-02 “Movement of Heavy Loads”
- NEI 08-05, “Industry Initiative on Control of Heavy Loads” Rev. 0
- NRC Regulatory Issue Summary 2008-28: “Endorsement of Nuclear Energy Institute Guidance for Reactor Vessel Head Heavy Load Lifts”, December 1, 2008
- USNRC Letter to TC Houghton dated 9/5/2008, NRC Safety Evaluation and Endorsement of NEI 08-05
- ANSI N14.6, 1978, “American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 Kg) or More for Nuclear Materials”
- ASME B30.9, 2003, “Slings”
- ASME B30.2, 2005, “Overhead and Gantry Cranes”
- Crane Manufacturers Association of America (CMAA) specification #70 and #74
- NUREG-0776, “Safety Evaluation Report Related to Operation of SSES Units 1 and 2”, Supplement 6

9.1-1 "Susquehanna New Fuel Storage Vault Criticality Safety Analysis for ATRIUM™-10 Fuel," EMF-96-151(P), Revision 1, Siemens Power Corporation, Nuclear Division, August 2000.

9.1-2 M. L. Kennedy and C. Ho, "Nuclear Criticality Analysis for the Spent Fuel Racks of the Susquehanna Power Plant," NAI 78-75 Revision 3, Nuclear Associated International, March 31, 1981.

9.1-3 "Criticality Safety Analysis Susquehanna Spent Fuel Storage Pool with Exxon Nuclear Company, Inc. 9x9 Reload Fuel (March 1986)," XN-NF-86-45 Revision 1, Exxon Nuclear Company, Inc., May 1986.

9.1-4 Deleted

9.1-5 Deleted

9.1-6 Deleted

9.1-7 Deleted

9.1-8 Deleted

9.1-9 "Design and Fabrication Criteria Spent Fuel Storage Racks for Susquehanna Steam Electric Station," PARSP/3157, P. 7-1 and Appendix I, Revision 6, Programmed and Remote Systems Corp., April 6, 1979.

9.1-10 Deleted

9.1-11 "Susquehanna Steam Electric Station, Unit 2 Cycle 8 Reload Summary Report," PL-NF-95-007, Rev. 2, PP&L, August 1996.

9.1-12 "Susquehanna Steam Electric Station, Unit 1 Cycle 10 Reload Summary Report," PL-NF-96-005, Rev. 2, PP&L, July 1997."

9.1-13 "Susquehanna Spent Fuel Storage Vault Criticality Safety Analysis for ATRIUM™-10 Fuel," EMF-96-136(P), Revision 0, Siemens Power Corporation, Nuclear Division, October 1996.

TABLE 9.1-1

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM COMPONENT DESCRIPTION

COMPONENT	EQUIPMENT NOS.	TYPE	QUANTITY	SIZE EACH	MATERIAL	FLOW EACH	TDH, FT.	PUMP POWER HX CAPACITY EACH	DESIGN PRESSURE/ TEMP. PSIG/°F
Fuel Pool Cooling Pumps	1P-211A,B,C	Horiz. Cntr.	3	-	SS	600 gpm	200	60 hp	150/155
Fuel Pool Cooling Pumps	2P-211A,B,C	Horiz. Cntr.	3	-	SS	600 gpm	200	60 hp	150/155
Fuel Pool F/D Holding Pump	0P,1P,2P-205	Horiz. Cntr.	3	-	SS	160 gpm	45	5 hp	150/200
Fuel Pool F/D Precoat Pump	0P-201	Horiz. Cntr.	1	-	SS	475 gpm	65	15 hp	150/200
Fuel Pool Skimmer Surge Tank	1T-208	Vert. Cyl.	1	8027 gal.	SS	-	-	-	15/200
Fuel Pool Skimmer Surge Tank	2T-208	Vert. Cyl.	1	8027 gal.	SS	-	-	-	15/200
Fuel Pool F/D Resin Feed Tank	0T-202	Vert. Cyl.	1	188 gal.	SS	-	-	-	Atm/150
Fuel Pool F/D Precoat Tank	0T-201	Vert. Cyl.	1	500 gal.	SS	-	-	-	Atm/150
Fuel Pool Filter Demineralizer	0F,1F,2F-202 Pressure Precoat	Vert. Cyl.	3	325 ft²	SS	650 gpm	-	-	150/200
Fuel Pool Heat Exch.	1E-202A,B,C 2E-202A,B,C	Shell and Straight	3	1310 ft²	Shell and Channels: CS	Shell: 296000 lb/hr	-	4.4×10^6 Btu/hr at 125/110°F Shell 95/104°F Tubes	150/220
		Tubes, Fixed Tube Sheets, Counter Flow	3	1310 ft²	Tubes & Tube-Sheets: SS	Tubes: 496000 lb/hr	-	4.4×10^6 Btu/hr at 125/110°F Shell 95/104°F Tubes	150/200

TABLE 9.1-2

FUEL SERVICING EQUIPMENT CLASSIFICATION

No.	Component Identification	Essential Classification (a)	Safety Classification (b)	Quality Group (c)	Seismic Category (d)
1	Fuel Prep Machine	PE	3	E	I
2	New Fuel Inspection Stand	NE	0	E	NA
3	Channel Bolt Wrench	NE	0	E	NA
4	Channel Handling Tool	NE	0	E	NA
5	Fuel Pool Sipper	NE	0	E	NA
6	Fuel Inspection Fixture	NE	0	E	NA
7	Channel Gauging Fixture	NE	0	E	NA
8	General Purpose Grapple	PE	2	E	I
9	Fuel Transfer Stand	NE	0	E	NA
10	New Fuel Channel Up Ender	NE	0	E	NA
11	New Fuel Up Ending Stand	NE	0	E	NA

<u>Table Notes</u>

(a) NE – Nonessential
PE – Passive Essential

(b) 0 – Other

(c) B – ASME Code Section III Class-2
D – ANSI B31.1
E – Industrial Code Applies
I – Electrical Codes Apply

(d) NA – No Seismic Requirements

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TABLE 9.1-3

REACTOR VESSEL SERVICING EQUIPMENT CLASSIFICATION

COMPONENT NO.	IDENTIFICATION	ESSENTIAL CLASSIFICATION[a]	SAFETY CLASSIFICATION[b]	QUALITY GROUP[C]	SEISMIC CATEGORY[d]
1	Reactor Vessel Service Tools	NE	O	E	NA
2a	Steam Line Plug (REM*Light Model)	PE	O	E	I
2b	Main Steam Line (MSL) Plugs (Spring Disk Model) (Wetlift)	PE	O	E	I
2c	MSL Plugs Restraint Ring (Wetlift)	PE	O	E	
3a	Shroud Head Bolt Wrench (Supplied w/Nuclear System)	NE	O	E	NA
3b	Shroud Head Bolt Wrench (Wetlift)	NE	O	E	NA
3c	Shroud Head Bolt Wrench(Scientech[gp1])				
4	Vessel Nut Handling Tool	NE	O	E	NA
5	Head Holding Pedestal	NE	O	E	NA
6	Head Nut and Washer Rack	NE	O	E	NA
7	Head Stud Rack	NE	O	E	NA
8a	Deleted				
8b	Deleted[gp2]				
8c	Dryer and Separator Strongback	PE	O	E	NA*
9	Head Strongback/Carousel	PE	O	E	NA*
10	Service Platform (e)	NE	O	E	NA
11	Service Platform Support (e)	NE	O	E	NA
12a	Steam Line Plug Inst. Tool (Integral with REM*Light Model)	NE	O	E	NA
12b	MSL Plugs I/R Tool (Wetlift)	PE	O	E	NA
13	Rigid Pole Handling System (Wetlift)	PE	O	E	NA*
14	Refuel Floor Auxiliary Platform (RFAP)	NE	O	E	**
15	Jet Pump Plugs	NE	O	E	I
16	360 Degree Refuel Work Platform	NE	O	E	**

Table Notes

(a) NE – Nonessential
PE – Passive Essential

(b) O – Other

(c) B – ASME Code Section III Class-2
D – ANSI B31.1
E – Industrial Code Applies
I – Electrical Codes Apply

(d) NA – No Seismic Requirements
I – Seismic Category I

(e) The Service Platform and Service Platform Support are not used and have been eliminated.

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* Dynamic analysis methods for seismic loading are not applicable, as this equipment is supported by the reactor service crane.

** Seismic Analysis was performed to ensure that this item is not a Safety Impact Item.

TABLE 9.1-4

UNDER-REACTOR VESSEL SERVICING EQUIPMENT AND TOOLS CLASSIFICATION

Equipment/Tool	Classification	Safety Class	Seismic Category
1. CRD Handling Equipment	Non-Essential	"Other"	NA
2. Equipment Handling Platform	Non-Essential	"Other"	NA
3. Thermal Sleeve Removal Tool	Non-Essential	"Other"	NA
4. In-Coore Flange Seal Test Plug	Non-Essential	"Other"	NA
5. Key Bender	Non-Essential	"Other"	NA

Table Notes

NA – No Seismic Requirements

TABLE 9.1-5
TOOLS AND SERVICES EQUIPMENT

Fuel Servicing Equipment Fuel Preparation Machines New Fuel Inspection Stand Channel Bolt Wrenches Channel Handling Tool Fuel Pool Sipper Channel Gauging Fixture General Purpose Grapples Fuel Inspection Fixture Fuel Transfer Stand New Fuel Channel Up Ender New Fuel Up Ending Stand **Servicing Aids** Pool Tool Accessories Actuating Poles General Area Underwater Lights Local Area Underwater Lights Drop Lights Underwater TV Monitoring System Underwater Vacuum Cleaner Viewing Aids Light Support Brackets In-Core Detector Cutter In-Core Manipulator	**In-Vessel Servicing Equipment** Multiple LPRM Strongback Instrument Strongback Control Rod Grapple Control Rod Guide Tube Grapple Fuel Support Grapple Grid Guide Control Rod Latch Tool (Standard Handle, Extended Handle, Flag) Instrument Handling Tool Control Rod Guide Tube Seal In-Core Guide Tube Seals Blade Guides Fuel Bundle Sampler Peripheral Orifice Grapple Orifice Holder Peripheral Fuel Support Plug Fuel Bail Cleaner Control Rod/Fuel Support Piece Combination Grapple **Refueling Equipment** Refueling Equipment Servicing Tools Refueling Platforms
Reactor Vessel Servicing Equipment Reactor Vessel Servicing tools Steam Line Plugs (REM*Light Model) Main Steam Line (MSL) Plugs (Spring Disk Model) [Wetlift] MSL Plugs Restraint Ring [Wetlift] Shroud Head Bolt Wrench [Supplied with Nuclear System] Shroud Head Bolt Wrench [Wetlift] Shroud Head Bolt Wrench [Supplied Scientech] Head Holding Pedestals Head Stud Rack Dryer-Separator Strongback Head Strongback /Carousel Steam Line Plug/Installation Tool (REM*Light) [Integral with REM*Light Plug] MSL Plugs I/R Tool [Wetlift] Vessel Nut Handling Tool Head Nut and Washer Storage Racks Rigid Pole Handling System [Wetlift] Refuel Pool Auxiliary Platform (RFAP) Jet Pump Plugs 360 Degree Refuel Work Platform	**Storage Equipment** Multi-Purpose Storage Canister Spent Fuel Storage Racks Channel Storage Racks Control Rod Storage Racks In-Vessel Racks New Fuel Storage Rack Control Rod Guide Tube Storage Rack Channel Bolt Storage Fixture Fuel Rod Storage Basket **Under-Reactor Vessel Servicing Equipment** Control Rod Drive Servicing Tools CRD Hydraulic System Tools Control Rod Drive Handling Equipment Equipment Handling Platform Thermal Sleeve Installation Tool In-Core Flange Seal Test Plug Key Bender

TABLE 9.1-2a

ORIGINAL DESIGN BASIS

DECAY HEAT OUTPUT UNDER NORMAL FUEL STORAGE CONDITIONS*

Year of Discharge	No. of Assemblies Discharged	Total No. of Assemblies in the Pool	Time After Shutdown	Decay Heat Fraction	Decay Heat (MW)
1982	248	248	14 years	$7.23(10^{-5})$	$7.72(10^{-2})$
1983	200	448	13 years	$7.40(10^{-5})$	$6.38(10^{-2})$
1984	184	632	12 years	$7.58(10^{-5})$	$6.01(10^{-2})$
1985	184	816	11 years	$8.15(10^{-5})$	$6.46(10^{-2})$
1986	184	1000	10 years	$8.35\ (10^{-5})$	$6.62(10^{-2})$
1987	184	1184	9 years	$8.55\ (10^{-5})$	$6.78(10^{-2})$
1988	184	1368	8 years	$8.78\ (10^{-5})$	$6.96(10^{-2})$
1989	184	1552	7 years	$9.03(10^{-5})$	$7.16(10^{-2})$
1990	184	1736	6 years	$9.35\ (10^{-5})$	$7.41(10^{-1})$
1991	184	1920	5 years	$9.83\ (10^{-5})$	$7.80(10^{-2})$
1992	184	2104	4 years	$1.07(10^{-4})$	$8.50(10^{-2})$
1993	184	2288	3 years	$1.26(10^{-4})$	$1.00(10^{-1})$
1994	184	2472	2 years	$1.73(10^{-4})$	$1.37(10^{-1})$
1995	184	2656	1 years	$3.16(10^{-4})$	$2.51(10^{-1})$
1996	184	2840	160 hours	$3.10(10^{-3})$	2.44

Total Decay Heat = 3.70 MW
$1.26(10^{7})$ Btu/hr

*The first three batches have an exposure of 25,500 MWd/MTU while all subsequent batches have an exposure of 28,500 MWd/MTU.

Unit No. 1 – 1996 Refueling

HISTORICAL INFORMATION

TABLE 9.1-2b

ORIGINAL DESIGN BASIS

DECAY HEAT OUTPUT UNDER NORMAL FUEL STORAGE CONDITIONS

Year of Discharge	No. of Assemblies Discharged	Total No. of Assemblies in the Pool	Time After Shutdown	Decay Heat Fraction	Decay Heat (MW)
1983	260	260	14 years	$7.23(10^{-5})$	$8.10(10^{-2})$
1984	192	452	13 years	$7.40(10^{-5})$	$6.13(10^{-2})$
1985	180	632	12 years	$7.58(10^{-5})$	$5.88(10^{-2})$
1986	184	816	11 years	$8.15(10^{-5})$	$6.46(10^{-2})$
1987	184	1000	10 years	$8.35(10^{-5})$	$6.62(10^{-2})$
1988	184	1184	9 years	$8.55(10^{-5})$	$6.78(10^{-2})$
1989	184	1368	8 years	$8.78(10^{-5})$	$6.96(10^{-2})$
1990	184	1552	7 years	$9.03(10^{-5})$	$7.16(10^{-2})$
1991	184	1736	6 years	$9.35(10^{-5})$	$7.41(10^{-2})$
1992	184	1920	5 years	$9.83(10^{-5})$	$7.80(10^{-2})$
1993	184	2104	4 years	$1.07(10^{-4})$	$8.50(10^{-2})$
1994	184	2288	3 years	$1.26(10^{-4})$	$1.00(10^{-1})$
1995	184	2472	2 years	$1.73(10^{-4})$	$1.37(10^{-1})$
1996	184	2656	1 year	$3.16(10^{-4})$	$2.51(10^{-1})$
1997	184	2840	160 hours	$3.10(10^{-3})$	2.44

Total Decay Heat = 3.70 MW
$1.26(10^{7})$ Btu/hr

Unit No. 2 1997 Refueling

HISTORICAL INFORMATION

TABLE 9.1-2c

ORIGINAL DESIGN BASIS

DECAY HEAT OUTPUT UNDER FULL CORE UNLOADED CONDITIONS *

Year of Discharge	No. of Assemblies Discharged	Total No. of Assemblies in the Pool	Time After Shutdown	Decay Heat Fraction	Decay Heat (MW)
1982	220	220	11 years	$7.76(10^{-5})$	$7.36(10^{-2})$
1983	200	420	10 years	$7.95(10^{-5})$	$6.86(10^{-2})$
1984	184	604	9 years	$8.15(10^{-5})$	$6.47(10^{-2})$
1985	184	788	8 years	$8.77(10^{-5})$	$6.96(10^{-2})$
1986	184	972	7 years	$9.03(10^{-5})$	$7.16(10^{-2})$
1987	184	1156	6 years	$9.34(10^{-5})$	$7.41(10^{-2})$
1988	184	1340	5 years	$9.82(10^{-5})$	$7.79(10^{-2})$
1989	184	1524	4 years	$1.07(10^{-4})$	$8.49(10^{-2})$
1990	184	1708	3 years	$1.26(10^{-4})$	$1.00(10^{-1})$
1991	184	1892	2 years	$1.72(10^{-4})$	$1.36(10^{-1})$
1992	184	2076	1 year	$3.13(10^{-4})$	$2.48(10^{-1})$
1993	764	2840	250 hours	$2.58(10^{-3})$	8.49

Total Decay Heat = 9.56 MW
$3.26(10^{7})$ Btu/hr

* The first three batches have an exposure of 25,500 MWd/MTU while all subsequent batches have an exposure of 28,500 MWd/MTU.

Unit No. 1 - 1993 Refueling

HISTORICAL INFORMATION

TABLE 9.1-2d

ORIGINAL DESIGN BASIS

DECAY HEAT OUTPUT UNDER FULL CORE UNLOAD CONDITIONS

Year of Discharge	No. of Assemblies Discharged	Total No. of Assemblies in the Pool	Time After Shutdown	Decay Heat Fraction	Decay Heat (MW)
1983	232	232	11 years	$7.76(10^{-5})$	$7.76(10^{-2})$
1984	192	424	10 years	$7.95(10^{-5})$	$6.58(10^{-2})$
1985	180	604	9 years	$8.15(10^{-5})$	$6.33(10^{-2})$
1986	184	788	8 years	$8.77(10^{-5})$	$6.96(10^{-2})$
1987	184	972	7 years	$9.03(10^{-5})$	$7.16(10^{-2})$
1988	184	1156	6 years	$9.34(10^{-5})$	$7.41(10^{-2})$
1989	184	1340	5 years	$9.82(10^{-5})$	$7.79(10^{-2})$
1990	184	1524	4 years	$1.07(10^{-4})$	$8.49(10^{-2})$
1991	184	1708	3 years	$1.26(10^{-4})$	$1.00(10^{-1})$
1992	184	1892	2 years	$1.72(10^{-4})$	$1.36(10^{-1})$
1993	184	2076	1 year	$3.13(10^{-4})$	$2.48(10^{-1})$
1994	764	2840	250 hours	$2.58(10^{-3})$	8.49

Total Decay Heat = 9.56 MW
$3.26(10^{7})$ Btu/hr

Unit No. 2 - 1994 Refueling

HISTORICAL INFORMATION

TABLE 9.1-2e

UPDATED DESIGN BASIS

DECAY HEAT OUTPUT UNDER NORMAL FUEL STORAGE CONDITIONS

Cycle of Discharge*	No. of Assemblies Discharged	Total No. of Assemblies in the Pool	Time After Shutdown	Decay Heat (MW)
X-8	290	290	16 years	0.0826
X-7	316	606	14 years	0.0957
X-6	316	922	12 years	0.1045
X-5	316	1238	10 years	0.1105
X-4	316	1554	8 years	0.1166
X-3	316	1870	6 years	0.1404
X-2	316	2186	4 years	0.1868
X-1	316	2502	2 years	0.3696
X	348	2850	144 hours	5.3083
			Total Decay Heat = 6.5150 MW	$2.2229 (10^7)$ Btu/hr

*The results bound any discharge cycle, X, and are based on power uprate conditions.

TABLE 9.1-2f
UPDATED DESIGN BASIS
DECAY HEAT OUTPUT UNDER FULL CORE UNLOAD CONDITIONS

Cycle of Discharge*	No. of Assemblies Discharged	Total No. of Assemblies in the Pool	Time After Shutdown	Decay Heat (MW)
X-7	190	190	14 years	0.0578
X-6	316	506	12 years	0.1045
X-5	316	822	10 years	0.1104
X-4	316	1138	8 years	0.1165
X-3	316	1454	6 years	0.1402
X-2	316	1770	4 years	0.1862
X-1	316	2086	2 years	0.3677
X	764	2850	250 hours	10.6952
Total Decay Heat = 11.7785 MW 4.0188(10^7) Btu/hr				

* The results bound any discharge cycle, X, and are based on power uprate conditions.

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TABLE 9.1-6a

UNIT 1 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Power supply	Loss of offsite power	All crane movements stopped by setting crane holding brakes and tripping all drive motors.	Crane operator	
Main hoist hooks	Failure of one hook	Non, the redundant hook supports the load.	Periodic inspection, if not identified during the crane use	
Main hoist wire ropes	Failure of one rope	Spurious, dynamic, load transfer to the redundant rope followed by setting of crane holding brakes and cessation of all crane movements. The dynamic load transfer will not cause the redundant rope load to exceed one-third of the rope breaking strength.	Crane operator	Two vane switches, mounted on the equalizer frame, are provided to detect the wire rope failure and cut off power to the hoist.
Main hoist drum	Failure of drum shaft	Possible load stalling, or noise and irregular hoist operation. Crane operator to stop hoist operation; this will result in setting of the holding brakes and the safe load suspension.	Crane operator	Then, the load can be positioned over its storage or laydown area and lowered by manual operation of the hoist holding brakes.

TABLE 9.1-6a

UNIT 1 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Main hoist holding brakes	Failure in open position of one brake, when main hoist is in operation and power to the main hoist holding brakes is cut off.	None, two additional holding brakes stop the main hoist movement and hold the load.	Periodic inspection	Three holding brakes are provided, all rated at 150% of the hoist motor torque, at the point of application.
Trolley holding brakes	Failure, in open position, of one brake when trolley is in operation and power to holding brakes is cut off.	None, the power to the trolley drive motor is cut off at the same time, and the trolley is stopped by the redundant holding brake.	Crane operator	Two holding brakes are provided, one rated at 100% and the other rated 150% of the trolley drive motor torque at the point of application.
Bridge holding brake	Failure of the bridge holding brake when bridge in operation and the power to the brake is cut off.	None, the power to the bridge drive motors is cut off at the same time, and the bridge is stopped by the holding brake on the other side of the bridge.		The holding brake is rated 100% of the bridge drive motor torque for each of the two bridge drive motors.

TABLE 9.1-6a

UNIT 1 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Main hoist drive gear cases	Failure of one gear case, resulting in gear disengagement			Two gear cases (drive and idler case) are provided for the main hoist.
	a) drive gear case	Spurious drum revolving in the load lowering direction. The overspeed switch activated by revolving drum will set the hoist holding brakes and stop the load.		
	b) idler gear case	None, the drive gear case with the hoist motor and the holding brakes maintain control of the load.	Crane operator	
Main hoist upward movement, geared (lower) limit switch	Failure of switch			
	a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes.	Crane operator or periodic testing	
	b) closed	None, if hoist continues its upward travel it will be stopped by action of the backup upper limit switch.	Periodic testing	

TABLE 9.1-6a

UNIT 1 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Main hoist upward movement (upper) limit switch	Failure of switch			Tripped by physical contact with moving upward lower load block.
	a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes.	Crane operator or periodic testing	
	b) closed	None, hoist upward movement will be limited by the backup lower geared limit switch, before it reaches the upper limit switch.	Periodic testing	
Main hoist downward movement geared limit switches	Failure of one limit switch			
	a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes.	Crane operator or periodic testing	
	b) closed	None, if hoist moves downward beyond the limit it will be stopped by the other (backup) limit switch.	Periodic testing	

Table Rev. 55

TABLE 9.1-6a

UNIT 1 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Main hoist overload switch	Failure of the overload switch			
	a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes.	Crane operator	
	b) closed	None, the hoist motor overcurrent and "current rate of rise" protection backs up the failed load switch.		
Bridge and trolley movement limit switches	Failure of one switch associated with a given bridge or trolley position			
	b) open	Immediate cut off of power to respective drive motor(s) and holding brake(s) and stopping of all crane movements.	Crane operator	
	b) closed	The load may enter the restricted area, unless prevented by crane operator action.	Periodic testing	

Table Rev. 55

TABLE 9.1-6b

UNIT 2 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Power supply	Loss of offsite power	All crane movements stopped by setting crane holding brakes and tripping all drive motors	Crane operator	
Main hoist hook or wire rope	Failure of hook or wire rope	Load drop	Crane operator	The results of this accident are addressed in the response to NUREG 0612.
Main hoist drum	Failure of drum shaft	Possible load stalling, or noise and irregular hoist operation. Crane operator to stop hoist operation; this will result in setting of the holding brakes and the safe load suspension.	Crane operator	Then, the load can be positioned over its storage or laydown area and lowered by manual operation of the hoist holding brakes.
Bridge holding brakes	Failure of the bridge holding brake when bridge is in operation and power to the brake is cut off.	None, the power to the bridge drive motors is cut off at the same time, and the bridge is stopped by the holding brake on the other side of the bridge.		One holding brake, provided for each of the two bridge drive motors. The holding brake is rated at 100% of the bridge drive motor toraue
Trolley holding brakes	Failure of the trolley holding brake when trolley is in operation and power to the brake is cut off.	None, the power to the trolley drive motor is cut off at the same time, and the trolley is stopped by the holding brake.	Crane operator	The trolley is supplied with two brakes, one rated at 100% and the second [rated at 50% of the full load motor torque.
Main hoist holding brake	Failure in open position of one brake, when main hoist in operation and power to the main hoist holding brakes is cut off.	None, an additional holding brake stays the main hoist movement and holds the load.	Periodic Inspection	Two holding brakes are provided, both rated at 150% of the hoist motor torque, at the point of application.
Main hoist gear case	Failure [of]gear case, resulting in gear disengagement	Uncontrolled lowering	Crane operator	Results of this accident are evaluated in response to NUREG 0612.

TABLE 9.1-6b

UNIT 2 REACTOR BUILDING CRANE FAILURE MODES AND EFFECT ANALYSIS

Component or Subsvstem	Component or Subsystem Failure Mode	Effect of Failure on the Svstem	Failure Mode Detection	Remarks
dain hoist upward novement, geared lower) limit switch	Failure of switch a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holdina brake.	Crane operator or periodic testing	
	b) closed	None, if the hoist continues its upward travel, it will be stopped by action of the backup upper limit switch.	Periodic testing	
dain hoist upward novement (upper) limit switch	Failure of switch a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brake.	Crane operator or periodic testing	
	b) closed	None, hoist upward movement will be limited by the backup lower geared limit switch, before it reaches the upper limit switch.	Periodic testing	
dain hoist downward novement switch	Failure of switch a) open	Immediate power cut off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes.	Crane operator or periodic testing	
	b) closed	Potential exists for reverse winding of the drum and damaging the wire rope and other components.	Crane operator or periodic testing	All major heavy loads are lifted in areas "here it is not possible to lower the hoist to a point that the switch would be challenged.
Bridge and trolley novement limit switches	Failure of one switch associated with a given bridge or trolley position a) open	Immediate cut off of power to respective drive motors(s) and holding brake(s) and stopping of all crane movements.	Crane operator	
	b) closed	The load may enter the restricted area, unless prevented by crane operator action.	Periodic testing	

TABLE 9.1-7a

LOAD COMBINATIONS & FACTORED ALLOWABLE STRESS LIMITS

The following load combinations shall be satisfied:

a) Normal Operating Conditions

		Stress Limits
i)	D+L	Fs
ii)	D+L+P	Fs
iii)	D+L+H	Fs
iv)	D+L+T	Fs
v)	D+L+T+P	Fs
vi)	D+L+T+H	Fs
vii)	D+L+T+E	1.25 Fs
viii)	P+H	Fs
ix)	D+L+E	Fs
x)	D+L+SRV	Fs (Note 2)
xi)	D+L+T+SRV	Fs (Note 2)
xii)	D+L+T+E+SRV	1.5 Fs (Note 2)
xiii)	D+L+T+E'+SRV	1.5 Fs (Note 2)

b) Design Accident and Extreme Environmental Conditions

		Stress Limits
i)	D+L+T+E'	(See Note 1)
ii)	D+L+T'+E'	(See Note 1)
iii)	D+L+T+I	1.25 Fs
iv)	D+L+T'+I	1.33 Fs
v)	D+L+T'	1.33 Fs
vi)	D+L+I	1.25 Fs
vii)	D+L+T+SRV+LOCA or CHUGGING	(See Note 1,2)
viii)	D+L+T+E+SRV+LOCA or CHUGGING	(See Note 1,2)
ix)	D+L+T+E'+SRV+LOCA or CHUGGING	(See Note 1,2)

NOTE:

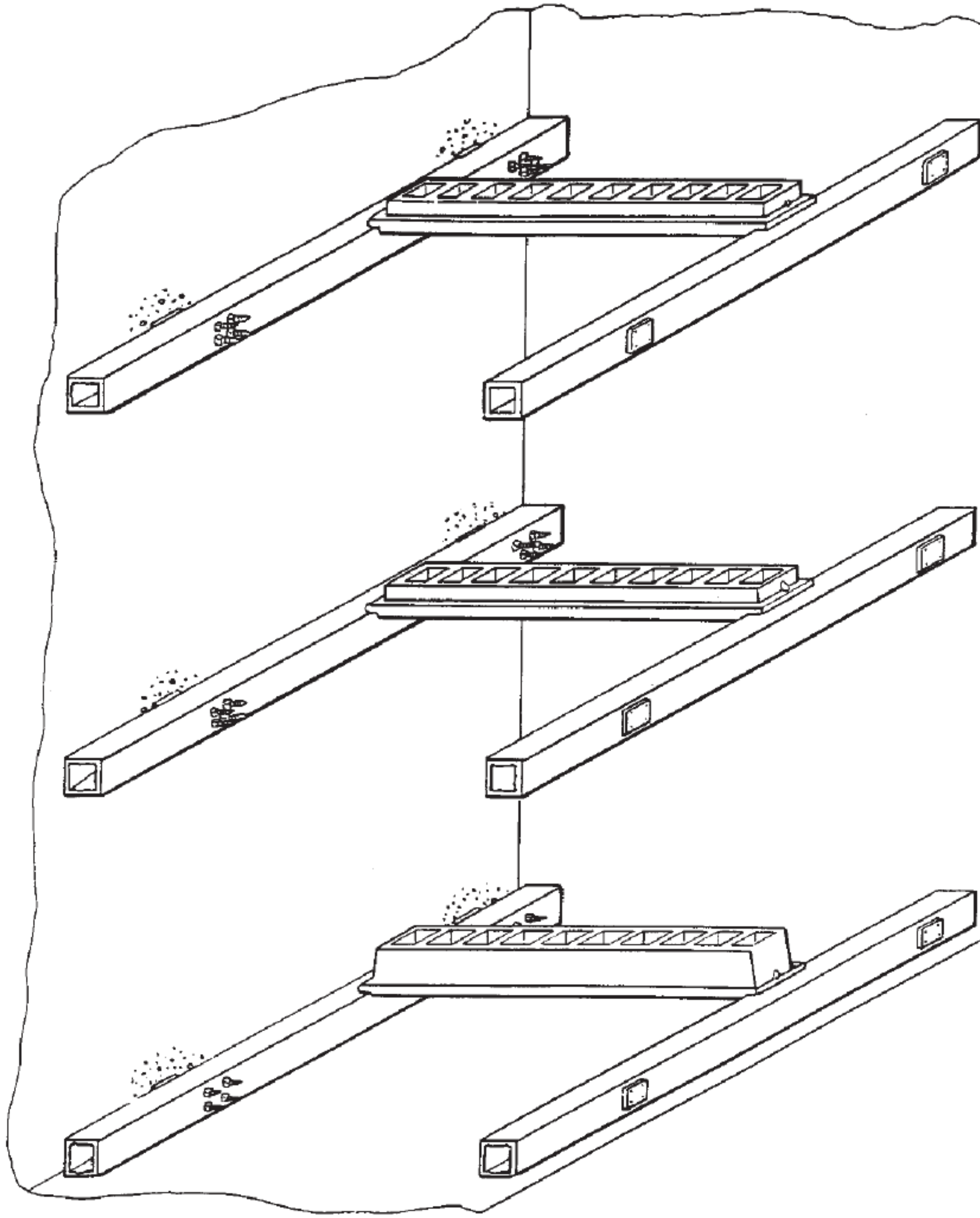
1. In no case shall the allowable stress exceed 0.9Fy in bending, 0.85Fy in axial tension or compression and 0.5Fy in shear. Where Fs is governed by requirements of stability (local or lateral buckling), fs shall not exceed 1.5Fs.

2. SRV, LOCA, CHUGGING loads shall be combined with the other loads by the absolute sum method.

TABLE 9.1-7b

LOAD DEFINITIONS

D	=	Dead load of racks including the support framing.
L	=	Live load due to the weight of fuel assemblies considered as varying from zero to full load, and loadings corresponding to varying placement of the fuel assemblies in the rack considered so that the most critical loads are obtained.
T	=	Thermal effects, loads moments and forces based on the most critical transient or steady state condition during normal operation and shut down conditions.
P	=	Lifting force of 4000 pounds applied to the top of rack at any fuel bundle location. (This is necessary in the event that the fuel assembly or grappling device binds during normal removal.)
H	=	Horizontal force of 1000 pounds applied to the top of rack at any fuel bundle location and at a varying angle from 0° to 45° from the horizontal.
E	=	Loads and resulting forces and moments generated by the Operating Basis Earthquake, (OBE) resulting from ground surface horizontal acceleration of 0.05g and vertical ground surface acceleration of 0.033g, acting simultaneously.
E'	=	Loads and resulting forces and moments generated by the Design Basis Earthquake (DBE) resulting from ground surface horizontal acceleration of 0.10g, and vertical ground surface acceleration of 0.067g, acting simultaneously.
SRV	=	Safety Relief Valve Loads
T'	=	Thermal effects, loads forces and moments which may occur during a design accident.
I	=	Impact loads resulting from the following as a result of a dropped fuel bundle impacting the racks from an elevation of 18 inches above the rack. The height of the fuel bundle above the racks is limited by the fuel handling equipment. The racks are analyzed for a bundle dropping thru an empty cavity. The racks will remain functional for this case.
LOCA	=	Loads Associated wtih Loss of Coolant Accident
CHUGGING	=	Chugging Loads



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SUSQUEHANNA STEAM ELECTRIC STATION
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FINAL SAFETY ANALYSIS REPORT

NEW FUEL STORAGE

FIGURE 9.1-1, Rev 49

AutoCAD: Figure Fsar 9_1_1.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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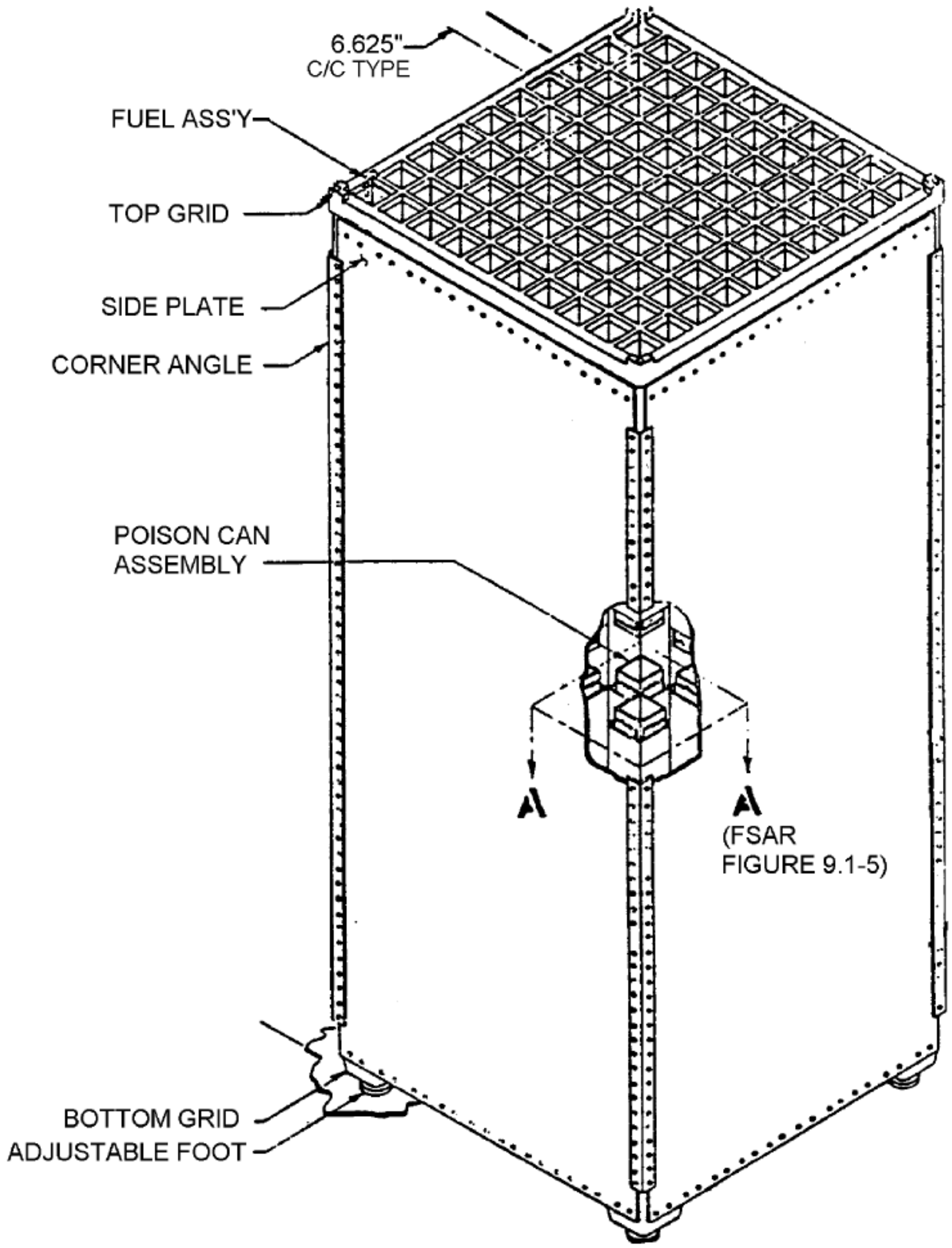
NEW FUEL VAULT COVER
DETAILS

FIGURE 9.1-2, Rev 49

AutoCAD: Figure Fsar 9_1_2.dwg



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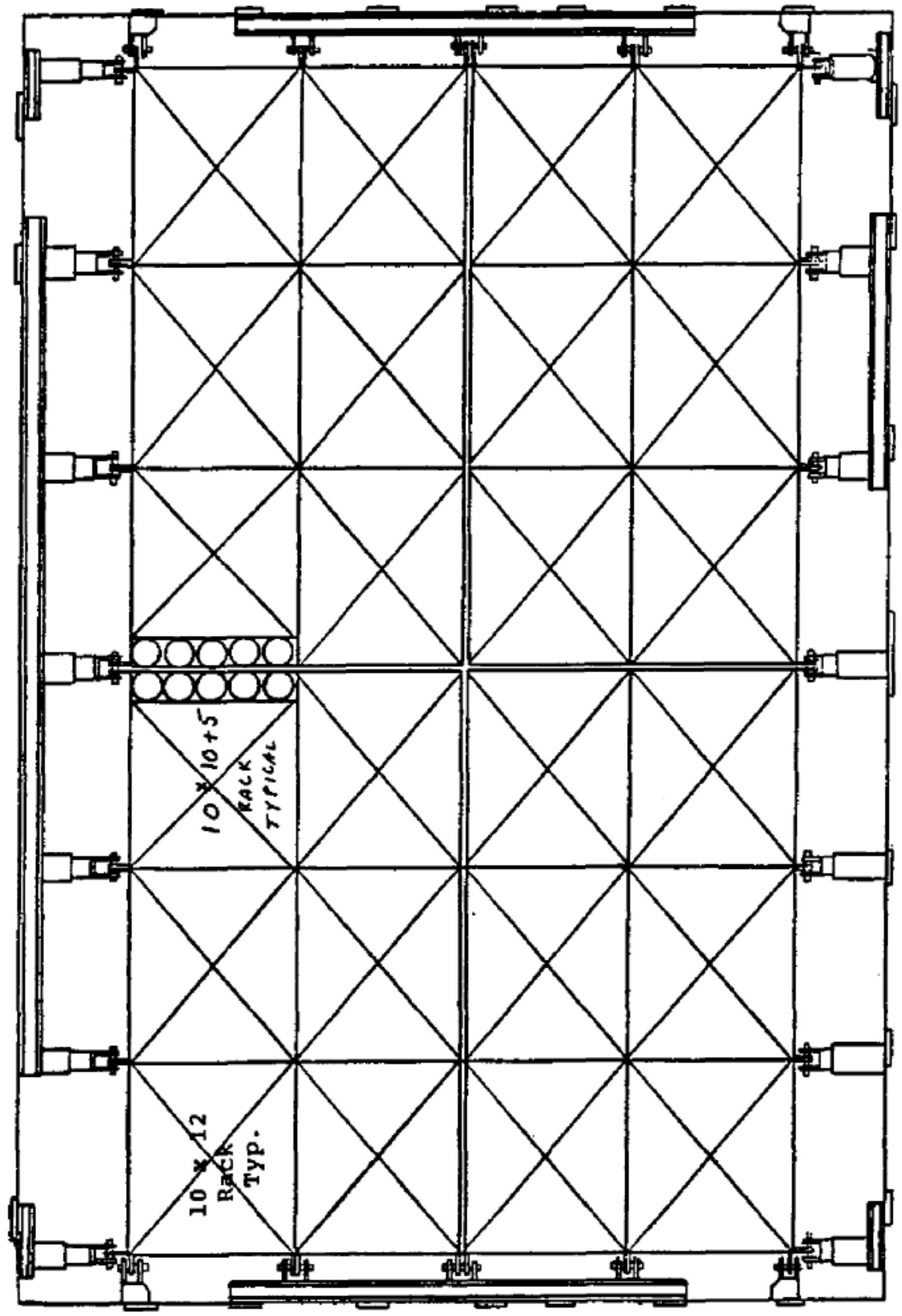
SPENT FUEL RACK ISOMETRIC

FIGURE 9.1-3, Rev 54

AutoCAD: Figure Fsar 9_1_3.dwg



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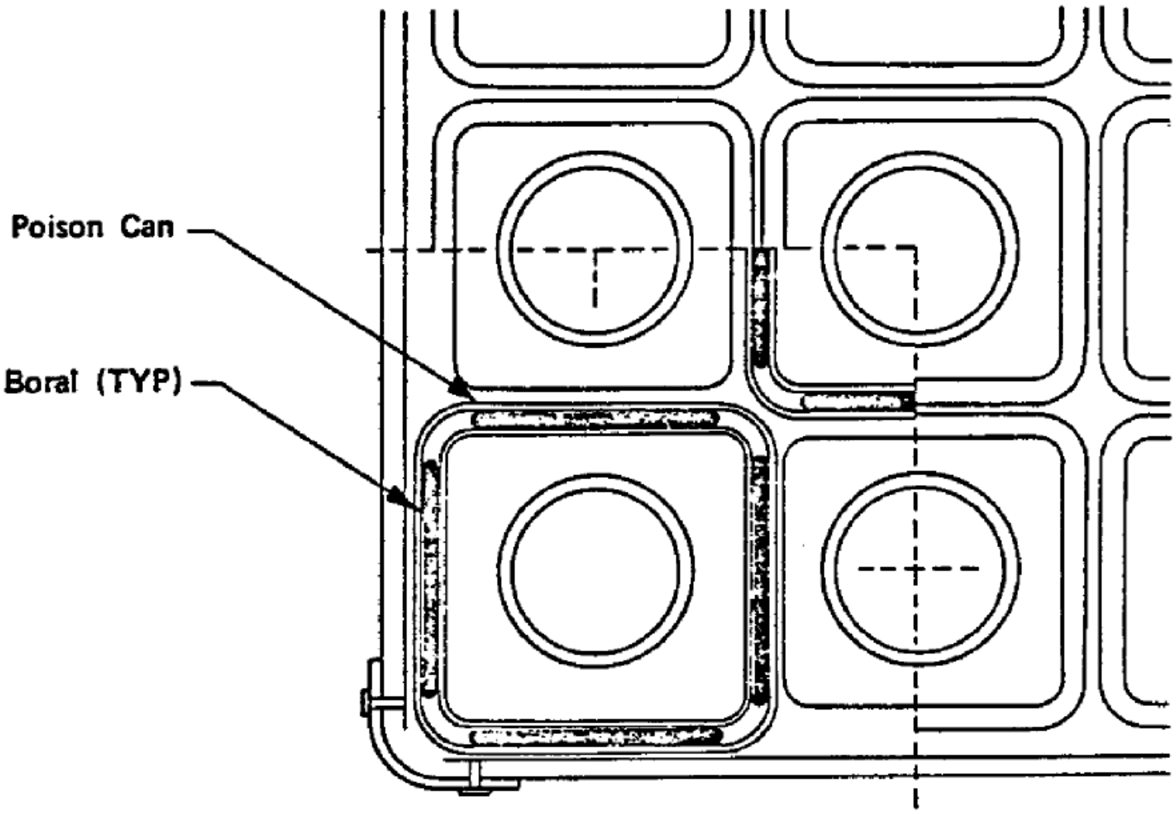
SPENT FUEL RACK ARRANGEMENT

FIGURE 9.1-4, Rev 49

AutoCAD: Figure Fsar 9_1_4.dwg



Section A-A (partial view of top grid)

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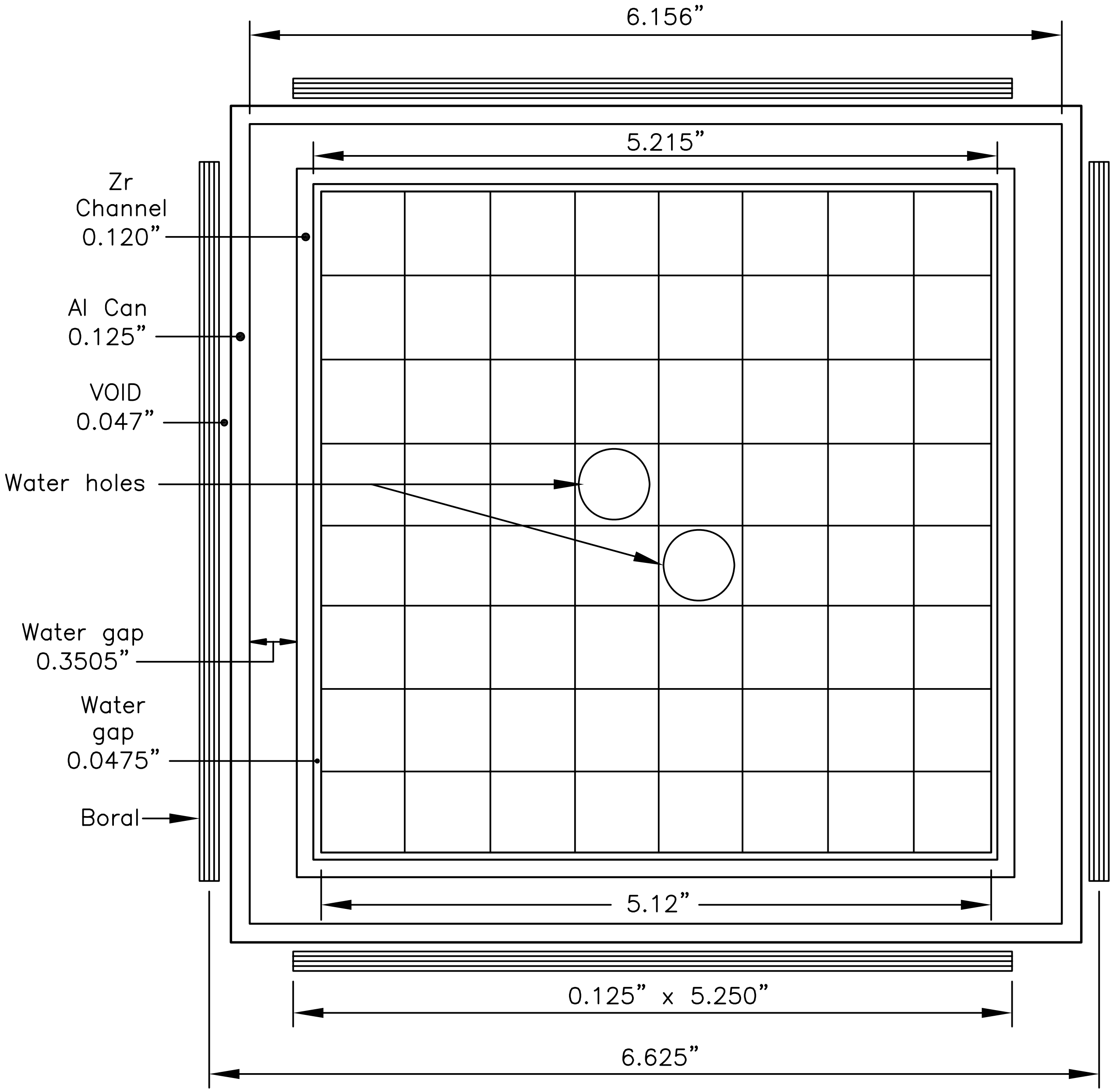
SPENT FUEL RACK DETAIL

FIGURE 9.1-5, Rev 49

AutoCAD: Figure Fsar 9_1_5.dwg



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REFERENCE CASE FUEL
STORAGE POISON CAN

FIGURE 9.1-6, Rev 49

AutoCAD: Figure Fsar 9_1_6.dwg

FIGURE 9.1-8 REPLACED BY DWG. M-154, SH. 1

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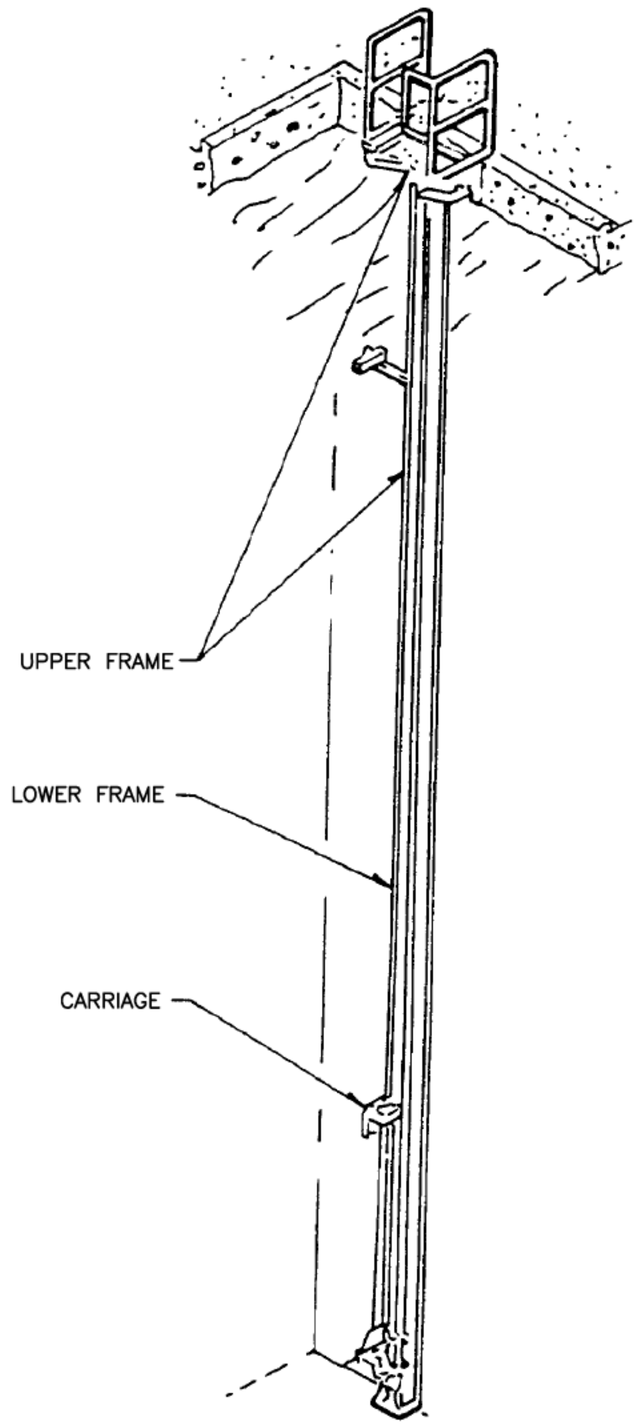
FIGURE 9.1-8 REPLACED BY DWG. M-154,
SH. 1

FIGURE 9.1-8, Rev. 49

AutoCAD Figure 9_1_8.doc



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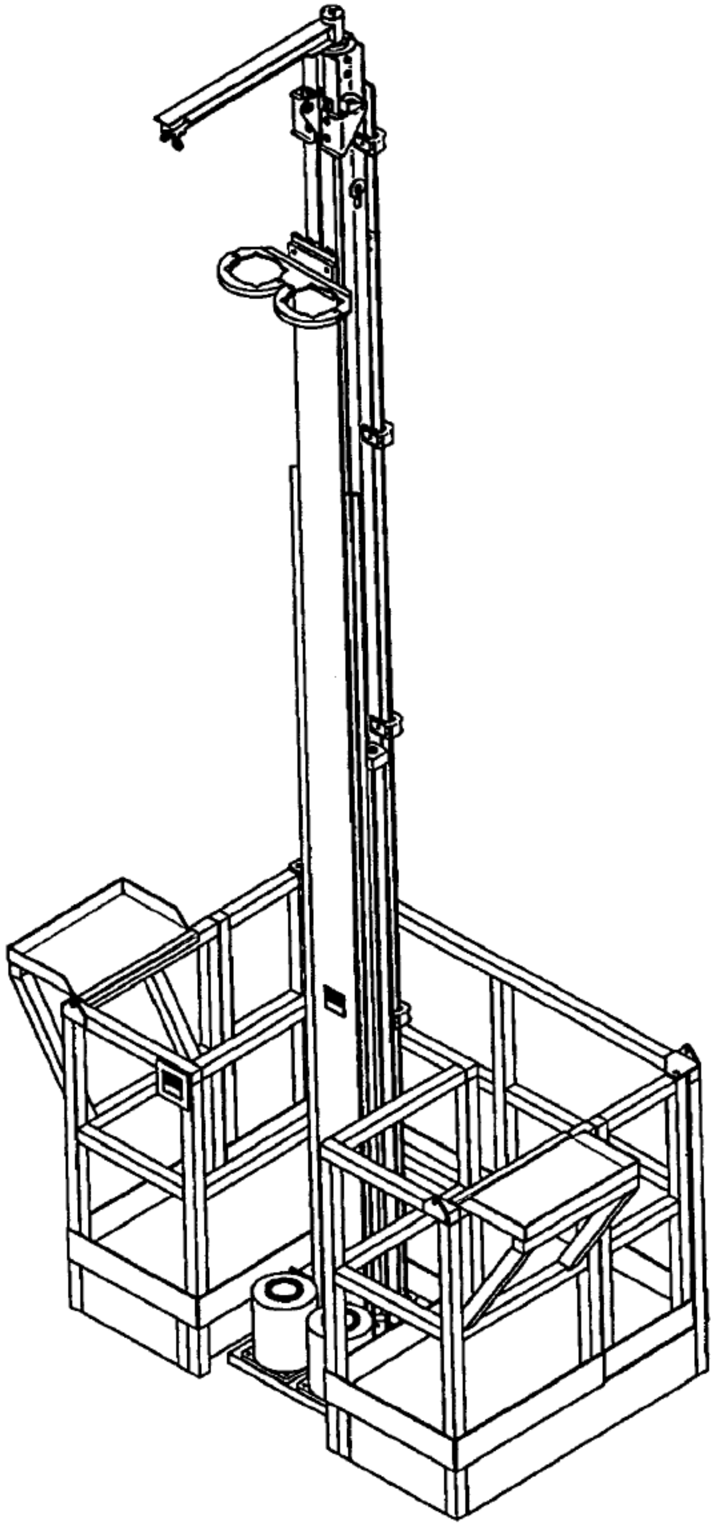
FUEL PREPARATION MACHINE

FIGURE 9.1-9, Rev 55

AutoCAD: Figure Fsar 9_1_9.dwg



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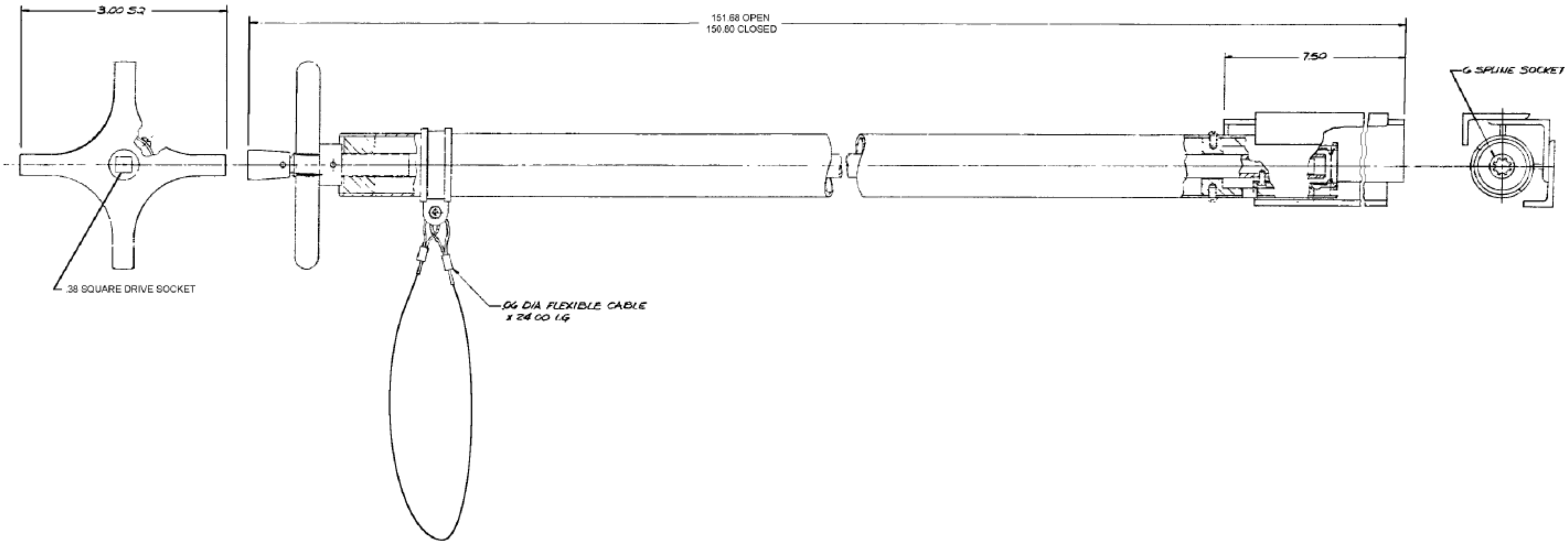
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

NEW FUEL INSPECTION STAND

FIGURE 9.1-10, Rev 50

AutoCAD: Figure Fsar 9_1_10.dwg



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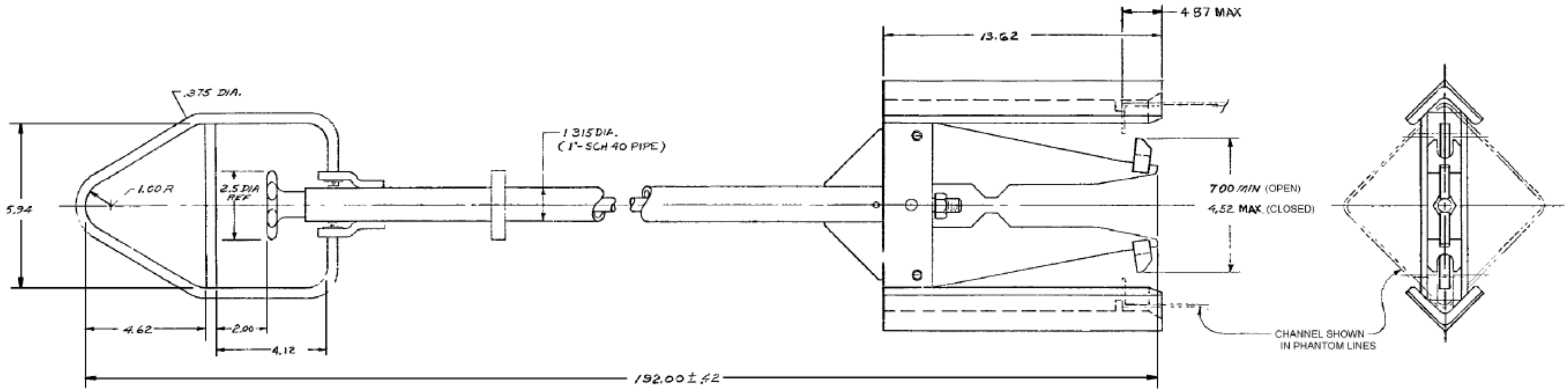
CHANNEL BOLT WRENCH

FIGURE 9.1-11, Rev 54

AutoCAD: Figure Fsar 9_1_11.dwg



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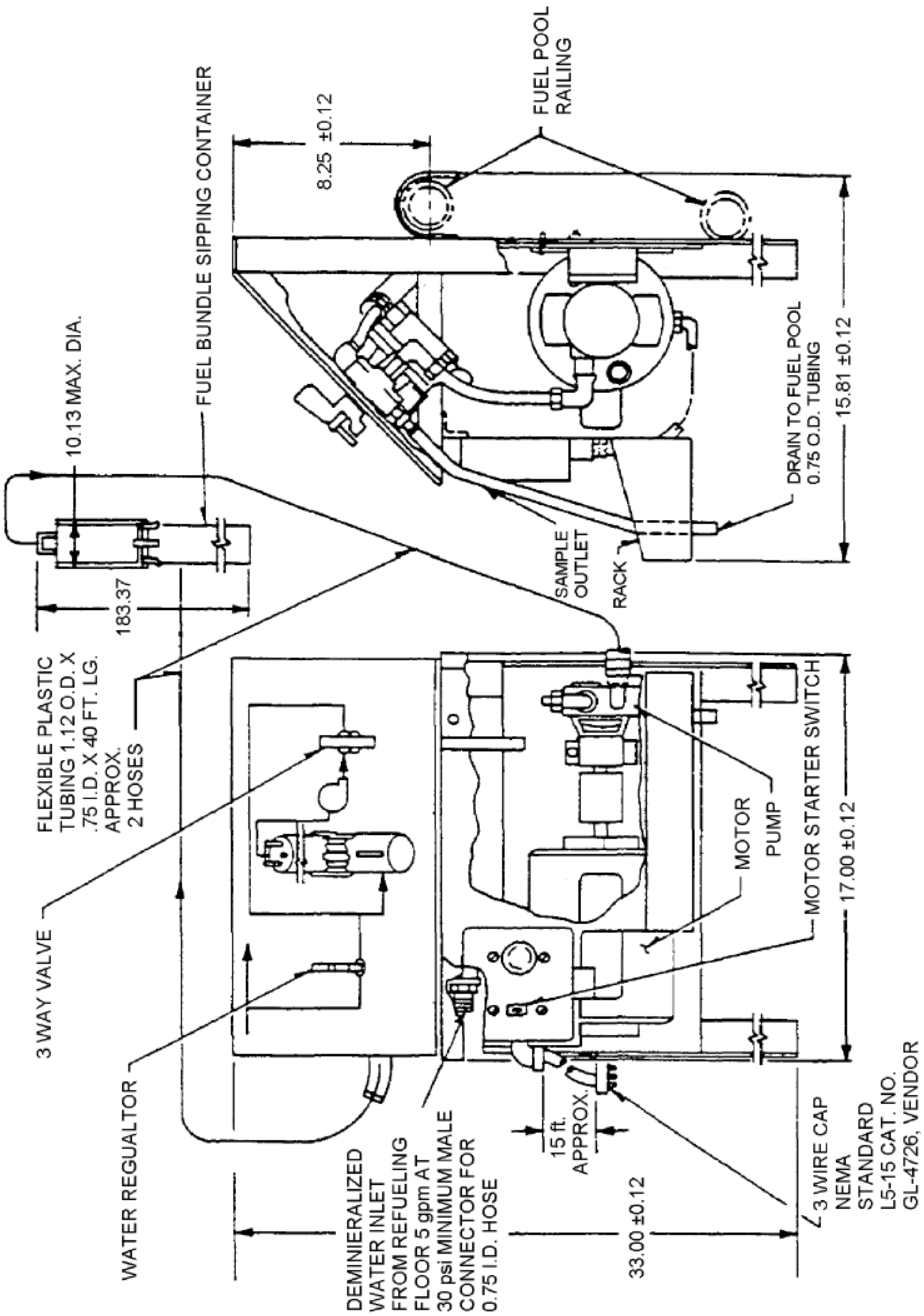
CHANNEL HANDLING TOOL

FIGURE 9.1-12, Rev 54

AutoCAD: Figure Fsar 9_1_12.dwg



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FUEL POOL SIPPER

FIGURE 9.1-13, Rev 54

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Figure Withheld Under 10 CFR 2.390

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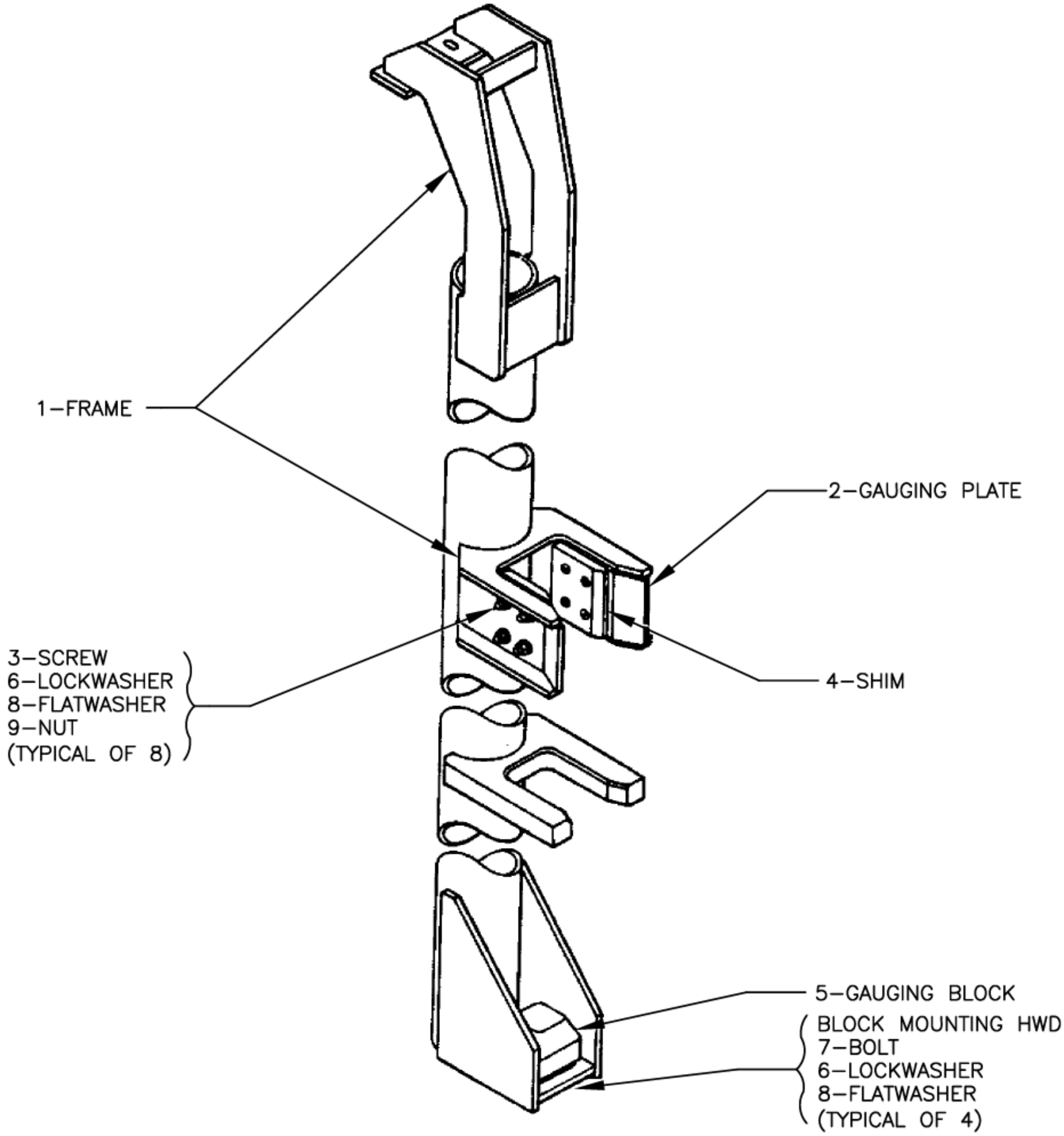
FINAL SAFETY ANALYSIS REPORT

FUEL INSPECTION FIXTURE

FIGURE 9.1-14, Rev 49

AutoCAD: Figure Fsar 9_1_14.dwg



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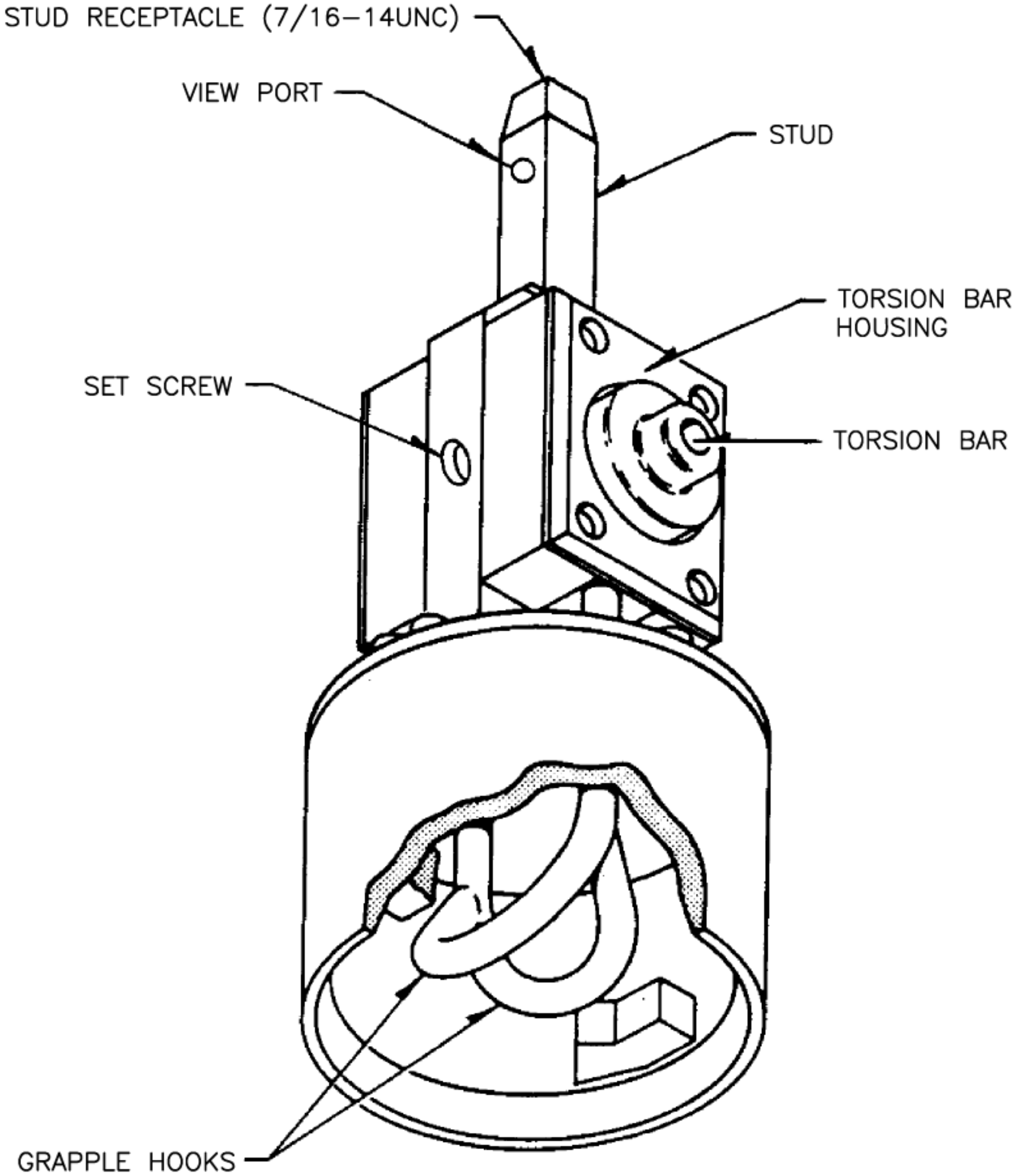
SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
CHANNEL GAUGING FIXTURE
FIGURE 9.1-15, Rev 49

AutoCAD: Figure Fsar 9_1_15.dwg



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GENERAL PURPOSE GRAPPLE

FIGURE 9.1-16, Rev 49

AutoCAD: Figure Fsar 9_1_16.dwg

FIGURE REPLACED BY PPL DRAWING C-1807, SH. 1

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FIGURE REPLACED BY PPL DRAWING C-1807, SH. 1

FIGURE 9.1-18, Rev. 56

AutoCAD Figure 9_1_18.doc

FIGURE REPLACED BY PPL DRAWING C-1807, SH. 2

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SUSQUEHANNA STEAM ELECTRIC STATION
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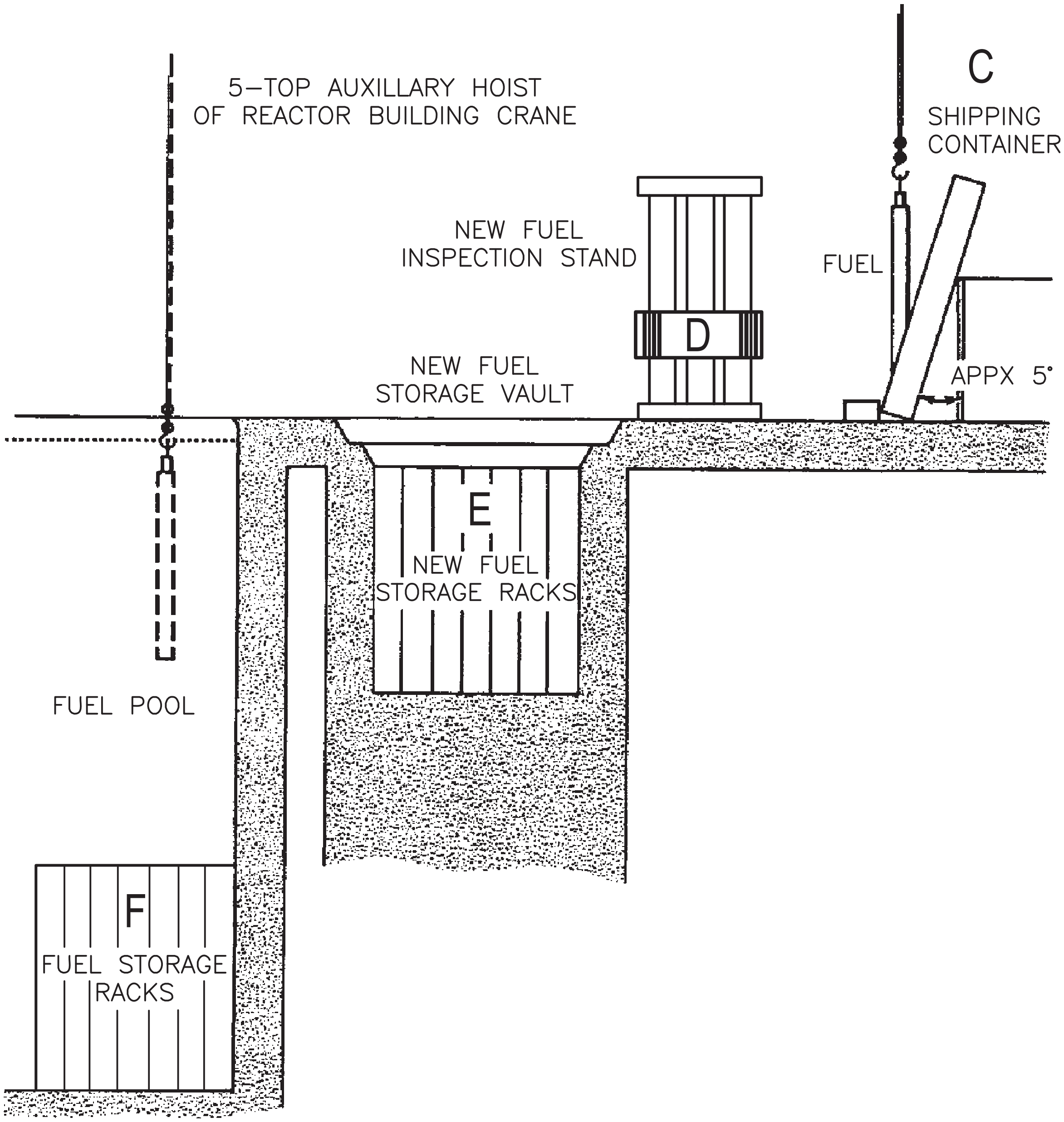
FIGURE REPLACED BY PPL DRAWING C-1807, SH. 2

FIGURE 9.1-19, Rev. 56

AutoCAD Figure 9_1_19.doc



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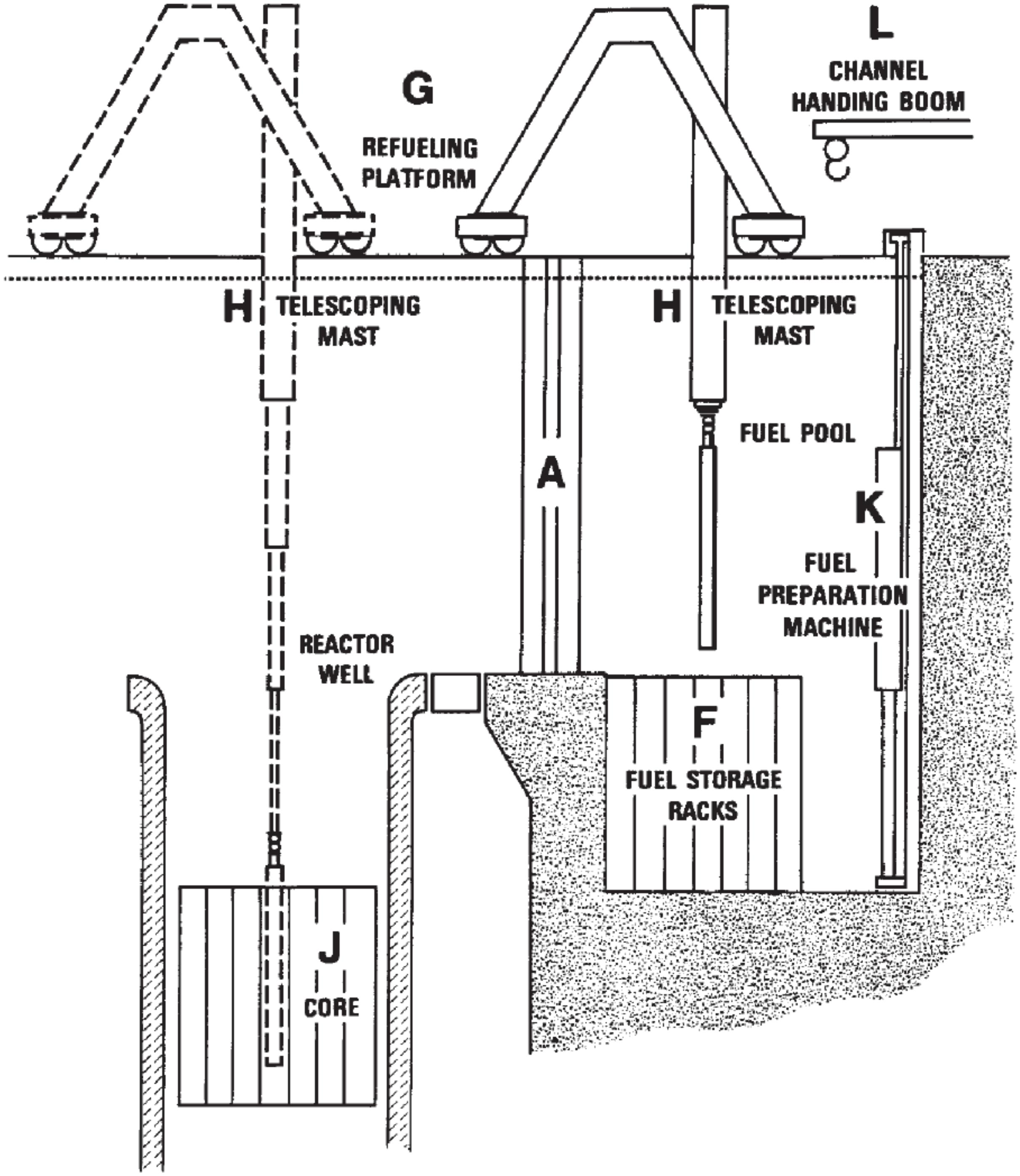
FINAL SAFETY ANALYSIS REPORT

SIMPLIFIED SECTION OF NEW
FUEL HANDLING FACILITIES
(SECTION X-X, FIGURE 9.1-18)

FIGURE 9.1-20, Rev 55

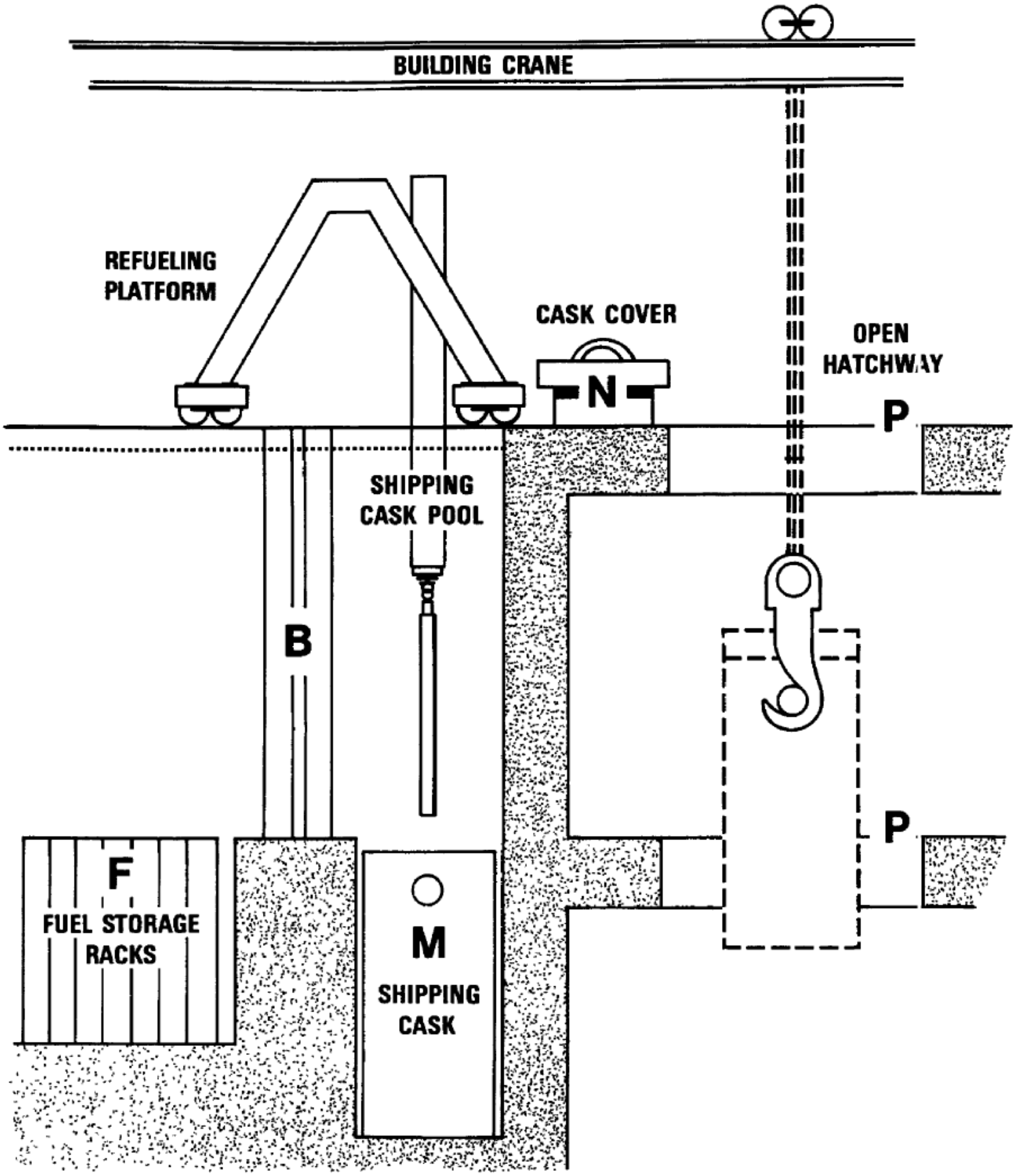
AutoCAD: Figure Fsar 9_1_20.dwg



FSAR REV.65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
SIMPLIFIED SECTION OF REFUELING FACILITIES (SECTION Y-Y, FIGURE 9.1-18) FIGURE 9.1-21, Rev 49

AutoCAD: Figure Fsar 9_1_21.dwg



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FINAL SAFETY ANALYSIS REPORT

SIMPLIFIED SECTION OF
FUEL SHIPPING FACILITIES
(SECTION Z-Z, FIGURE 9.1-19)

FIGURE 9.1-22, Rev 55

AutoCAD: Figure Fsar 9_1_22.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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FINAL SAFETY ANALYSIS REPORT

UNIT 2 REFUELING MAST
AND GRAPPLE OUTLINE

FIGURE 9.1-23, Rev 55

AutoCAD: Figure Fsar 9_1_23.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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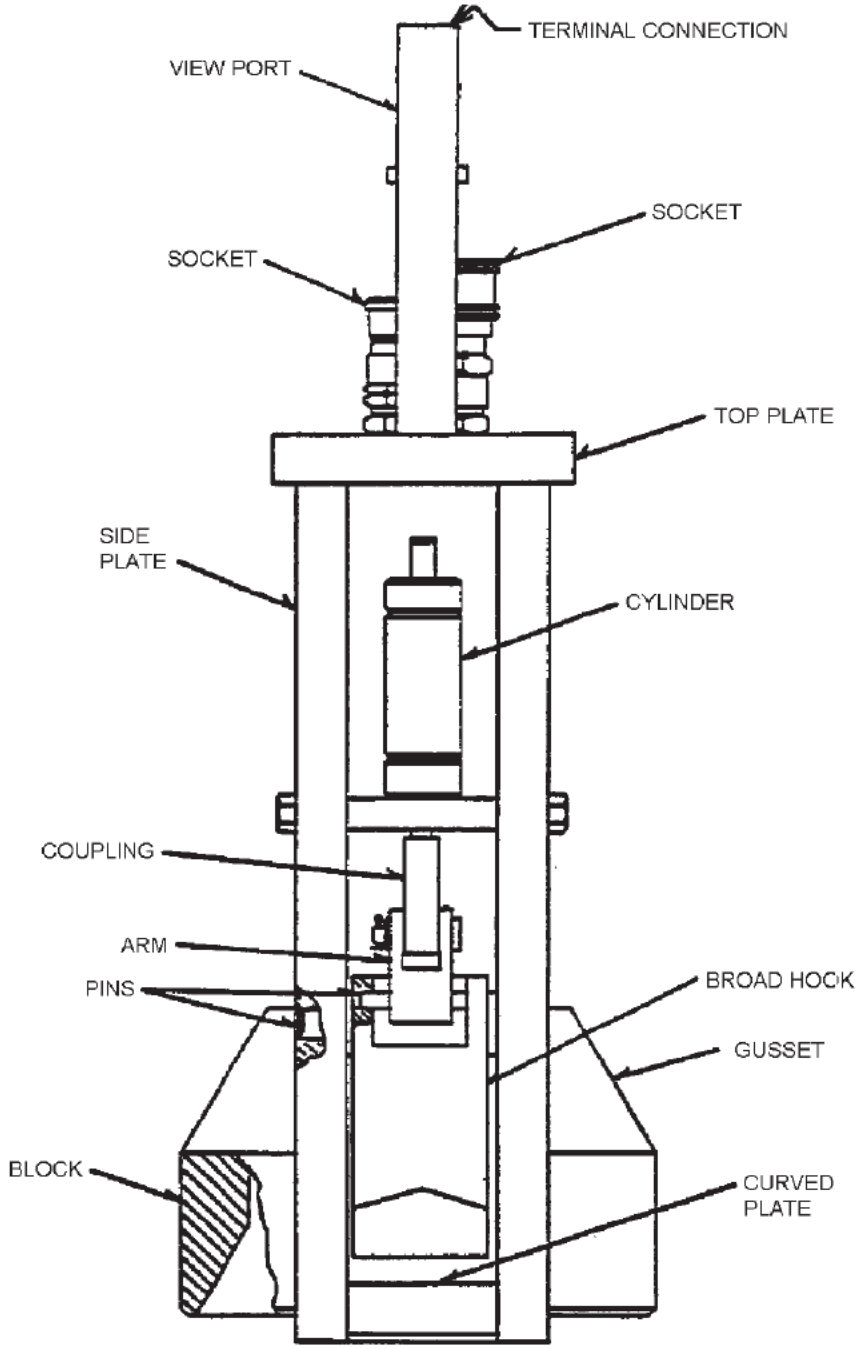
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FUEL TRANSFER STAND

FIGURE 9.1-24, Rev 55

AutoCAD: Figure Fsar 9_1_24.dwg



AIR OPERATED GENERAL PURPOSE GRAPPLE

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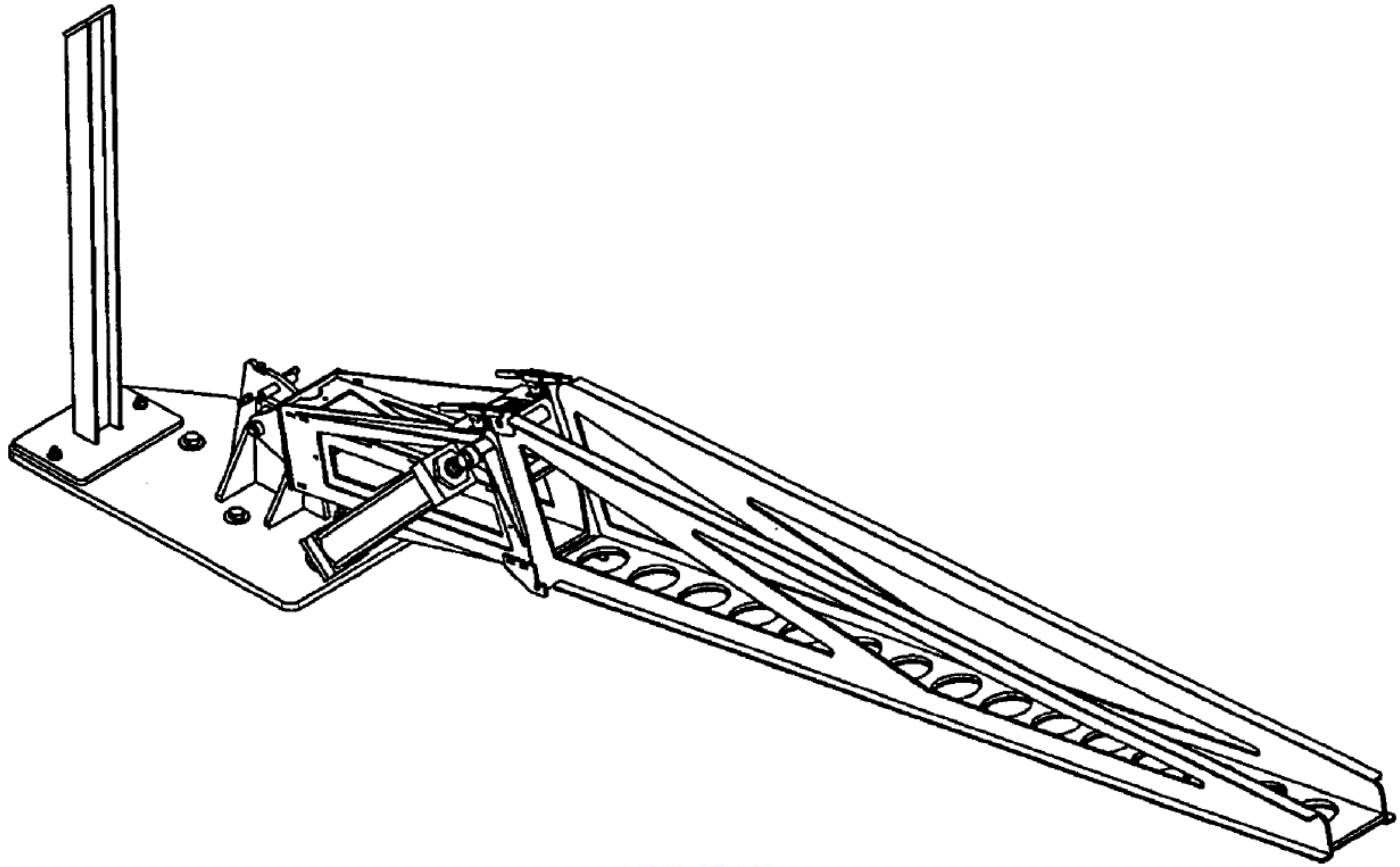
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

AIR OPERATED GENERAL
PURPOSE GRAPPLE BWR 6

FIGURE 9.1-25, Rev 55

AutoCAD: Figure Fsar 9_1_25.dwg



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SUSQUEHANNA STEAM ELECTRIC STATION
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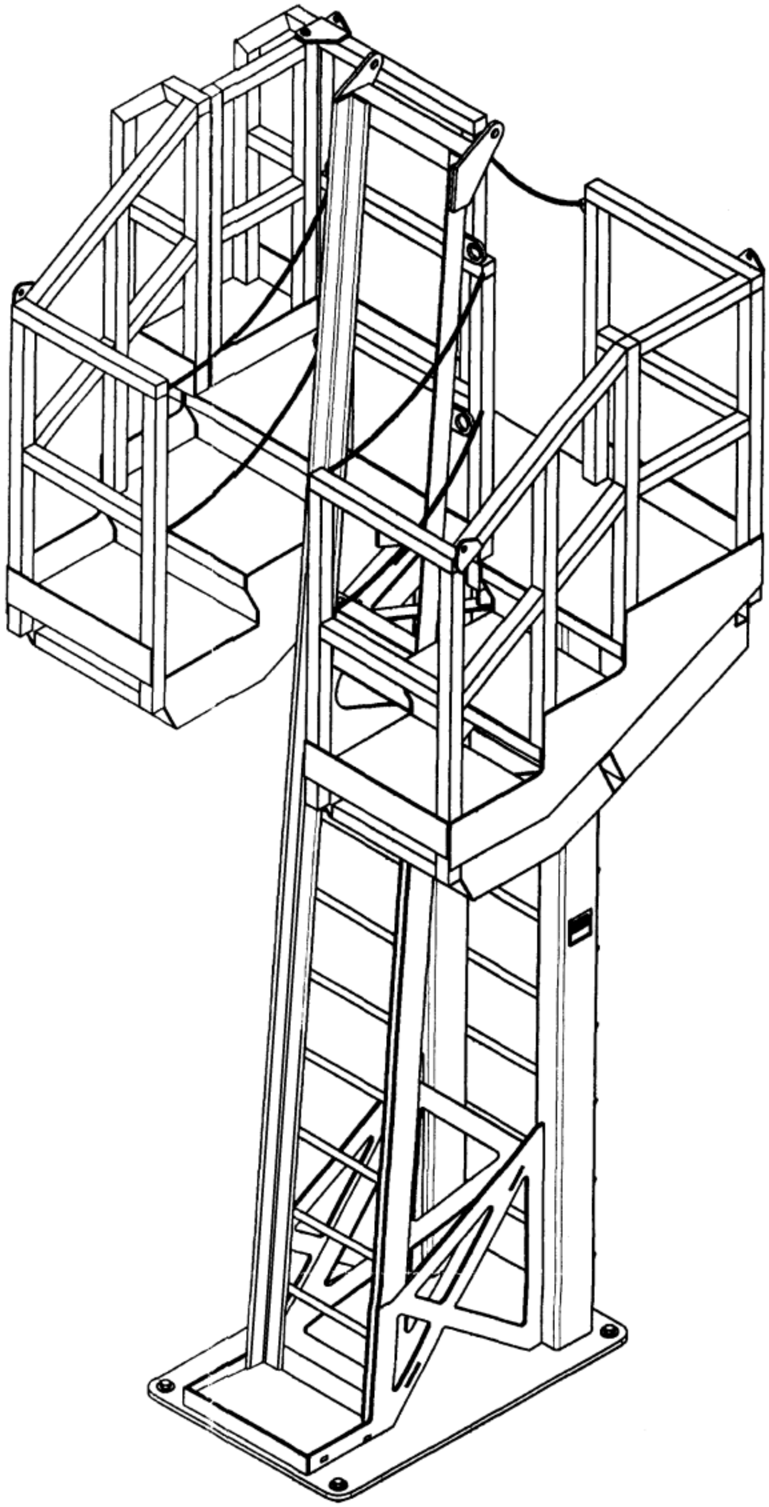
FINAL SAFETY ANALYSIS REPORT

NEW FUEL CHANNEL UP ENDER

FIGURE 9.1-26, Rev 1

AutoCAD: Figure Fsar 9_1_26.dwg



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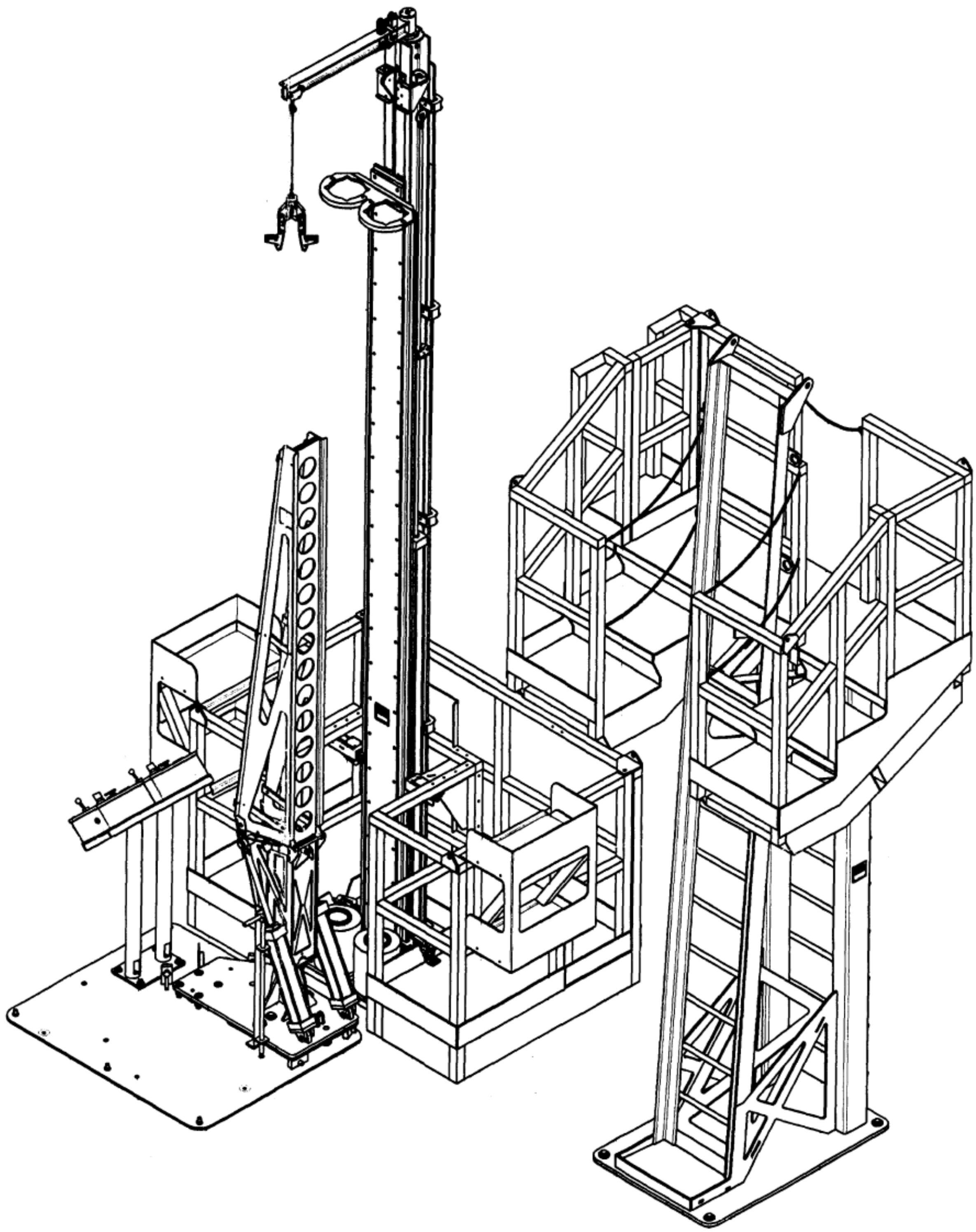
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

NEW FUEL UP ENDING STAND

FIGURE 9.1-27, Rev 1

AutoCAD: Figure Fsar 9_1_27.dwg



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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

NEW FUEL INSPECTION EQUIPMENT
GENERAL ARRANGEMENT

FIGURE 9.1-28, Rev 1

AutoCAD: Figure Fsar 9_1_28.dwg

FIGURE 9.1-7-1 REPLACED BY DWG. M-153, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-7-1 REPLACED BY DWG. M-153, SH. 1

FIGURE 9.1-7-1, Rev. 55

AutoCAD Figure 9_1_7_1.doc

FIGURE 9.1-7-2 REPLACED BY DWG. M-153, SH. 2

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.1-7-2 REPLACED BY DWG. M-153, SH. 2

FIGURE 9.1-7-2, Rev. 55

AutoCAD Figure 9_1_7_2.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.1-17-1, Rev. 55

AutoCAD Figure 9_1_17_1.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.1-17-2, Rev. 55

AutoCAD Figure 9_1_17_2.doc

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

UNIT 1 REFUELING MAST
AND GRAPPLE OUTLINE

FIGURE 9.1-23-1, Rev 55

AutoCAD: Figure Fsar 9_1_23_1.dwg

FIGURE DELETED

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UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.1-17A-1, Rev. 55

AutoCAD Figure 9_1_17A_1.doc

FIGURE DELETED

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FIGURE DELETED

FIGURE 9.1-17A-2, Rev. 55

AutoCAD Figure 9_1_17A_2.doc

FIGURE DELETED

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FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.1-17B-1, Rev. 55

AutoCAD Figure 9_1_17B_1.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
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FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.1-17B-2, Rev. 55

AutoCAD Figure 9_1_17B_2.doc

9.2 WATER SYSTEMS

9.2.1 SERVICE WATER SYSTEM

9.2.1.1 Design Bases

The Service Water System (SWS) has no safety related function and is designed to remove heat from heat exchangers in the turbine, reactor, and radwaste buildings and to transfer this heat to the cooling towers where it is dissipated.

The SWS is designed to operate during normal plant operation and plant shutdown with offsite power available. The system will not operate on loss of offsite power.

9.2.1.2 System Description

The SWS is a single loop, which includes three 50 percent capacity, horizontal, centrifugal, single stage pumps, located in the circulating water pump house, operating in parallel (Normally, two pumps are in service with the third on automatic standby. The system can be operated with one pump in service during plant shutdowns when heat loads are low) to circulate cool side cooling tower water through the heat exchangers listed in Table 9.2-1 and to discharge it back to the tower by way of the circulating water piping. In most cases the service water flows through the heat exchangers' tubes. The system is shown schematically on Dwgs. M-109, Sh. 1, M-109, Sh. 2, M-109, Sh. 3, M-110, Sh. 1 and M-2110, Sh. 1.

The water source and heat sink for the service water system is the cooling tower. The cooling tower dissipates a maximum design heat load of approximately 1.88×10^8 Btu/hr of heat from the service water system. The system is designed for a maximum total flow of 26,617 gpm with a corresponding discharge pressure of approximately 126 psi. The system piping design pressures vary throughout the system. The piping design pressures were established based on the evaluation and location of the piping in the system. Each of the two generating units is provided with a separate SWS and cooling tower, although the two systems are interconnected so that equipment common to both units can be supplied from either SWS.

The system's heat exchangers are sized to operate with 95°F service water at the inlets. For accessible areas the pipe is carbon steel with a corrosion allowance of 0.1875 in., while for inaccessible areas 90/10 copper nickel piping is used.

The temperature of fluids in the respective heat exchangers are regulated by either recirculation of the service water or flow control of the service water.

Recirculation

In this type of regulation the inlet temperature of the service water is controlled by recirculating some of the warm service water discharging from the respective heat exchanger back into the cool service water entering the heat exchanger. The amount of warm service water recirculated is controlled by a valve that is regulated by a temperature controller in the service water discharge from the heat exchanger.

This type of temperature regulation is used for the following:

a) Control structure chillers

b) Radwaste building chillers

c) Turbine building chillers

d) Reactor building chillers.

<u>Flow Control</u>

In this type of regulation the temperature of the fluid being cooled is regulated by adjusting the flow of service water through the respective heat exchanger. This is done by a control valve located in the service water discharge line from the heat exchanger, which is regulated by a temperature controller that senses the temperature of the cooled fluid.

This type of temperature regulation is used for the following:

a) Generator hydrogen coolers

b) Turbine Building Closed Cooling Water (TBCCW) heat exchangers

c) Reactor Building Closed Cooling Water (RBCCW) heat exchangers

d) Gaseous Radwaste Recombiner Closed Cooling Water (GRRCCW) heat exchangers

e) Main turbine lube oil coolers

f) Reactor feed pump turbine lube oil coolers

g) Alterrex air coolers

h) Reactor recirculation pump M-G set hydraulic fluid coolers

The balance of the heat exchangers as listed in Table 9.2-1 have the service water flow adjusted manually to obtain the required fluid temperature.

A back pressure regulator installed in the service water return header from the fuel pool heat exchangers maintains a positive pressure differential between the tube and shell sides of the heat exchangers to prevent possible radioactive contamination of the SWS.

In the case of loss of offsite power, the cooling of the RBCCW heat exchangers and TBCCW heat exchangers can be remote manually transferred from the SWS to the Emergency Service Water System (ESWS) as permitted in system operating procedures. However, since the heat exchangers are designed for non-essential service, the transfer valves are designed to close on failure of the solenoid valves which control them, ensuring no loss of emergency service water.

A Chemical Addition System is located in the basement of the Circulating Water Pumphouse and dispenses water treatment chemicals such as corrosion inhibitors, dispersants, scale inhibitors and biocides directly into the Service Water System pump suction headers of both units. The Chemical Injection System is designed as an independent system (except for required control logic tie-in) so that its failure would not render the SWS inoperable. The system includes pump skids, 2000 gallon storage tanks, control cabinets, and a fill station outside of the Circulating Water Pumphouse.

Internal corrosion is being monitored through periodic non-destructive examination of in-plant piping, including ultrasonic measurement of wall thickness and radiography, at selected locations. This is supplemented by visual inspection of selected piping and components when opened for maintenance, and destructive examination of piping removed during maintenance or modification as appropriate. The inspection program is described in PPL Specification H-1019, Inspection Program for Piping Corrosion and Degradation.

9.2.1.3 Safety Evaluation

The SWS operation has no safety related function and failure of the system will not compromise any safety related system or component or prevent a safe nuclear shutdown.

9.2.1.4 Tests and Inspections

The system is hydrostatically tested prior to startup and preoperationally tested in accordance with the requirements of Chapter 14. The standby pump will be tested and put into regular service periodically to ensure system integrity. Standby heat exchangers will be alternated into service on a regular basis.

9.2.1.5 Instrumentation Applications

The suction header of the service water pumps is provided with a pressure indicator and each pump has a pressure indicator on its discharge line. A temperature indicator is located on the common discharge header. The discharge header is monitored for low pressure. If either of the operating pumps fails, the standby pump will start automatically.

Each heat exchanger in the system, except the Containment ILRT Equipment and the Deaerator Seal Water Cooler, is provided with a pressure test connection or pressure indicator in both the inlet and outlet lines. A temperature indicator is also provided in the outlet lines.

Manually operated throttling valves have been provided downstream of the heat exchangers for initial design service water flow rates adjustment. Automatic temperature control valves have been provided wherever it is necessary to keep operating temperatures controlled within a specific range.

9.2.2 REACTOR BUILDING CLOSED COOLING WATER SYSTEM

9.2.2.1 Design Basis

The Reactor Building Closed Cooling Water (RBCCW) System has no safety related function and is a closed loop system that transfers heat from miscellaneous reactor auxiliary plant equipment to the service water system through the heat exchangers. The plant equipment serviced by the RBCCW system is located in the Reactor and Radwaste Buildings.

The RBCCW system is required to operate during normal operation and on loss of off-site power. In the event that the Reactor Building chillers are unavailable, the RBCCW system is designed to automatically furnish cooling water to the Reactor Building Chilled Water System for drywell cooling. The drywell coolers can also be manually switched to the RBCCW system.

9.2.2.2 System Description

The RBCCW system consists of two 100 percent capacity cooling water pumps, two 100 percent heat exchangers, one head tank, one chemical addition tank, associated valves, piping and controls as shown on Dwg. M-113, Sh. 1.

System containment penetrations and isolation valves are designed to Seismic Category I and ASME Code Section III, Class 2 requirements. The system piping located inside containment to and from the Reactor Recirculation Pump and Motor coolers is designed to ANSI B31.1 requirements. This piping is designed to withstand the SSE such that its failure or loss of function will not impair safety related systems located inside containment. The system piping which is located outside containment is designed to ANSI B31.1 requirements. All piping is carbon steel.

The RBCCW system provides cooling water to non-safety related equipment located in the Reactor and Radwaste Buildings which has the potential to carry radioactive fluids or which requires a clean water supply to minimize long term corrosion. The service water in the heat exchanger tube side is maintained by the service water pumps at a higher pressure than the closed loop system in the heat exchanger shell side. In the event of tube failure, the service water would leak into the closed loop system to preclude the possibility of radioactive release to the environment.

During normal operation, one cooling water pump and one heat exchanger are in service. The second pump is on automatic standby. A heat load of approximately 19.85×10^6 Btu/hr is transferred from the closed cooling water system to the service water system in the heat exchanger. During normal plant operation, the RBCCW system furnishes cooling water to the following components:

The following equipment is located in the Reactor Building:

1) Cleanup Non-Regenerative Heat Exchanger

2) Cleanup Recirculation Pump Coolers

3) Reactor Recirculation Pump Seal and Motor Oil Coolers

4) Reactor Building Sump Cooler

5) Sample Station Chillers and Coolers

6) Containment Instrument Gas Compressor Coolers

7) Process Sampling Cooler

The following equipment is located in the Radwaste Building:

1) Low Pressure Compressor and After Cooler

2) Off gas Precoolers

3) Off gas Refrigeration Condensers

The water is circulated throughout the closed loop by the pump, which is rated at 1100 gpm at 90 ft head. The capacity of cooling water required by each plant component is set by a manual throttling valve on the cooling water outlet of each unit.

The closed loop cooling water temperature leaving the RBCCW heat exchanger is automatically controlled by an air-operated flow control valve located on the service water side. Automatic control is carried out by a temperature indicating controller which maintains the closed cooling water outlet temperature at approximately 90°F. While there is no specified lower limit for operation there is an alarm set at 105°F to ensure cooling is being furnished to the above mentioned components.

Upon loss of off-site power without occurrence of a loss of coolant accident, the RBCCW heat exchangers can be manually switched from the service water (SW) system to the emergency service water system (ESW) as permitted by system operating procedures. The RBCCW pumps start automatically, using standby ac power furnished by the diesel generators in accordance with the loading sequence. One pump can be taken out of service by remote manual switching. The RBCCW system furnishes cooling water to the Reactor Recirculation pump seal water coolers and motor oil coolers. The drywell coolers (RB chilled water system) can be manually valved in after the RBCCW heat exchanger is manually switched from SW to ESW. A total heat load of 7.65×10^6 Btu/hr. would be transferred from the closed cooling water system to the emergency service water system at this time.

The remainder of the RBCCW system receives a reduced amount of cooling water; therefore, no appreciable heat load is transferred from the other RBCCW users. These users can be isolated manually from the system when required.

During loss of off-site power or loss of both Reactor Building chillers, the cleanup non-regenerative heat exchanger is automatically isolated from the RBCCW system.

During certain plant operating conditions, such as startup, excess water is normally removed from the reactor by blowdown through the reactor water cleanup system non-regenerative heat exchanger. During blowdown, the heat rejected to the RBCCW system is 25.19×10^6 Btu/hr. The second RBCCW heat exchanger may be put into service to handle this additional, transient heat duty.

The head tank, which is located at the highest point in the system, accommodates thermal expansion and provides ample net positive suction head (NPSH) to the cooling water pumps. The head tank, which has a capacity of 800 gallons, also provides necessary makeup water as required.

The RBCCW supply and makeup is furnished from the demineralized water system. When required, chemicals are added to the system through the chemical addition tank (15 gal. capacity) to maintain a concentration of 500 ppm of nitrites for corrosion prevention.

The RBCCW system pumps, heat exchangers, chemical addition tank, and head tank are all located in the Reactor Building.

9.2.2.3 Safety Evaluation

The RBCCW has no safety-related function. Failure of the system will not compromise any safety-related system or component or prevent a safe shutdown of the plant.

The RBCCW system is not required to operate after a loss-of-coolant accident. The containment isolation valves will close automatically under this condition.

9.2.2.4 Testing and Inspection Requirements

The RBCCW system is hydrostatically tested prior to operation. The motor-operated containment penetration valves can be manually closed by the operator in the control room. These valves will be tested to assure that they are capable of opening or closing by operating the manual switches and observing the position lights in the control room.

Test connections are located inside containment to test and verify the leak tightness of the containment penetration isolation valves prior to operation.

The RBCCW system pumps, heat exchangers, head tank, chemical addition tank and piping (to the extent practicable) are located in the Reactor Building to permit periodic inspection during normal operation.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.2.2.5 Instrumentation Requirements

The flow rate of cooling water to all coolers is regulated manually by individual throttling valves on the cooling water outlet from each unit. Flow elements are provided for the coolers located inside the primary containment for initial flow balancing of these components. A temperature indicator is provided on the RBCCW system header outside containment to verify satisfactory cooling of components inside containment. Temperature indicators are provided at the outlet of each cooler located outside primary containment except the off-gas precoolers and off-gas refrigeration condensers. Test points are furnished across all coolers in the system except the sample station chillers for pressure measurement.

Continuous radiation monitors are installed in the pump suction header of the RBCCW system. This instrumentation indicates, records, and alarms in the main control room any radioactive leakage into the RBCCW system.

High and low level switches on the RBCCW head tank detect leakage into or out of the system. Switch operation actuates an alarm in the control room. The RBCCW heat exchanger outlet temperature and pressure are monitored. These signals alarm conditions of system high temperature and/or low pressure in the control room.

A low pressure switch is provided on the cooling water pumps discharge header to automatically start the standby pump in the event the system pressure drops below a preset value. The switch also actuates an alarm in the control room.

9.2.3 TURBINE BUILDING CLOSED COOLING WATER SYSTEM

9.2.3.1 Design Basis

The Turbine Building Closed Cooling Water (TBCCW) System has no safety related function and is a closed loop cooling system that transfers heat from miscellaneous turbine plant components to the service water system through the TBCCW heat exchangers.

The TBCCW system is required to operate during normal plant operation. During loss of offsite power, the TBCCW pumps are automatically loaded on the diesel generator and the TBCCW system will operate.

9.2.3.2 System Description

The TBCCW system consists of two 100-percent capacity cooling water pumps, two 100-percent heat exchangers, one head tank, one chemical addition tank, associated valves, piping and controls as shown on Dwg. M-114, Sh. 1. The system is designed to ANSI B31.1 requirements.

The TBCCW system furnishes cooling water to the following turbine plant components:

1) Control Rod Drive Pump Bearing and Oil Coolers
2) Condensate Pump Motor Upper and Lower Bearing Coolers
3) Instrument Air Compressor Coolers
4) Service Air Compressor Coolers
5) EHC Fluid Coolers
6) Turbine Building Sample Station Coolers and Chillers
7) Auxiliary Boiler Sample Station Coolers
8) Auxiliary Boiler Conductivity Monitoring Sample Coolers

During normal plant operation, one cooling water pump and one heat exchanger are in service. The second pump is on automatic standby. A heat load of approximately 1.1×10^6 Btu/hr is transferred from the closed cooling water system to the service water system in the heat exchanger. The water is circulated throughout the closed loop by the pump which is rated at 325 gpm at 120 ft of head. The capacity of cooling water required by each plant component is set by manual throttling valves located on the cooling water outlet of each unit.

The closed loop cooling water temperature leaving the TBCCW heat exchanger is automatically controlled by an air operated flow control valve located on the service water side. Automatic control is carried out by a temperature indicating controller which maintains the closed cooling water outlet temperature at the Operator Adjustable Setpoint between 92 to 98°F.

After a loss of offsite power, the pumps start automatically to provide cooling water to the control rod drive pump bearing/oil coolers and the instrument air compressors as required. The TBCCW heat exchangers tube side flow may be transferred from the service water system to the emergency service water system by remote switching as permitted by system operating procedures. A heat load of 0.24×10^6 Btu/hr would be rejected from the control rod drive pump bearing/gear oil coolers and the instrument air compressors to the emergency service water at this time. TBCCW system operation is not required during a loss-of-coolant accident.

The head tank, which is located at the highest point in the system, accommodates thermal expansion and provides ample net positive suction head (NPSH) to the cooling water pumps. The head tank, which has a capacity of 400 gallons, also provides necessary makeup water as required.

The TBCCW supply and makeup is furnished from the demineralized water system. When required, chemicals are added to the system through the chemical addition tank (15 gal. capacity) to maintain a concentration of at least 500 ppm of nitrites for corrosion prevention.

The TBCCW system pumps, heat exchangers, chemical addition tank, and head tank are all located in the Turbine Building.

9.2.3.3 Safety Evaluation

Since the TBCCW system has no safety-related function, failure of the system will not compromise any safety-related system or component or prevent a safe shutdown of the plant.

9.2.3.4 Testing and Inspection Requirements

The TBCCW system is hydrostatically tested prior to operation. All portions of the system are accessible for visual examination and inspection during normal operation.

The system will be preoperationally tested in accordance with the requirements of Chapter 14.

9.2.3.5 Instrumentation Requirements

The flow rate of cooling water to all coolers is regulated manually by individual throttling valves on the cooling water outlet from each unit. Temperature indicators and test points for pressure measurements are provided on all coolers except the Turbine Building sample coolers and chillers.

High and low level switches on the TBCCW head tank detect leakage into or out of the system. Switch operation actuates an alarm in the control room. The TBCCW heat exchanger outlet temperature and pressure are monitored. These signals alarm conditions of system high temperature and/or low pressure in the control room.

A low pressure switch is provided on the cooling water pumps discharge header to automatically start the standby pump in the event the system pressure drops below a preset value. The switch also actuates an alarm in the control room.

9.2.4 GASEOUS RADWASTE RECOMBINER CLOSED COOLING WATER SYSTEM

9.2.4.1 Design Basis

The Gaseous Radwaste Recombiner Closed Cooling Water (GRRCCW) System has no safety related function and is a closed loop cooling system that transfers heat from the gaseous radwaste recombiner condenser condensate cooler, and motive steam jet condenser to the service water system through the GRRCCW heat exchangers.

The GRRCCW system is required to operate only during normal plant operation.

9.2.4.2 System Description

A separate GRRCCW system is provided for each of the three recombiner trains. Each closed cooling water system consists of one cooling water pump, one heat exchanger, one head tank, one chemical addition tank, associated valves, piping and controls as shown on Dwg. M-131, Sh. 1. The system is designed to ANSI B31.1 requirements.

The GRRCCW system furnishes cooling water to only its respective gaseous radwaste recombiner skid.

During normal operation when a recombiner train is in operation, the heat transferred from its respective GRRCCW system to the service water system is approximately 18.71×10^6 Btu/hr in the heat exchanger. The design of the heat exchanger is approximately 18.94×10^6 Btu/hr. At this time the single cooling water pump and heat exchanger are in operation. The cooling water pump is rated at 1450 gpm at a head of 100 ft. Since the recombiner skids are the only components on the GRRCCW system, no throttling valves are required for flow regulation.

The closed cooling water temperature leaving the GRRCCW heat exchanger is automatically controlled by a flow control valve located on the service water side. GRRCCW temperature is regulated to as low as possible down to 60°F minimum. When a recombiner train is in operation, the closed cooling water pump, which is started by manual initiation in the control room, circulates the cooling water throughout the GRRCCW system.

The head tank, which is located at the highest point in the system, accommodates thermal expansion and provides ample net positive suction head (NPSH) to the cooling water pump. The head tank, which has a nominal capacity of 400 gallons, also provides necessary makeup water as required.

The GRRCCW supply and makeup is furnished from the demineralized water system. When required, chemicals are added to the system through the chemical addition tank (15 gallons capacity) to maintain a concentration of 500 ppm of nitrites for corrosion prevention.

The GRRCCW system pump, heat exchanger, head tank and chemical addition tank are all located in the Turbine Building.

9.2.4.3 Safety Evaluation

Failure of the GRRCCW system will not compromise any safety-related system or component or prevent a safe shutdown of the plant.

9.2.4.4 Testing and Inspection Requirements

The GRRCCW system is hydrostatically tested prior to operation. In lieu of hydrostatic testing, alternate test/evaluation may be used provided the piping integrity is evaluated and dispositioned in accordance with 10CFR50.59. (See Reference 9.2-5) All portions of the system are accessible for visual examination and inspection during normal operation.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.2.4.5 Instrumentation Requirements

A temperature indicator is provided at the outlet of the recombiner train. Test points are furnished across the recombiner train for pressure measurement. A flow element has been included in the system piping for flow determination.

High and low level switches on the GRRCCW head tank detect leakage into or out of the system. Switch operation actuates an alarm in the control room. The GRRCCW heat exchanger outlet temperature and pressure are monitored. These signals alarm in the control room conditions of system high/low temperature and low pressure.

The closed cooling water pump operation is controlled by a handswitch located in the control room. A low pressure switch located on the pump discharge header signals an alarm in the control room if system pressure falls below a preset value.

9.2.5 EMERGENCY SERVICE WATER SYSTEM

9.2.5.1 Design Bases

The Emergency Service Water System (ESWS) has a safety related function and is designed to supply cooling water to the emergency diesel generator units, RHR pumps, and to those room coolers (except for the emergency switchgear and load center room coolers, which are normally supplied by the control structure chilled water system in Unit 1 or the direct expansion (DX) cooling system in Unit 2) required during normal and emergency conditions necessary to safely shut down the plant.

The ESWS is designed to take water from the spray pond (the ultimate heat sink), pump it to the various heat exchangers and return it to the spray pond by way of a network of sprays that dissipate the heat to the atmosphere.

The ESWS is required to supply cooling water to:

a) The RHR pump room unit cooler and the motor bearing oil cooler of each RHR pump during all modes of operation of the RHR system.

b) All the heat exchangers associated with the four diesel generators aligned to the system during operation and test modes, except for the governor oil coolers.

c) The room coolers for the core spray (CS) pumps, the high pressure coolant injection (HPCI) pumps, and reactor core isolation cooling (RCIC) pumps during the operation of these systems.

d) The control structure chiller, the Unit 2 emergency switchgear cooling condensing unit, reactor building closed cooling water (RBCCW) heat exchangers, and the turbine building closed cooling water heat exchanger (TBCCW) during emergency operation.

e) The Spent Fuel Pools to provide makeup for evaporative losses during operation of the normal Fuel Pool Cooling system or RHRFPC mode, as well as, filling the SFP in support of RHRFPC. The ESWS is also capable of supplying makeup for postulated boiling conditions as described in Appendix 9A for a seismic event.

The ESWS starts automatically within approx. 40-100 seconds after the diesel generators receive their start initiation signal. The ESWS can also be started manually from either the main control room or from one of the two remote shutdown panels. (i.e., ESW loop A can only be started from the Unit 2 remote shutdown panel and ESW loop B can only be started from the Unit 1 remote shutdown panel.)

The ESW pump start sequence is controlled by a timer circuit in order to avoid unacceptable voltage drops. This timer circuit includes provisions to avoid simultaneous starts of the ESW, RHR, and CS pumps.

The ESWS is designed to operate during any of the following conditions:

a) Loss of offsite power

b) The operating basis earthquake (OBE)

c) Design high and design low level spray pond conditions.

It is also designed to remain functional following the design Safe Shutdown Earthquake (SSE).

The ESWS has sufficient redundancy so that a single failure of any active component, assuming the loss of offsite power, cannot impair the capability of the system to perform its safety related functions.

The system is designed so that the emergency service water is at a higher pressure than each of the fluids being cooled. This avoids the possibility of any radioactive leakage into the system.

ESWS Pipe Crack Leakage Detection is discussed in Section 9.2.5.6.

The ESWS will operate under the conditions set by the design basis accident (DBA) for no less than 30 days with no water makeup to the spray pond. Under these conditions the pond's depth will always be greater than the minimum submergence of 7 ft required by the pumps (see Subsection 2.4.11.5).

Active components of the ESWS can be inspected and tested during plant power generation.

The system is designed for the 40 year life of the plant. Since the system must perform during the period of extended operation, aging of equipment is managed to ensure it continues to perform its intended function.

9.2.5.2 System Description

The ESWS is shown schematically in Dwgs. M-111, Sh. 1, M-111, Sh. 2, M-111, Sh. 3, and M-111, Sh. 4. The system consists of two loops each of which is designed to supply 100 percent of the ESW requirements to both units and the common emergency diesel generators simultaneously.

A fifth diesel generator (Diesel Generator 'E') is installed and serves as a replacement for any one of the normally aligned emergency diesel generators (A, B, C, or D). In the event that a diesel generator is removed from service for repair or maintenance, Diesel Generator 'E' can be aligned to the Class 1E power supply. Under these conditions, the normally aligned Loop A and B isolation valves at the disabled diesel generator are closed and the ESW Loop A and B isolation valves at the Diesel Generator 'E' are opened.

Whenever Diesel Generator 'E' is not aligned and in the test mode, it is connected to either Loop A or B of ESW system. The other four operable diesel generators (A, B, C and D) are normally aligned to the ESW Loop A and B system. In the event of an emergency start signal (LOCA or Loop) while Diesel Generator 'E' is operating in the test mode, the Diesel Generator 'E' Loop A and Loop B isolation valves will automatically close.

Each loop of the ESWS buried supply header and the RHRSW buried return header have connections as shown schematically in Dwgs. M-111, Sh. 1 and M-112, Sh. 1. Plant shutdown flow rates are listed in Table 9.2-3. Each loop has two 50 percent capacity, vertical, turbine type, single stage pumps operating at 1780 rpm and rated at 6000 gpm each. These are located in the engineered safeguard service water pumphouse which is built at the edge of the spray pond. Description of the pumphouse is found in Subsection 3.8.4.

The emergency service water flows through the tube side of all heat exchangers. The tubes in the air cooling coils for the ECCS and RCIC pump room coolers are constructed of AL-6XN, a high performance stainless steel that is resistant to Microbiologically Influenced Corrosion (MIC). All other heat exchangers, except those in the RHR pump motor coolers and diesel generator B&D jacket water coolers, have 90/10 Cu-Ni tubes. The RHR pump motor oil coolers and diesel generator B&D jacket water coolers utilize stainless steel (AL-6XN) tubes.

The supply and return piping is made of carbon steel with a 1/4 in. corrosion allowance. All piping outside of the pumphouse, main plant, and spray pond is buried and it is coated and wrapped for corrosion protection, except piping surfaces without coating that were evaluated and determined to be acceptable without further repair. Corrosion protection will be provided by the Catholic Protection system. Copper-copper sulfate reference electrodes are installed near the damaged pipe surfaces to monitor pipe to electrolyte potential which is indicative of level of corrosion protection to the pipe surfaces. The potential is monitored at regular interval selected for the Cathodic Protection system. Internal corrosion is being monitored through periodic non-destructive examination of in-plant piping, including ultrasonic measurement of wall thickness and radiography, at selected locations. This is supplemented by visual inspection of selected piping and components when opened for maintenance, and destructive examination of piping removed during maintenance or modification as appropriate. The inspection program is described in PPL Specification H-1019, Inspection Program for Piping Corrosion and Degradation.

If necessary, buried piping can be accessed for corrosion evaluations. The buried return pipe to the spray pond is predominantly 36 in. diameter, which can be entered and visually examined. Manways with removable blind flanges are provided to allow periodic inspection of the inside of the pipe.

In-service inspection will be in accordance with ASME B&PV Code, Section XI for Section III, Class 3 components. The piping is designed, fabricated, inspected, and tested in accordance with requirements of ASME B&PV Code, Section III, Class 3. The spray pond piping network and ESSW pumphouse are described in Subsections 9.2.7 and 3.8.4 respectively.

During normal power generation the ESWS is not operating but is available for shutdown cooling, suppression pool cooling, surveillance testing or emergencies. The system is initiated automatically once the emergency diesel generators have started (see Subsection 9.2.5.1).

Following a loss of off-site power, ESW is protected from water hammer by two vacuum breakers installed on the control structure chiller return line and a check valve on its supply line. Additionally, Unit 2 ESW is protected from water hammer by a vacuum breaker installed on the return line of the direct expansion unit (Dx) and a check valve on its supply line.

The Emergency Condenser Water Circulating Pump (OP-171) is protected from being air bound after the vacuum breakers open by having the air purged from the return line (air can be introduced to the pump supply via the temperature mixing valve, TV 08612) before the pump starts.

Each of the two ESWS loops supply cooling water to separate equipment in each unit, except in the case of the common emergency diesel generators, RHR Pump 1P202C motor bearing oil cooler 1E217C, RHR Pump 1P202D motor bearing oil cooler 1E217D, RHR Pump 2P202C motor bearing oil cooler 2E217C and RHR Pump 2P202D motor bearing oil cooler 2E217D. This arrangement provides the necessary cooling capacity required by both units while maintaining the redundancy of active components and loops. The emergency diesel generator heat exchangers, RHR Pump 1P202C motor bearing oil cooler 1E217C RHR Pump 1P202D motor bearing oil cooler 1E217D, RHR Pump 2P202C motor bearing oil cooler 2E217C and RHR Pump 2P202D motor bearing oil cooler 2E217D are connected to both ESWS loops and they can be supplied by either.

It is not considered credible to have a common cause loss of the common RHRSWS/ ESWS loop that affects the systems capability to bring either or both units to a safe shutdown condition under emergency conditions. See 9.2.6.2.

Motors of the four ESWS pumps are connected to each of the four aligned diesel generator Unit 1 buses which serve as backup in the case of loss of offsite power. When loss of offsite power occurs, the four (4) aligned diesel generators start automatically and these provide emergency power for the pumps and motor operated valves. This transfer from the offsite power source to the standby power supply is automatic.

9.2.5.3 Safety Evaluation

The ESW system, with the exception of the buried piping and the piping in the spray pond, is housed within either the reactor building, the control structure, the diesel generator buildings or the ESSW pumphouse, all of which are Seismic Category I. Tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

Each unit has two 100 percent capacity independent ESWS loops to supply cooling water for plant shutdown. This arrangement ensures that the full heat removal capacity required is available after the postulated active failure of a single component.

Each loop is isolated from the other by barriers, separate trenches, or distance to ensure that simultaneous loss of both loops cannot occur.

Failure of either a motor operated valve, an aligned diesel generator, or an ESW pump, will not prevent the system from removing the full heat capacity.

Overpressure protection is provided in the portion of the ESW piping serving Diesel Generator 'E'. A thermal relief valve is utilized to prevent overpressurization following the operation of Diesel Generator 'E' and the subsequent closure of the Loop A and B isolation valves.

Upon loss of power, all safety related components (pumps, valves, and instruments) of this system will automatically be switched to the standby power supply (see Section 8.3).

Except for the Reactor Building Closed Cooling Water (RBCCW) heat exchanger and the Turbine Building Closed Cooling Water (TBCCW) heat exchanger, the entire ESWS including structures, pumps, motors, piping, valves, heat exchangers, and essential instruments are designed in accordance with Seismic Category I requirements. The RBCCW and TBCCW heat exchangers are not Seismic Category I since these are non-essential services. The RBCCW and/or TBCCW heat exchangers can be manually connected to one loop of ESW provided the other ESW loop is operable. Since the RBCCW and TBCCW heat exchangers are manually connected to the ESW after loss of off-site power, a failure of the non-safety related piping followed by a single failure in the safety related emergency service water system will not preclude one of the ESW loops from performing its safety function. If the single failure occurs in the emergency service water loop not connected to TBCCW or RBCCW, RBCCW and TBCCW will be manually isolated from the connected loop as permitted by system operating procedures. If the single failure is in the normally closed, fail closed isolation valve (between ESW and RBCCW/TBCCW), the remaining emergency service water loop would not be affected.

Operators will verify the integrity of the non-essential piping prior to valving it onto the ESW system.

The ESWS is designed to include the capability for testing through the full operational sequence that brings the system into operation for reactor shutdown and for LOCA, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

The ESWS pumps, piping, and heat exchangers are sized to provide the flow and cooling capacities required by the various RHR pump and motor coolers during any mode of RHR operation. Tables 9.2-3, 9.2-4 and 9.2-5 show the users and cooling duties on the ESW cooling cycle.

Table 9.2-3 lists all users; Tables 9.2-4 and 9.2-5 relate users to time for two types of shutdown.

The cooling loads are carried out to 30 days after the shutdown initiation since this is the design life of the ultimate heat sink for operation without make-up water. The operation of all equipment listed at the cooling duty shown represents design conditions. Under actual operating conditions certain pieces of equipment may be shutdown or operated under reduced loads.

9.2.5.4 Tests and Inspections

The ESWS will be hydrotested in accordance with ASME Section III. Pipe welds are subjected to heat treatment, testing, and inspection according to ASME Section III and the material specification.

The system components will be preoperationally tested in accordance with the requirements of Chapter 14.

The ESWS will be tested during normal plant operations in accordance with the requirements of the Technical Specifications.

9.2.5.5 Instrumentation Applications

Logics and instrumentation are discussed in Subsection 7.3.1.1b and the displays are discussed in Section 7.5. A complete list of the system's safety related process instrumentation is provided in Table 7.5-5.

The ESWS pumps are designed for remote operation from the control room. Loop B can be remotely operated from the Unit 1 Remote Shutdown Panel, and Loop A can be remotely operated from the Unit 2 Remote Shutdown Panel. Each loop has been provided with a pump discharge pressure transmitter, the indicator for which is in the control room, and each pump chamber is provided with a low level submergence switch which alarms in the control room.

9.2.5.6 Pipe Crack Leakage Detection

Leakage from the ESWS can be detected by one of several methods depending on location. Leakage from piping within the ESSW Pumphouse drains into a pit which is equipped with a level switch to alarm on high water. The yard piping from the ESSW pumphouse to the pump discharge flow elements is contained in a guard pipe which drains back to the ESSW Pumphouse and into the same pit as described above. The remaining yard piping is located in a high traffic area and the presence of a significant leak will be visually apparent.

Leak detection within the Reactor Buildings, Control Structure and Diesel Generator Buildings differs depending on the location. Seismically analyzed room flood detectors are used in the lowest elevations, such as, the RHR, Core Spray, HPCI, RCIC and TBCCW Heat Exchanger rooms. Flood detection for the rooms containing ESW lines supplying the RBCCW heat exchangers, Control Structure Chillers, Unit 2 Dx units and Fuel Pool Makeup is not feasible nor desirable, since the lines are located in upper elevations of the Reactor Building and Control Structure. In these areas, floor drains route the leakage to radwaste via either the Reactor Building or Turbine Building sumps. The excessive influent into the radwaste system will alert operators to a pipe leak.

9.2.6 RHR SERVICE WATER SYSTEM

9.2.6.1 Design Bases

The Residual Heat Removal Service Water System (RHRSWS) has a safety related function and is designed to supply cooling water to the residual heat removal (RHR) heat exchangers of both units.

The RHRSWS is designed to take water from the spray pond (the ultimate heat sink), pump it through the RHR heat exchanger, and return it to the spray pond by way of a spray network that dissipates the heat to the atmosphere.

The RHRSWS is designed to provide a reliable source of cooling water for all operating modes of the RHR system including heat removal under post-accident conditions, RHR Fuel Pool Cooling (RHRFPC) following a seismic event, and also to provide water to flood the reactor core or the primary containment after an accident, should it be necessary.

The RHRSWS is designed to operate under any of the following conditions:

a) Loss of offsite power

b) Design high and design low level spray pond conditions

c) A safe shutdown earthquake (SSE).

The RHRSWS is designed with sufficient capacity and redundancy so that a single failure of any active component, assuming the loss of offsite power, cannot impair the capability of the system to perform its safety related functions.

A radiation monitor is provided in the RHRSW service water discharge piping from each RHR heat exchanger to alarm in the event of high activity level.

RHRSWS Pipe Crack Leakage Detection is discussed in Section 9.2.6.6. The RHRSWS is designed with the capability to operate under the conditions set by the design basis accident (DBA) for no less than 30 days without water makeup to the spray pond. The pond's depth will

always be greater than the minimum submergence depth of 5 ft required by the pumps. (See Subsection 2.4.11.5.)
Active components of the RHRSWS can be inspected and tested during plant power generation.

The system is designed for the 40 year life of the plant. Since the system must perform during the period of extended operation, aging of equipment is managed to ensure it continues to perform its intended function.

9.2.6.2 System Description

The RHRSWS is shown schematically in Dwg. M-112, Sh. 1. The system consists of two RHRSWS loops (A and B) per unit. Each loop has a 100 percent capacity, vertical, turbine type two stage pump operating at 1180 rpm and a rated capacity of 9000 gpm. The Unit 1 A and Unit 2 A loop pumps are cross connected so that they can supply cooling water to either the Unit 1 A or the Unit 2 A loop heat exchanger. The same is true for the Unit 1 B and Unit 2 B loop pumps. The four RHRSWS pumps are located in the ESSW pumphouse at the edge of the spray pond. A description of the pumphouse is found in Subsection 3.8.4. The RHR heat exchangers are described in detail under the RHR system.

The RHR service water flows through the tube side of the RHR heat exchangers, the tubes of which are made of corrosion resistant 70 - 30 Cu-Ni in accordance with ASME Section II, SB-395. The supply and return piping is made of carbon steel with a 1/4 in. corrosion allowance. All piping outside of the pumphouse, main plant, and spray pond is buried and it is coated and wrapped for corrosion protection. Piping surfaces found with damaged coating and or protective wrapping were left in as-found condition without any repair. Corrosion protection will be provided by the Cathodic Protection system. Copper-copper sulfate reference electrodes are installed near damaged pipe surfaces to monitor pipe to electrolyte potential which is indicative of level of corrosion protection to the pipe surfaces. The potential is monitored at regular interval selected for the Cathodic Protection system. Internal corrosion is being monitored through periodic non-destructive examinations of in-plant piping, including ultrasonic measurement of wall thickness and pipe radiography, at selected locations. This is supplemented by visual inspection of selected piping and components when opened for maintenance, and destructive examination of piping removed during maintenance or modification as appropriate. The inspection program is described in PP&L Specification H-1019, Inspection Program for Piping Corrosion and Degradation.

If necessary, buried piping can be accessed for corrosion evaluations. The buried return pipe to the spray pond is predominantly 36 in. diameter, which can be entered. Manways with removable blind flanges are provided to allow inspection of the inside of the pipe.

In-service inspection will be in accordance with ASME B&PV Code, Section XI for Section III Class 3 components. The piping is designed, fabricated, inspected, and tested in accordance with requirements of ASME B&PV Code, Section III, Class 3. The spray pond piping network and ESSW pumphouse are described in Subsections 9.2.7 and 3.8.4, respectively.

During normal power generation the RHRSWS is not operating, but is available for normal shutdown or emergencies.

When under emergency conditions, the RHRSW pump motors obtain their power from the standby power supply. The pumps are started manually 10 minutes after the diesel generators start. Waiting 10 minutes allows sequential loading of the diesel generators so that they will not be overloaded.

The buried pipe runs of each of the two RHRSWS loops are shared by both units and this provides the necessary capacity required for both units while maintaining the redundancy of active components and loops. Both the cooling water discharging from the RHR heat exchanger and the cooling water headers to the spray pond discharging from the corresponding ESW system are returned to the spray pond in a common header.

There are no credible single failures that can result in the loss of a common loop of RHRSW/ESW heat removal systems. There are no single active component failures that can cause this loss, no passive failures that could not be tolerated, and no operator error that could not be corrected in time to prevent plant or system damage.

Should the capability to remove decay heat from an unfaulted unit be lost, there is sufficient procedural and design capacity available to allow recovery of offsite power, repair of single failure or recovery from operator error.

Single failure coping can be accomplished with existing procedures. The Primary Containment Control Emergency Operating procedure leads directly to containment protection actions in the event of high drywell pressure and temperature. These actions permit extended operation without heat removal and assure maintenance of adequate core cooling. Extended duration without containment heat removal has been evaluated for the more extreme case of the station blackout, where containment integrity and adequate core cooling can be maintained indefinitely provided that the containment is vented according to the procedure. In addition, a distribution manifold is provided on each division of the Unit 2 RHRSW system to support plant shutdown under extended loss of AC power conditions. The distribution manifold can be used to provide cooling water to the RCIC lube oil cooler, RHR pump motor oil cooler and RHR pump room cooler under extended loss of AC power conditions. Normally closed isolation valves are provided on each manifold connection point. No RHRSW distribution manifold is installed in Unit 1. In Unit 1, cooling to the RHR pump motor oil cooler and RHR pump room cooler are provided from valves 112077 (Division 1) or 112084 (Division 2) under extended loss of AC power conditions. Cooling to the RCIC lube oil cooler is provided from valves 112017 (Division 1) or 112023 (Division 2) under extended loss of AC power conditions. The redundant fuel pool makeup connection points provided on the Unit 2 RHRSW distribution manifold can provide makeup to both Units spent fuel pools under extended loss of AC power conditions; therefore no Unit 1 fuel pool makeup connections are required.

The defense in depth is therefore maintained for the decay heat removal capability. Design requirements for the heat removal capability specifically require design tolerance of single failures under DBE conditions. The decay heat removal systems are suitably designed, as required by General Design Criteria 38 and 44, to tolerate credible single failures without loss of the capability, and the plant is suitably designed to tolerate a temporary loss of the capability for a reasonable duration as may be required to recover the plant heat removal systems.

Motors of the four RHRSWS pumps are connected to each of the four diesel generator buses that serve as backup in the case of loss of offsite power. When loss of offsite power occurs, the diesel generators start automatically, providing emergency power for the pumps and motor operated valves. This transfer from the offsite power source to the standby power supply is automatic. Although the transfer from offsite power to standby power supply is automatic, the pumps themselves have to be started manually.

To prevent freezing, there is provision for draining the piping in the spray pond.

9.2.6.3 Safety Evaluation

The RHRSW system, with the exception of the buried piping and the piping in the spray pond, is housed within either the reactor building or ESSW pumphouse, both of which are Seismic Category I. Tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

Each generating unit has two independent RHRSWS loops, one for each RHR heat exchanger, to supply cooling water for plant shutdown. This arrangement ensures that the full heat removal capacity required is available after the postulated active failure of a single component.

Each loop is isolated from the other by barriers, separate trenches, or distance to ensure that simultaneous loss of both loops cannot occur.

Failure of either a motor operated valve, a diesel generator, or RHRSW pump will not prevent the system from removing the full heat capacity.

The entire RHRSWS including structures, pumps, motors, piping, valves, heat exchangers, and essential instruments are designed in accordance with Seismic Category I requirements.

The RHRSWS is designed to include the capability for testing through the full operational sequence that brings the system into operation for reactor shutdown and for LOCA, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

The RHRSWS pumps, piping, and heat exchangers are sized to provide the flow and cooling capacities required by the RHR system during any mode of its operation. Tables 9.2-3, 9.2-4 and 9.2-5 show the users and cooling duties on the ESW cooling cycle.

Table 9.2-3 lists all users; Table 9.2-4 and 9.2-5 relate users to time for two types of shutdown.

9.2.6.4 Tests and Inspections

The RHRSWS will be hydrotested in accordance with ASME Section III. Pipe welds are subjected to heat treatment, testing, and inspection according to ASME Section III and the material specification.

The system will be preoperationally tested in accordance with the requirements of Chapter 14.

The RHRSWS will be tested during normal plant operations in accordance with the requirements of the Technical Specifications.

9.2.6.5 Instrumentation Applications

Logics and instrumentation are discussed in Subsection 7.3.1.1b and the displays are discussed in Section 7.5. A complete list of the system's process instrumentation is provided in Table 7.5-1.

The RHRSWS pumps are designed for remote operation from the control room. One loop from each unit can be remotely operated from either of the two remote shutdown panels. Each pump has been provided with a discharge pressure transmitter, the indicator for which is in the control room. Each pump chamber is provided with a low level submergence switch that alarms in the control room.

The main water supply line to each heat exchanger is instrumented with control room mounted flow indication, low flow alarm, high temperature alarm, and low pressure alarm. Each heat exchanger has control room operated isolation valves on the inlet and outlet, which remain closed until the system is operated or tested.

Double remotely operated isolation valves are provided on the cross-tie lines between the RHRSW system and the RHR pump discharge for flooding the containment if such action is necessary and no other source of water is available.

9.2.6.6 Pipe Crack Leakage Detection

Leakage from the RHRSWS can be detected by one of several methods depending on location. Leakage from piping within the ESSW Pumphouse drains into a pit which is equipped with a seismically analyzed flood detector. The yard piping from the ESSW pumphouse to the pump discharge flow elements is contained in a guard pipe which drains back to the ESSW Pumphouse and into the same pit as described above. The remaining yard piping is located in a high traffic area and the presence of a significant leak will be visually apparent.

The RHRSW piping in the Reactor Buildings are located within the RHR rooms which are designed as watertight compartments, as discussed in Section 3.4. Leakage into the rooms will be detected by seismically analyzed room flood detectors.

9.2.7 ULTIMATE HEAT SINK

The ultimate heat sink has safety related functions and provides cooling water for use in the Emergency and RHR Service Water systems, described in Subsections 9.2.5 and 9.2.6, during ESSW testing, normal shutdown, and accident conditions.

9.2.7.1 Design Bases

The ultimate heat sink is capable of providing sufficient cooling water without makeup to the spray pond for at least 30 days to (a) permit simultaneous safe shutdown and cooldown of both nuclear reactor units and maintain them in a safe shutdown condition, (b) mitigate the effects of an accident in one unit, permit safe control and cooldown of the other unit, and maintain it in a safe shutdown condition or (c) permit simultaneous safe shutdown and cooldown of both units and maintain them in safe shutdown while providing adequate cooling to both spent fuel pools following a seismic event. Continued cooling beyond 30 days is ensured by use of the makeup pumps to keep the pond at normal water level. The makeup pumps are designed to operate below the historic minimum water level of the Susquehanna River. In the event that makeup water from the makeup pumps is not available, additional provisions will be made in the 30 days available to assure continued cooling of the emergency equipment beyond 30 days. These provisions include but are not limited to: re-establishing makeup pump flow to the spray pond, emptying the cooling tower basins into the spray pond, trucking in water from neighboring water sources (such as the Susquehanna River), and providing temporary pumps and/or lines to pump water from neighboring water sources (such as the Susquehanna River, on site storage tanks, well water, etc.). This is in compliance with NRC Regulatory Guide 1.27 Rev. 2 as discussed in Section 3.13.

The ultimate heat sink is also capable of providing enough cooling water without makeup, for a design basis LOCA in one unit with the simultaneous shutdown of the other unit, for 30 days while assuming a concurrent SSE, single failure, and loss of offsite power. This event is evaluated in Subsection 9.2.7.3.1.

The ultimate heat sink consists of at least one highly reliable water source with a capability to perform the safety function required above during and after any one of the following postulated design basis events:

a) The most severe natural phenomena, including the safe shutdown earthquake, tornado, flood, or drought taken individually

b) Nonconcurrent site related events including loss of offsite power, transportation accidents, or oil spills and fires

c) Reasonably probable combinations of less severe natural phenomena and/or site related events

d) Any credible single mechanistic failure of a man-made structure or component.

Codes and standards applicable to the ultimate heat sink are listed in Table 3.2-1.

9.2.7.2 System Description

9.2.7.2.1 General Description

The ultimate heat sink for both units consists of the Susquehanna River and one Seismic Category I spray pond. These water sources ensure that a reliable source of cooling water is available, for shutdown and cooldown of the reactor, and for mitigation of accident conditions. Pertinent design data for ultimate heat sink components is given in Tables 9.2-6 and 9.2-7.

The spray pond is initially filled from the Susquehanna River by four makeup water pumps. Pond level is maintained under normal conditions by rainfall on the pond surface (46 inches per year average) and by a small continuous flow of makeup water from the Susquehanna River. The average rainfall will generally exceed the average evaporation from the pond by 2 million gallons per year. This excess rainwater will tend to decrease the concentration of total dissolved solids (TDS) in the pond. This decrease is offset by evaporative losses and by the ingress of more concentrated cooling tower basin water from ESW keepfill, valve leakage and hot circulating water. The hot circulating water, at a flow rate of less than 100 gpm, is used as required to de-ice the screens at the pump suctions. The concentration of dissolved solids will be between that of the river water and the water in the cooling tower basis, depending upon the quantity of heat rejected to the pond, evaporative losses, blowdown and other liquid losses, and the ratio of river water makeup to circulating water ingress.

During an emergency, accompanied by the loss of makeup pumps, up to 67% of the pond water may be lost by evaporation over 30 days, assuming conditions that maximize evaporative losses. This would approximately triple the concentration of dissolved solids in the pond. Liquid losses under these conditions can increase the total losses to a maximum 96% of the initial volume, which will further increase concentration.

Shortly after a DBA, heat transfer surfaces in ESW and RHRSW can approach 150°F. Concentration of pond water can cause scale (calcium carbonate) to form on hot surfaces. Pond chemistry will be controlled during normal operation so that no operator action will be needed to prevent scaling during the first week following the initiation of an emergency condition. After the first week, acids and/or scale inhibiting chemicals can be added to prevent scaling until makeup becomes available.

During normal operation, pond water chemistry is monitored periodically by grab samples. Pond chemistry is adjusted by dilution, acid addition, and/or the addition of scale inhibitors, so that scaling will not occur at 150°F assuming that the pond is concentrated by a factor of 1.25. This is the maximum pond concentration factor after seven days of an emergency condition without makeup.

The PSAR described the flow of cooling tower blowdown through the spray pond and then to the river. This original routing was selected for environmental reasons. The EROLS section 10.10 now states that the cooling tower blowdown bypasses the pond and flows directly to the river. This revised routing has been selected based upon a reassessment of environmental considerations of flow through the pond. The direct route to the river also eliminates many of the temperature and chemical problems of spray pond water management.

9.2.7.2.2 Component Description

Generally the ultimate heat sink consists of a concrete lined spray pond covering approximately 8 acres and containing 25,000,000 gallons of water, and an ESSW intake structure housing four RHRSW pumps and four ESW pumps which pump the water from the pond through their respective loops and back to the pond through a network of sprays located in the pond. The pond and ESSW pumphouse are described in more detail in Subsection 3.8.4.1 and shown on Dwgs. M-284, Sh. 1, C-64, Sh. 1, C-65, Sh. 1, C-66, Sh. 1, and C-67, Sh. 1.

The spray pond is a Seismic Category I design excavated below grade and has a normally maintained water level of 678.5 ft MSL. The spray pond water volume is adequate for 30 days of cooling without any makeup, as demonstrated in Subsection 9.2.7.3. The spray pond is concrete lined to minimize seepage.

The ESSW intake structure which houses the RHRSW pumps and ESWS pumps is located on the spray pond so that a positive water supply is provided at all times to each pump suction. The pumps are the vertical type and the pump pit dimensions are such that the required NPSH for each pump is ensured even at the minimum water level. The spray pond location is shown in Section 1.2. The ESSW intake structure is Seismic Category I and its design is explained in Subsection 3.8.4.

The spray system for the pond consists of one Seismic Category I network for each ESSW service water train. The system is designed so that the pressure drop across the spray nozzles necessary for proper spray performance is achieved for all anticipated modes of RHRSW and ESW operation. The nozzle, Spray Engineering Model 1751A, is shown in Figure 9.2-23. The nozzles are precision-cast and are of a design that provides good thermal performance while minimizing drift loss. The nozzles have no internal parts that are susceptible to clogging. The piping in the spray system is designed and installed in accordance with ASME Section III, Class 3.

Four one-third capacity 13,500 gpm 315 ft. head, motor driven pumps are located in the river intake structure. They supply makeup water to the entire plant through a buried line sized to provide sufficient water to replenish the losses resulting from normal operating plant demands such as the cooling tower basins as well as makeup to the spray pond. An 18 in. makeup connection to the spray pond is tapped off the main 42 in. supply line at a point close to the spray pond. The makeup line, which is also used for de-icing, is arranged in such a manner as to avoid the possibility of water draining from the pond if a failure occurs in the makeup supply system. This line is used to fill the pond initially and to refill it following its use as the result of an emergency. When the pond is not in use the only loss is by evaporation, which is made up by rainfall and a continuous flow of water through a 4 in. bypass line around the closed isolation valve in the 18 in. makeup line. Any excess water in the pond flows over a weir and back to the river. Meteorology for the area indicates that rainfall is expected to add more water to the pond than is lost by evaporation.

9.2.7.2.3 System Operation

Summer Startup and Operation

System operation is controlled to ensure that the Ultimate Heat Sink design temperature will not be exceeded. The temperature conditions that could exist in the pond during summer startup will be less severe than the conditions that could exist during summer operation. No attempt will be made to start up either unit if the pond is not at the minimum specified level in Technical Specifications.

During plant startup and summer operation when high ambient wet bulb temperatures and non-spray conditions exist, the pond temperature will approach an equilibrium temperature which is the temperature a stagnant body of water will reach after prolonged exposure to ambient conditions. The maximum Susquehanna pond temperature was calculated to be 89°F under these conditions.

Under normal plant operating conditions, the maximum pond temperature will approach the equilibrium temperature. Operating procedures control the RHRSW and ESW total return flow inventory through either the system spray network or direct pond discharge path as required to maintain Ultimate Heat Sink temperature within the design operating range.

Technical Specifications limit plant operation if the pond bulk temperature reaches 85°F. This temperature has been calculated to be the maximum allowable starting temperature to maintain the engineered safeguard service water (ESSW) temperature, under worst case meteorological and plant accident conditions, consistent with the ESSW design basis, as shown in Figure 9.2-21 for maximum temperature and Figure 9.2-22 for Ultimate Heat Sink inventory control.

Winter Startup and Operation

Startup of either unit will not be initiated unless the spray pond, spray network, and pumping system are available for operation.

At times of subfreezing temperatures, procedures will be enforced to prevent icing of the spray system. These consist primarily of the following:

a) The total return flow of both the RHRSW and ESW pumps will be first discharged directly into the pond, through a bypass line, without passing through the spray network. This will permit the operation of the pond if nozzles become covered with ice from, for example, a freezing rain. As the water temperature in the pond increases, conduction of heat to the nozzle will melt any accumulated ice. The bypass lines enter above the pond level so that they drain to prevent freezeup and therefore always assure a flow path for the ESW & RHRSW. The bypass lines are located as shown in Figure 9.2-24-1, approximately 400 feet away from the pump suctions. The physical distance between the pump suctions (which are kept ice free) and the return lines makes the probability of increasing the water temperature of the pump suction above the design maximum temperature due to short circuiting negligible, even if the pond surface does not thaw significantly. An overview of the pond piping and bypass lines is shown on Figure 9.2-24-1. The bypass lines are numbered as 36" HRC-1 and 36"HRC-2.

b) Portions of the nozzle header and riser system that are located above pond water level can be drained when not in service. Draining is performed during the winter months after the sprays are operated or when leakage through the spray array isolation valves creates the potential to freeze the spray array piping. Draining is accomplished by pumping the water out of the spray arrays from low points in the piping. This can be done manually or automatically.

   Each division of sprays has an active drain pump and an installed spare. The pumps take suction from 3 inch drain lines that originate at low points in the piping for each spray array. Each drain line is isolated from its associated pump by a motor operated drain valve. The pumps and drain valves are located in the spray pond valve vault.

c) The majority of the water distribution system associated with the ultimate heat sink will be either buried below the frost line or located inside heated buildings and therefore not exposed to freezing problems.

d) Any sections of the piping which are either not within buildings, or drainable will be electrically traced to protect against freezing. The electrical supply for the tracing is not supplied from the diesel generators since, in the event of auxiliary power loss, heated water will be flowing in the piping that is traced.

The maximum expected ice thickness, assuming there is no heat load on the spray pond, is estimated to be 22 inches, which agrees closely with the maximum expected ice thickness based on probability studies that used field data for colder regions of North America.

The extreme weather conditions used for the above analysis were obtained from meteorological records and were based on the month having the lowest average dry bulb temperature. This average temperature was used for the analysis and the resulting estimate of maximum ice thickness is therefore conservative.

With the extreme (cold) meteorological conditions considered, no provision is made to prevent freezing of the spray pond surface if both units were shut down at the same time. However, freezing of the pond when the units are shut down is not a safety concern.

9.2.7.3 Safety Evaluation

The ultimate heat sink spray pond is capable of providing enough cooling water to safely shut down and cool down both reactors, without the addition of makeup water, for 30 days concurrent with any of the following postulated design basis events:

a) SSE, flood or drought.

b) Any single site related event.

c) A reasonably probable combination of less severe natural phenomena and/or site related events.

d) Man-made structural features of the spray pond are designed considering all conceivable failure mechanisms, including the SSE and design basis tornado effects. Conservative allowances are added to the spray pond water volume as shown in Table 9.2-8.

Where the above design events could result in the loss of offsite power, such a loss is assumed. In addition, a single failure is postulated.

The ESSW intake structure is located directly adjacent to the spray pond; therefore, no canals, conduits, or waterways are associated with or required to ensure positive water flow to the suction of the RHRSW pumps and ESW pumps.

The pumps for each loop are in separate closed rooms within the ESSW pumphouse. There are no communication pathways between pump rooms. Internal flooding due to a leaking crack in the moderate energy piping would be mitigated by four 3' by 3' openings with gratings which drain to the spray pond. The pump room doors are at an elevation 3 inches higher than the drains to contain the leakage, estimated at less than 1600 gpm within the room. Therefore, flooding in one pump room will have no effect on the safe shutdown capabilities of the other loop.

If a tornado passes over the site and causes a loss of water from the spray pond, makeup water will be provided by either the makeup water pumps or in an extreme emergency the cooling tower basins. The minimum operating water elevation in the spray pond will be 678'-1" MSL. The maximum anticipated elevation will be 682.3' which occurs under PMF conditions. The only postulated exception to these limits is that during the event of a tornado passing over the pond, the water level may temporarily be lower than elevation 678'-1".

The power supply to the motors for the makeup water pumps is provided from an offsite power source through underground cables. Even if one of the makeup pumps fails, a sufficient flow of water to the spray pond is ensured since each of the four pumps is designed to deliver one-third of the total plant makeup flow requirement.

All spray network headers are located in concrete trenches at the bottom of the spray pond and covered with concrete 18" thick to resist the impact of a tornado missile.

The spray pond and its associated ESSW intake structure are protected from the maximum probable flood level as discussed in Subsection 2.4.8 if a flood requires shutdown of the plant.

The spray pond is designed to contain the total volume of water required for 30 days of cooling without makeup. After 30 days water will be available from the river for makeup to the pond for long-term cooling. The Susquehanna River is a reliable source of water even during a severe drought (see Section 2.4). As a result of the reliability of the river and the spray pond, a drought has no impact on the operation or shutdown of the plant. The potential for incapacitating accidents on the site has been evaluated and is discussed in Section 2.2. The physical remoteness of the ultimate heat sink to the avenues used for bulk petroleum transportation makes massive fouling of the heat sink surface by an oil spill unlikely. Vehicles delivering diesel fuel oil to the site will not be permitted to remain in the area of the ultimate heat sink in order to prevent an accident involving the delivery vehicle, which could result in an oil spill.

A fire would have minimal impact upon safe shutdown cooling, inasmuch as the ultimate heat sink and related equipment are largely heat resistant or noncombustible. However smoke detectors are installed inside the ESSW intake structure and CO fire extinguishers are located there. A hydrant is also available adjacent to the structure.

The credible failure of a man-made structural feature will not result in the loss of the ultimate heat sink safety function. The lined spray pond is constructed by excavation and is not subject to catastrophic failure (see Subsection 2.5.5).

9.2.7.3.1 30-Day Transient

The Seismic Category I spray pond has enough water available for at least 30 days without makeup and the design maximum cooling water temperature is 97°F which is based on the worst atmospheric conditions on record. Analyses have been performed to demonstrate the ability of the spray pond to meet these criteria.

In analyzing the ability of the spray pond to dissipate the heat rejected from both the RHRSW and ESW systems, alternative 30 day transients have been considered. The method of analysis is presented in Subsection 9.2.7.3.2, and a discussion of the conservatisms used is included in Subsection 9.2.7.3.7. Calculation results are shown in Figures 9.2-21 and 9.2-22.

An analysis of the 30 day transient coincident with loss of offsite power to both generating units is presented below.

If both generating units have been operating at full power and a LOCA occurs on one unit, followed by a forced shutdown (without offsite power) on the second, the following sequence of events is assumed to occur:

a) Both reactors would be scrammed and both turbine-generators isolated.

b) The loss of power would cause loss of makeup and circulating water and loss of condenser vacuum on both units. Loss of the main condenser places maximum heat dissipation requirements on the ultimate heat sink.

c) Safeguard equipment, common to both units, would be actuated (four diesels, four ESW pumps).

d) On the unit experiencing the LOCA, all safeguard equipment would be actuated (four core spray pumps, four RHR pumps, ADS, and HPCI).

e) On the unit undergoing the forced shutdown due to loss of offsite power, the RCIC system would actuate to hold reactor water level while the safety relief valves limit reactor pressure.

f) All supporting systems associated with the above steps would be brought into service (e.g., diesel-generators, emergency service water, RHR service water).

The occurrence of the accident automatically initiates safeguards operation. After 10 minutes, the equipment is operator controlled and, by defining the time these operations are started, the heat rejected to the ultimate heat sink is established. This complicates the analysis and necessitates the study of alternative means of shutdown to determine which result in the limiting heat sink criteria.

The maximum heat load to the spray pond will occur with a LOCA/Forced Shutdown combination, as opposed to a two unit forced shutdown. Two different LOCA/Forced Shutdown scenarios were developed for this analysis. The shutdown scenario for the minimum heat transfer case assumes spray and bypass array configuration that maximize spray pond temperature. The shutdown scenario used for the minimum heat transfer case is shown in Tables 9.2-4 and 9.2-21. The shutdown scenario developed for the maximum water loss case assumes the availability of both spray networks, thereby maximizing drift losses. The maximum water loss shutdown scenario is shown in Tables 9.2-5 and 9.2-21a.

The most stringent criteria were used in the analysis and the results demonstrated the ability of the Susquehanna SES spray pond to meet the performance requirements of an ultimate heat sink.

9.2.7.3.2 Methods of Analysis

The analysis is directed at providing sufficient information to define the following three parameters:

a) Pond surface area
b) Pond water volume
c) Nozzle arrangement

Input Parameters

Heat rejection after the postulated accident during the shutdown sequence is due to decay heat, sensible heat, and auxiliary system heat loads. The analysis decay heat is based on the methods described in ANSI/ANS 5.1 – 1979, “American National Standard for Decay Heat Power in Light Water Reactors”. The decay heat data is presented in Table 9.2-19. The values listed in Table 9.2-19 include fission product and heavy element contributions to the heat generation rate. Sensible heat release is included in the mathematical treatment of the heat removal system model. The emergency service water system heat loads are presented in Table 9.2-20.

The cooling system flow rates released as heat loads to the pond are tabulated in Table 9.2-21 for the RHR and RHR Service Water Systems and in Table 9.2-22 for the Emergency Service Water System.

The initial conditions assumed for the heat removal system model are listed in Table 9.2-23. The results of the containment analysis was used to determine containment initial conditions (10 minutes after LOCA for this analysis).

The input parameters used in the spray pond thermal efficiency calculations and drift loss calculations are based on spray pond geometry, assumed shutdown sequence, and synthesized meteorology.

Pond Surface Area

Sufficient area is provided to allow the full complement of spray nozzles to be located on the pond surface.

Sufficient area is provided to ensure that the distance of the outermost line of nozzles to the edge of the pond is great enough to prevent unacceptable water losses that result from drift.

Pond Water Volume

Pond water volume has been selected such that the water losses listed in Table 9.2-8 can be experienced over the 30 day transient period while the pond is still able to perform the necessary cooling duty until the end of the 30th day. Sufficient water is provided to ensure that the sensible heat capacity of this heat sink, together with the cooling ability of the nozzles, are sufficient to keep the temperature of water supplied to the equipment below the design temperature of the equipment. Ensuring that the design temperature is not exceeded is essential in meeting manufacturers' recommendations for equipment and also in limiting the containment transient temperatures that are dependent on the RHR service water temperature.

The spray pond volume and network are designed to maintain the maximum Emergency and RHR Service Water temperature, under worst case meteorological and plant accident conditions, consistent with the Emergency and RHR Service Water design basis, as in shown in Figure 9.2-21 for maximum temperature and Figure 9.2-22 for inventory control.

An overflow weir fixes the level of the pond as water is continuously introduced through a 2 in. bypass line around the isolation valve in the 18 in. makeup line; thus, the minimum level is always maintained while either unit is operating. (See Subsection 2.4.8.)

Nozzles and Nozzle Arrangement

Nozzles and nozzle arrangement, shown in Figures 9.2-23, 9.2-24-1, 9.2-24-2, and 9.2-24-3 are selected such that the optimum heat dissipation is reached, satisfying the following requirements:

a) There are sufficient nozzles to dissipate the maximum heat load resulting from the emergency shutdown operation without allowing the pond temperature to exceed the maximum permissible as discussed above.

b) The nozzles are as close to one another as possible without hindering individual performance.

c) The spray pressure at the nozzles has been selected to optimize the water droplet surface area for heat rejection while minimizing small droplet generation that would increase drift losses. The selected nozzle was chosen because of the experience of the supplier, wide use of this particular nozzle, and a spray pattern close to optimum for minimum drift with maximum thermal dissipation.

d) The piping distribution system supplying the nozzles is arranged to permit isolation of nozzle networks. This will permit startup and shutdown of selected RHRSW or ESW pumps throughout the 30 day transient, while maintaining optimum nozzle pressure.

The large number of parameters associated with the above basic variables necessitated the development of analytical models suitable for computer use. There are three principle models and these are outlined below.

9.2.7.3.3 Pond Performance Models

The analysis of the SSES emergency cooling water system is based on three computer models: the spray cooling thermal performance model, the drift loss model, and the system response model. Each of these models are discussed individually.

Use of the three models requires input details on ambient conditions and these have been prepared by PPL's meteorological consultant, Ford, Bacon & Davis. A discussion of the use of the meteorology report is presented in Subsection 9.2.7.3.5.

Spray Cooling Thermal Performance Model

The performance of the spray pond depends on many parameters, such as spray array geometry, drop size spectrum, wind velocity, atmospheric conditions and spray height. All the controlling parameters have been included in the computer model as described below.

The thermal performance model predicts the cooling capability of the spray arrays and the evaporation rate due to spray cooling.

Separate thermal performance models are used to predict the overall cooling capability of the spray arrays for high wind speeds and low wind speeds.

The computer model developed for this analysis includes the effects of the following parameters:

1. Drop mean diameter.
2. Wind speed and direction.
3. Air dry bulb temperature.
4. Air wet bulb temperature or relative humidity.

5. Height of nozzles above water level.
6. Pressure drop through the nozzle or height attained by the spray.
7. Dimensions of the spray volume.
8. Water flow rate in spray volume.

For high wind speeds (above 3 mph approximately), the heat transfer mechanism is assumed to be forced convection. For low wind speeds cooling is assumed to be by natural convection only. The individual spray patterns are lumped together to form the spray volume which is divided into a number of increments in the direction of the air movement. The temperature and vapor content of the air in each increment is assumed to be uniform within the increment and is numerically the same as that exiting the preceding increment. The sprayed water temperature, air temperature, and air moisture content for each increment is calculated and the results combined to yield an average sprayed water temperature for the spray volume. A critical aspect of the calculation is the determination of the evaporation rate within the increment. The empirical work of Ranz and Marshall (Ref. 1 of Question 371.18) on droplet heat and mass transfer was used as the basis for the evaporation rate and air temperature calculations. In their experiments, Ranz and Marshall suspended a drop from a capillary tube, supplied a known air flow over the drop surface, and measured the drop temperature, air temperature, drop diameter (held constant with water flow through the capillary tube from a microburet), and make-up flow rate from the microburet. In this way the heat transfer coefficients were derived by correlation with the data.

The increment mass and energy balance used in the calculation of spray cooling efficiency is shown schematically in Figure 9.2-17. Water enters the increment through the spray nozzles and exits the increment after undergoing mass and energy transfer. The amount of mass and energy transferred is calculated from heat and mass transfer coefficients derived empirically:

$$N_{NU} = \frac{h_c D}{K} = 2.0 + 0.6\{N_{PR}\}^{1/3}\{N_{RE}\}^{1/2}$$

$$N_{SH} = \frac{h_d D}{D_v} = 2.0 + 0.6\{N_{SC}\}^{1/3}\{N_{RE}\}^{1/2}$$

where

N_{NU} = Nusselt number

N_{SH} = Sherwood number

h_c = Heat transfer coefficient for conduction and convection

h_d = mass transfer coefficient

D = drop diameter

K = thermal conductivity of air-vapor moisture

D_v = diffusivity of vapor in air

N_{PR} = Prandtl number

N_{RE} = Reynolds number

N_{SC} = Schmidt number

The energy transfer rate is the sum of contributions from conduction, convection and evaporation. The lifetime of a drop in the increment, calculated from the pond geometry and other parameters affecting the drop trajectory, is used with the energy transfer rate to determine the temperature of the cooled water leaving the increment. The moisture content of the air leaving the increment is determined from the mass transfer (evaporation) rate and the air flow rate (residence time of the air in the increment). The temperature of air exiting the increment is calculated from an energy balance on the increment. The exit air temperature and moisture content for increment i is used in increment i + 1 to determine the heat and mass transfer rate in that increment. This process is repeated until all the increments have been treated.

At low wind speeds (less than approximately 3 mph), air enters the spray volume from all sides rather than one; therefore, the increment definition used for low wind speeds is rectangular, like a picture frame. The air velocity entering each increment is determined from the density difference between the air-vapor mixture in the increment and the ambient.

Spray efficiencies for wind speeds below 3 mph are calculated assuming natural convection only. Spray efficiencies for wind speeds greater than or equal to 3 mph are calculated assuming forced convection only. This procedure shows good agreement with the test results and avoids excessive conservatism.

The results of the calculation described above is a set of cooled water temperatures, one for each increment. Since the air temperature and moisture content for each increment is different, the cooled water temperatures are different. The average cooled water temperature, T, is calculated.

where

$$\bar{T} = \sum_{i=l}^{N} \frac{Ti}{n}$$

T_i = incremental cooled water temperature,

n = number of increments in the spray volume

The thermal efficiency, E_{th} , is calculated from the ambient air wet bulb temperature, T_{wb}, and the water temperature before spraying, T_s .

$$E_{th} = \frac{T_s - \bar{T}}{T_s - T_{wb}}$$

The primary conservatism in the thermal performance prediction model is the lack of convective air motion into the spray volume, (for all but very low wind speeds) which results in lower calculated efficiencies. The convective air motion is most important at low wind speeds; consequently, the degree of conservatism increases as wind speed decreases. Since thermal performance at low wind speeds is most important, this is a desirable effect as long as the degree of conservatism is not unrealistic. Data taken at existing spray ponds has been used to demonstrate the degree of conservatism of the model.

In the model the temperature of the water being sprayed is calculated using an iterative technique based on the temperature of the pond and the heat addition to the spray water at each increment in time. If the heat dissipated by the sprays is less than that added to the system, the temperature of the water entering the pond after spraying is higher than the bulk pond temperature. As a result, the pond temperature increases until the heat added to the system equals that dissipated by the sprays. As the heat load on the pond decreases with time, the sprays dissipate more heat than is being added and the pond temperature begins to decrease.

<u>Drift Loss Model</u> During periods of prolonged spray pond operation without makeup water, it is essential that accurate predictions of water consumption are available. The thermal performance model that was developed is used in conjunction with the system model to predict evaporative losses. An independent model has been developed to predict drift losses. A review of the literature revealed no efforts directly applicable to calculation of drift losses from a spray pond. Due to basic system differences, cooling tower drift measurements cannot be applied directly to spray ponds; therefore, a model was developed from principles of analytical mechanics. The following parameters were included in the model:

1. Drop size spectrum
2. Wind speed and direction
3. Elevation necessary for loss of a drop from the pond
4. Distance of each nozzle from the perimeter of the pond in the direction of drift
5. Pressure drop across the nozzle
6. Angle at which water leaves the nozzle
7. Vertical air entrainment of droplets

Drift is caused by the horizontal drag force exerted on small drops as they move relative to the air. A water drop leaves the nozzle with a certain initial velocity and from that time its motion is determined by drag and gravitational forces. By solving the equations of motion the position of each drop is determined as a function of time. When all initial velocities are considered, the positions of drops of the same size that left the nozzle at the same time trace out a locus in the horizontal plane. When drops of similar size are grouped together a locus results for each drop size group.

The loci are concentric circles for a wind velocity of zero, and are somewhat distorted and translated in the wind direction for nonzero wind speeds.

Once the loci have been determined, for a given wind speed, the fraction of flow lost by drift for each drop size group is the ratio of the length of the locus outside the pond perimeter to the total locus length. Since a locus represents the position of drops of a given group no drops from that group are off the locus at that elevation; consequently, the length of the locus is used to calculate loss fraction rather than the enclosed area. The percentage of flow lost by drift is the sum over the drop size groups of the product of drift loss fraction and flow fraction.

$$P = \sum_{i=l}^{N} F_i B_i$$

Where

P	=	percentage of flow lost by drift
F_i	=	fraction of flow in drop size group i that is lost
B_i	=	fraction of total flow in drop size group i
N	=	number of drop size groups

In order to facilitate evaluation of the drag coefficient for each drop size group, the drops are assumed to be spherical. High speed photographs show that drops deviate very little from being spherical, especially in smaller diameters that are most important in drift loss considerations.

Since the drag force on a sphere is proportional to the relative velocity raised to a power between 1 and 2 (depending on the Reynold's number), the resulting equations of motion are non-linear. An approximation is made to allow a solution in closed form in which the drag force is assumed to vary linearly over a certain range of velocities. Two velocity ranges are used and for all velocities the approximation equals or exceeds the actual drag force, thus preserving conservatism by maximizing drift losses.

The linear drag force approximation in combination with Newton's Second Law is used to determine the acceleration of a drop and the acceleration is integrated to determine the position of the drop as a function of time. This is done for both the X and Z directions, shown in Fig. 9.2-18 to determine the coordinates, Xi(t,0)' Zi(t,0)' of drop position for the ith drop size group as a function of time and initial direction. The motion in the Y direction is used for calculation of the drop exposure time only.

In order to find the locus of a given drop size group at the elevation necessary for loss from the pond, the time of flight, or exposure time, must be calculated. The motion of a drop in the y-direction, shown in Figure 9.2-18, is used to calculate the exposure time. Since the water leaves the nozzle in a conical pattern, no drag is applied for the first few feet of travel in the vertical direction to allow maximization of the time in the air, which maximizes drift losses. Drag is applied immediately in calculation of X and Z coordinates in order to maximize drift losses. The vertical position, y(t), is determined as a function of time; subsequently, the elevation necessary for loss from the pond is substituted for the position and the resulting implicit equation is solved for exposure time. There is a different exposure time for each drop size group due to the dependence of drag force on drop diameter.

With the exposure time determined, the locus for each drop size group can be generated by considering all initial velocity directions. A computer program has been written to supply the coordinates of points of each locus. The locus in the X, Z plane for each drop size group is integrated numerically over its length to determine the fraction of the locus, and hence the drop size group, that is beyond the perimeter of the pond. The losses for the different drop size groups are summed to determine the total drift loss percentage from the pond.

The percentage of flow loss due to drift is an input parameter for the system model discussed later. The system model uses it as a loss term in determining the water remaining in the spray pond at any time after the start of operation of the sprays. The drift loss for the SSES spray pond is determined as a function of wind speed, and this information is entered as a table, wind speed versus drift loss, in the system program. The drift loss is determined from the table at each time step in the calculation of system parameters.

System Response Model

In order to predict the response of the emergency cooling water system of the SSES design, it was necessary to develop a computer model of the system. Due to the feedback effects of service water temperature on containment response, the model includes the system from the reactor vessel to the spray pond. Of particular interest in the transient analysis of the system is the containment temperature, the service water temperature, and the pond water inventory.

In the computer model the system analyzed is represented by a set of simultaneous differential equations resulting from mass and energy balances written for each element of the system. The following assumptions have been made in writing the equations:

1. The absorption of heat by cooling water system equipment and piping during the transient does not significantly contribute to the system response and is therefore neglected.

2. Saturated conditions are assumed to prevail in the containment and reactor pressure vessel.

3. The RHR heat exchanger effectiveness is calculated using equations from Kays and London (Ref. 5 of Question 371.18) when operating as water-water heat exchangers.

4. Flow rates are assumed to change instantaneously when changed.

5. The ANSI/ANS 5.1 – 1979 decay heat generation methodology is used.

6. The transient analysis is initiated after blowdown at 10 minutes after a LOCA.

7. Complete mixing is assumed where flows are combined in piping.

8. No heat is assumed to be transferred through the containment walls, piping, or spray pond liner.

9. Complete mixing in those elements containing water.

The set of equations that represents the system is solved using a discrete finite differential method. The output of the computer model provides temperatures and water inventories at various points in the system at specified times during the transient analysis. This information is used to plot parameters of interest.

The pond temperature vs. time for the minimum heat transfer case, and pond volume vs. time for the maximum water loss case are shown in Figures 9.2-21 and 9.2-22, respectively.

9.2.7.3.4 Droplet Spectrum Test

Both drift and performance models rely on droplet size input data. A program by the nozzle vendor has been established for measuring the droplet size spectrum from the particular nozzle selected for the system and at the particular nozzle pressure chosen. These measurements are based on established high speed photographic techniques. The test program droplet size spectrum data have been used in the 30 day transient analyses.

9.2.7.3.5 Discussion of Meteorology

The evaluation of spray pond performance as an ultimate heat sink is based on conservative atmospheric conditions. The basis for selection of these conditions is critical due to the sensitivity of performance to variations in wind speed, temperature, and relative humidity. This requires investigation of two somewhat opposing sets of atmospheric conditions: one that would result in maximum water loss (high wind speed resulting in maximum drift loss) and one that would result in minimum heat transfer (low wind speed, high wet bulb temperature, and high relative humidity). The two sets of conditions have been determined from the available weather data.

The combined effects of wind speed, wet bulb temperature, and dry bulb temperature were considered in selection of the worst time periods. The results of the analyses have been used to synthesize separate 30 day periods of minimum heat transfer and maximum water loss.

Meteorological databases from Avoca Airport near Scranton, PA and from the SSES site were examined to determine these two 30 days periods.

Minimum Heat Transfer Case

The ability of the spray pond to reject heat is dependent on both ambient conditions and water temperature at the sprays. It thus becomes important to evaluate the spray water temperature corresponding to any data point condition before analyzing whether that data point is unfavorable for heat transfer.

The meteorological conditions for the minimum heat transfer case are determined using a coefficient of performance that assigns a relative cooling performance value to each set of coincident meteorological conditions. The coefficient of performance is based on the empirical work of Ranz and Marshall (Ref 1 of Question 371.18) for cooling of water droplets in air.

The meteorological data used for the minimum heat transfer case was selected to comply with Regulatory Guide I.27 Rev. 2. A 30 day period of meteorological data was synthesized by using the worst day, two worst consecutive days, and 27 days of the worst 30 day running average period as selected by a coefficient of performance model. Since the site data for this 30 day period was slightly more severe than that for Avoca Airport, the site data was used for the minimum heat transfer design meteorology. The results are summarized in Table 9.2-9. In addition, the computer model includes solar radiation. The day of the year used to determine the solar input to the Spray Pond was chosen to coincide with the same calendar day as the worst meteorological day.

Maximum Water Loss Case

The major water loss mechanisms that are dependent on meteorology are evaporation and drift loss. A coefficient of water loss was derived based on (a) the work of Ranz and Marshall (Ref 1 of Question 371.18) for evaporation loss and (b) the drift loss versus wind speed curve resulting from the drift model of Subsection 9.2.7.3.3. This coefficient was used to determine the worst 30 day period for water loss. Since the worst 30 day period for water loss from the Avoca Airport was more severe than that from the site, the Avoca data was used for the maximum water loss design meteorology. The results of the analysis for the worst period for water loss are presented in Table 9.2-12. In addition, the Table 9.2-10 data was conservatively combined with the most severe solar radiation conditions during the maximum water loss critical time period.

The maximum water losses are not necessarily coincident with high ambient temperatures. This results from consideration of both drift and evaporative contributions to water loss. Since the object is to establish the adequacy of the water supply during periods of high total water loss, the 30 day period of highest total water loss is considered rather than a period of "high temperature and maximum persistent wind speeds."

9.2.7.3.6 Discussion of Results

The intent of this discussion is to compare the analytical results of the transient analysis with all other applicable methods of system sizing. Since the analysis has been done to define three separate design parameters (spray array efficiency, drift loss, and system response), this discussion of the results will treat each separately.

Spray Array Efficiency

The spray arrays were tested in July 1983 to demonstrate that measured heat dissipation capability equals or exceeds that which is predicted by analysis. For this test, the spray arrays were operated with a heat load from Unit 1. Ambient conditions were recorded along with the temperature of RHRSW/ESW before and after spraying. Efficiencies were then calculated based on the measured ambient conditions using the thermal performance model and compared to the measured efficiencies.

For wind speeds below 4.5 mph, the measured sprayed water temperature was shown to be lower than the sprayed water temperature predicted by the thermal performance model. This demonstrates conservatism in the low wind speed model. For wind speeds above 4.5 mph, measured sprayed water temperatures were generally higher than those predicted by the model. This indicates that the cooling capability of the spray arrays is less than predicted by the high wind speed model. However, since spray cooling is directly related to spray evaporation, the high wind speed model predicts more evaporation losses than actually occur. The high wind speed model, therefore, is conservative in terms of spray evaporation losses.

For the minimum heat transfer case all wind speeds are set to zero in the calculation of spray efficiencies by the thermal performance model. This is done despite the existence of several data points in the minimum heat transfer design meteorology that have wind speeds above 3 mph. Since the test results indicate that the low wind speed model predicts less heat dissipation than is actually experienced, the exclusive use of this model for the minimum heat transfer analysis is conservative.

For the maximum water loss case, only the high wind speed model is used since all data points in the design meteorology have wind speeds above 3 mph. The sole use of the high wind speed model for the maximum water loss case is conservative since the actual spray evaporation losses are lower than predicted by analysis. The cooling capability of the spray arrays is not a limiting factor in the maximum water loss analysis. Comparison of the conditions measured at Canady's and Rancho Seco Spray Ponds indicated close agreement with the performance predicted analytically (refer to Subsection 9.2.7.6). The analytical results indicate somewhat lesser cooling than was actually measured in both cases and therefore the model provides conservative estimates of spray cooling performance.

A further check on the conservatism of the analytical model has been made by comparing the calculated nozzle performance with other methods that could be found for determining nozzle performance. In every case the model predicted more conservative results (less cooling) than the other methods, and these other methods are not all based on purely theoretical approaches. The Spray Engineering Company, for example, predicts the performance of their nozzles on information obtained from numerous operating installations.

Drift Loss

The drift loss calculations were performed using the Bechtel drift loss program. A typical loss versus wind speed relation is shown in Figure 9.2-15. This represents the total drift loss percentage from a typical spray network at a given spray nozzle pressure. The drift loss program can also calculate the drift loss percentage as a function of nozzle location (nozzle distance from the perimeter of the pond) as shown in Figure 9.2-16 for a typical spray nozzle pressure. There is a rapid increase in drift losses for nozzles near the perimeter as the wind speed exceeds 15 mph. Consequently, the perimeter of the spray pond is designed to be a minimum of 60 feet from the spray nozzles.

The drift loss is calculated for each aligned spray array in the maximum water loss analysis. The results of the analysis show a total drift loss of 5.41 million gallons of water during the 30 day transient, as shown in Table 9.2-8.

Susquehanna drift loss was measured during spray operation and compared to the drift loss as predicted by the drift loss model. Analysis of the drift data collected indicates that drift losses predicted by model are considerably more than measured losses. Drift loss model predictions also compare favorably with data obtained from tests conducted by the University of California at the Rancho Seco spray pond (Ref. 2 of Question 371.18).

System Response

The system response model is a series of mass and heat balance equations representing the transfer processes that exist in the reactor heat removal circuits.

Various cases of the minimum heat transfer analysis for spray pond performances were made assuming different operating modes and component failures. The results of the minimum heat transfer case and the maximum water loss cases are presented in Table 9.2-12. The maximum pond temperature observed during the thirty day minimum heat transfer transient is 97°F. This supports the 97°F ESSW temperature limit since all ESW and RHRSW heat exchangers were analyzed for a 97°F cooling water temperature.

The solar evaporation losses are calculated in a manner similar to that outlined in NUREG 0733. Information on total losses is given in Table 9.2-8.

9.2.7.3.6.1 Thermal Short-Circuiting

Spray pond thermal short-circuiting due to wind blown spray is not considered to be a design problem. The spray nozzles are located at least 60 feet from the intake. Wind has the greatest displacement effect on small droplets. Wind blown spray that may be blown toward the intake has a smaller droplet size spectrum than that for water leaving the nozzle. It should be noted that the heat transfer rate is inversely proportional to droplet diameter. This smaller droplet size spectrum, combined with the winds necessary to produce the drift and the distance the droplets must travel to the intake assures that the small droplets will be cooled with a closer approach to the wet bulb temperature than the large droplets falling near the nozzles. This has been verified by computations using the thermal performance model and the drift model.

9.2.7.3.7 Discussion of Conservatisms Used

In an attempt to ensure the availability and performance of the pond under all circumstances of ambient and cooling duties, the following conservatisms have been employed in the analysis.

9.2.7.3.7.1 Conservatisms in Meteorology

Time Steps in Meteorology

As suggested in Regulatory Guide 1.27, worst day, worst two consecutive days and worst 30 day running average periods are determined and used to synthesize conservative design meteorology.

Magnetic tapes containing 34 years of meteorological observations from Avoca Airport near Scranton, Pa. were obtained from the National Climatic Center operated by the National Oceanographic and Atmospheric Administration in Asheville, North Carolina. The period of record for Avoca data was from January 1, 1949 to December 31, 1982. The data from Avoca Airport was compared to 11 years of data collected on site. The period of record for the site data was from November 1, 1972 to December 5, 1983.

A computer-aided search was done for both databases to determine two periods of time for use as design meteorology. One was chosen such that the ability to cool sprayed water was minimized (minimum heat transfer case). The other was chosen such that the potential for water loss was maximized (maximum water loss case).
The daily average meteorological conditions were computed for the entire period of record for both the Avoca and site data bases. The daily averages were then used to calculate

coefficients of performance (COP) and coefficients of water loss (COWL). The COP is a parameter whose value is indicative of the rate of change in temperature of a falling spray droplet, considering convection and heat loss due to evaporation. The COWL is indicative of the water consumption rate, considering evaporative and drift losses. In the calculation of the COP and COWL, coefficients of heat and mass transfer are calculated based on the empirical work of Ranz and Marshall for falling drops. This closely resembles the treatment of falling drops in the calculation of thermal efficiency for the spray arrays.

For the minimum heat transfer case, meteorology is selected such that the most severe meteorology corresponds with the peak pond temperature. The peak pond temperature will occur when the total heat loads on the pond equal the total heat losses. When plant heat loads, solar loads, evaporative losses, conduction/convection losses and sprays heat dissipation are considered, the peak pond temperature occurs on the second or third day of the transient. Therefore, the most severe two or three day period is most important in the selection of design meteorology for the MHT case.

For the minimum heat transfer case, COPs were selected for the following:

- Worst single day
- Worst two consecutive days
- Worst thirty consecutive days

This was done for both the site and Avoca databases. The COPs were then compared.

The COPs calculated for the worst single day are identical for the site and Avoca data. For the worst two consecutive days and worst 30 consecutive days, the COPs calculated for the site data are slightly more severe than those from Avoca. Therefore, the meteorology selected from the site data is used for the minimum heat transfer design meteorology. The use of the site data as design meteorology is appropriate, despite its short record, since the search of 34 years of Avoca data did not reveal periods of time when the potential for heat transfer was lower.

The design meteorology as used in the minimum heat transfer analysis utilized the worst single day, worst two consecutive days and 27 synthetic days, each of which is an average of the worst 30 consecutive day period. The design meteorology selected for the MHT case is listed in Table 9.2-9.

For the maximum water loss case, the worst 30 consecutive day average COWL was selected from both the Avoca and site databases. A comparison of the COWLs selected indicates that the Avoca meteorology is more severe than that from the site. Therefore, the use of the Avoca meteorology as the basis for the maximum water loss transient is conservative. The design meteorology selected for the maximum water loss case is listed in Table 9.2-10.

<u>Rainwater Additions</u>

No credit is taken for any rainwater additions to the pond volume over the 30 day transient.

9.2.7.3.7.2 Conservatisms in System Operation

Shutdown Operations The sequence of shutdown operations affects the peak pond temperature during the transient. For at least the first 10 minutes actions are assumed to be fully automatic and outside the operator's control. The subsequent operations are operator actuated.

The peak temperature reached in the pond is dependent on the rate at which the heat is dissipated. As discussed in Section 9.2.7.3.l, the shutdown sequences have been developed to provide a worst case realistic combination of heat loads and flows to the spray pond for both the minimum heat transfer and maximum water loss analysis.

Diesel Operation

The 30 day transient analyses for maximum water loss and minimum heat transfer assume the four aligned diesels are in continuous service for the duration of the transient.

9.2.7.3.7.3 Conservatisms in Models

Drift Loss Model

Drag force for motion in the horizontal direction is assumed to be applied immediately, even though the drop is not formed until it is a few feet from the nozzle.

The time the drop is in the air above the elevation necessary for it to be lost from the pond is calculated on the basis that:

a) The drag force is conservatively estimated so that the time used in the calculation for the drop to fall from its maximum height is longer than it will be in practice.

b) Using the conservatively estimated drag force to calculate the initial velocity at which the spray rises will result in a higher velocity than will actually occur. Consequently the corresponding initial velocity in the horizontal plane, which was used to calculate the drift loss, will also be higher than the actual horizontal velocity. Thus the calculated drift loss, which was used to help determine the capacity of the pond, will be larger than will actually occur.

c) Vertical airflow is included because it increases the time the drop is in the air and hence the time the drop is exposed to horizontal drag forces. The vertical flow model combines the effects of convective airflow and airflow due to entrainment of air in the sprays themselves. The model was verified by comparison with experimental results from the Rancho Seco tests (Ref. 2 of Question 371.18).

The drift loss data collected at Susquehanna and Rancho Seco indicates that the drift loss model is conservative.

Thermal Performance Model

The time the drop is exposed to the air is calculated assuming no drag force. This reduces the overall exposure time, and hence the heat transfer.

System Model

Water loss due to natural evaporation is calculated from a cooling pond model ignoring the spray volume. This increases the natural evaporation loss because the pond area available for natural evaporation loss is greater than it would be if the pond was being sprayed.

Conservative values of all input parameters, such as suppression pool water volume, were used in the calculations made for the system model. Assumption 1 in Paragraph 9.2.7.3.3 is also a conservatism in the system model.

9.2.7.4 Tests and Inspections

The ultimate heat sink will be pre-operationally tested in accordance with the requirements of Chapter 14 as part of tests P14.1, RHR Service Water, and P54.1, Emergency Service Water.

Pre-operational tests will be performed to verify that the controls for the system are functioning properly and that design flows required for operation can be obtained.

A performance test has been performed on the completed pond with heat input from unit one, demonstrating that measured performance equals or exceeds that which is predicted by analysis. (Refer to Subsection 9.2.7.3.6.)

Pipe welds are subjected to heat treating, testing, and inspection in accordance with ASME Section III, Class 3, and the material specification.

The spray system will be tested regularly during normal plant operations in accordance with the requirements of Chapter 16.

9.2.7.5 Instrumentation Applications

Logics and instrumentation are discussed in Subsection 7.3.1.1b and the displays are discussed in Section 7.5. A complete list of the system's process instrumentation is provided in Table 7.5-6.

The bypass and spray header motorized valves in the spray pond system are designed for remote operation from the control room. Loop B operation is also provided from the Unit 1 remote shutdown panel and Loop A operation is also provided from the Unit 2 remote shutdown panel.

The spray pond has temperature indication and alarms for high water temperature and near freezing water temperature.

9.2.7.6 COMPARISON OF SPRAY POND THERMAL PERFORMANCE RESULTS

In order to further demonstrate the conservatism of the spray pond thermal performance model, the model has been applied to a spray pond comparable in size to the one proposed for SSES and on which some performance evaluation tests have been performed. The tests were performed on the spray pond at Canady's Station of South Carolina Electric and Gas Company.

In addition to these tests the model has also been applied to a smaller pond with well documented performance, the Rancho Seco Nuclear Power Station of the Sacramento Municipal Utility District. The two sets of test results are discussed separately below.

Canady Station Tests

In order to reduce the temperature rise of the Edisto River due to the Canady Station condenser discharge, a spray pond facility was recently built to lower the temperature of the water returned to the river. The South Carolina Pollution Control Authority required that the river temperature rise not exceed 5°F for all river flow rates. The spray pond was designed to provide the required cooling based on various recommendations. It was found that the expected performance was not realized.

Measurements of wind speed, wind direction, wet bulb and dry bulb temperatures, water temperature before spraying, water temperature just before entering the pond, and pond bulk temperature were taken. The water temperature after spraying was measured just above the surface of the pond at several locations and the average reported. Due to the more extensive instrumentation, the results of the Canady tests must be compared to model predicted values on a point to point basis. The general description of the Canady station spray pond is given in Table 9.2-27. The original design specified that 120,000 gpm were to be cooled from 102°F to 84°F with a coincident wet bulb temperature of 78°F. Subsequently, the design spray flow rate was increased to 180,000 gpm and the cooled water temperature to 88°F. These design conditions proved optimistic.

The results of the comparison of the Canady Station performance with that predicted by the spray pond thermal performance model are presented in Table 9.2-28. The model predictions agree well with the data and are in general more conservative than the measured efficiencies.

Rancho Seco Tests

At the request of the Atomic Energy Commission, the Sacramento Municipal Utility District (SMUD) arranged to have the Rancho Seco spray ponds tested to verify the ability of the ponds to meet the design criteria. SMUD asked the University of California, Berkeley, to perform an experience evaluation of the performance of the ponds. Of particular interest from a performance standpoint was the thermal efficiency of the nozzles and drift loss versus wind speed.

The same parameters recorded in the Canady Station tests were also recorded in the Rancho Seco tests, with the addition of accurate pond level measurements. The Rancho Seco test results are compared with model predicted efficiency values on a point to point basis as was done with the Canady Station tests.

The general description of the Rancho Seco spray ponds (2) is given in Table 9.2-27.

The result of the comparison of the Rancho Seco performance tests and model predictions is given in Table 9.2-29. It can be observed that the model predictions for performance are more conservative that the measured efficiencies.

9.2.8 RAW WATER TREATMENT SYSTEM

9.2.8.1 Design Basis

The raw water treatment has no safety related function and does not convey radioactive materials.

The raw water treatment system is designed to provide filtered and clarified water at an average effluent turbidity of less than 0.3 Nephelometric Turbidity Units (NTUs), 80 to 85 percent of the time, when the equipment is operating at a rate not to exceed 2.0 gpm/sq. ft., and less than 0.5 NTUs when the equipment is operating at a rate not to exceed 4.0 gpm/sq. ft. The filtered and clarified water is furnished to the systems and components listed in Subsection 9.2.8.2.

9.2.8.2 System Description

The Well Water System is the source of domestic water and is the normal source of clarified water. During evolutions which demand more clarified water than the Well Water System is able to supply (e.g. outages, flushing, etc.), the Raw Water Treatment System is placed in service and is the source of clarified water.

The raw water treatment system consists of the following:

a) One sludge recirculating type clarifier

b) One chemical feed system designed to inject alum, coagulant aid, Hypochlorite, and caustic solutions into the clarifier

c) Two gravity filters

d) One clearwell, 15,000 gal capacity

e) Two clearwell pumps, each 100 percent capacity

f) One 500,000 gal capacity clarified water storage tank

g) Three clarified water pumps of 100 gpm, 200 gpm, and 300 gpm capacity

h) One clarifier sludge holdup sump of 10,000 gal capacity with two discharge pumps, each 100 percent capacity

i) One 10,000 gal filter backwash holding tank with two discharge pumps

l) Associated piping and controls for all system operations. The piping is carbon steel for the water lines throughout the system and is rated at 125 psig at 350^{o}F. The chemical inlet lines to the clarifier are stainless steel and polyvinyl chloride (PVC) for corrosion protection.

The system is depicted on Dwgs. M-117, Sh. 1, M-117, Sh. 2, M-117, Sh. 3, M-117, Sh. 4, and M-117, Sh. 5.

The river water turbidity is reduced in the clarifier by the addition of chemicals. Design flow through the clarifier is 300 gpm. During clarifier operation flow rates can range between the minimum required flow rate for the clarifier of 100 gpm and the design flow rate. Clarified water can be bypassed to the Circulating Water System to maintain the minimum clarifier flow rate. The flow rate and pressure of the river water entering the clarifier is controlled by a pressure regulator and a flow control valve. The flow control valve is controlled by the water level in the clearwell.

The clarifier is a positive internal recirculation upflow unit. All chemical addition shall be in proportion to the inlet flow to the clarifier. An inlet flow recorder with totalizer is used to pace the chemical feed utilizing timers. Backflushing and sludge blowdown from the clarifier is automatic and controlled in proportion to inlet flow. The sludge is directed to the clarifier sludge holdup sump for disposal.

The clarified water flows out of the clarifier to the gravity filters. Normally the flow is split between the two filters. However, the system is designed to allow one filter to pass 300 gpm flow while the other filter is backwashing or out for maintenance. An interlock is provided so that only one filter can be backwashed at a time. Backwashing of the filter is initiated by pressure drop or a timer. High pressure across the filters is annunciated. A pushbutton on the panel allows the operator to initiate backwashing of either filter at any time. The backwash flow is routed to the backwash holding tank from where the discharge pumps operated by level switches pump the backwash water back to the clarifier for further settling.

The filtered water flows by gravity to the clearwell. One clearwell pump is in continuous operation which sends the water to the clarified water storage tank. Flow to the storage tank is controlled by a flow control valve on the clarified water tank inlet. A controller throttles the inlet valve in proportion to the clarified water storage tank level. A recirculation line from the clearwell pumps discharge header to the clearwell is provided for protection during low flow demand.

A single header from the clarified water storage tank supplies the clarified water pumps at a positive suction pressure. The 100 gpm capacity pump is in continuous operation to furnish the expected normal demand of clarified water. If water demands increase, flow switches will start the second and third pump as required to meet the system demands. Flow switches will in turn trip the two additional pumps in sequence as water demands decrease. Minimum flow recirculation lines to the storage tank are provided for each pump discharge line for pump protection. The clarified water pumps can furnish water for the following use during normal operation:

a) Make Up Demineralizer System

b) Clarifier Bearing Seals

d) Circulating Water Biocide Injection Skid for Flushing

e) Circulating Water Pumps Bearing and Seal Cooling

f) Service Water Pump Bearing and Seal Cooling

The well water system provides a backup supply for Circulating and Service Water Pump seal cooling.

The raw water treatment equipment is located in the water treatment building. The clarified water storage tank is located in the yard. The storage tank also acts as the primary water source for fire protection with a standpipe in the tank which reserves 300,000 gal of the stored water for fire protection.

9.2.8.3 Safety Evaluation

Failure of the system will not compromise any safety related system or component or prevent a safe shutdown of the plant.

There is sufficient redundancy and sizing in the raw water treatment system to ensure a sufficient supply of clarified water for plant operating conditions.

9.2.8.4 Testing and Inspection Requirements

Prior to station operation, the raw water treatment system was operated to furnish clarified water to the makeup demineralizer system for startup operations. This use verified that all system components and controls function properly.

Since the raw water treatment system and associated equipment is in daily use, no periodic equipment testing is required. All equipment is accessible for observation where inspection during use will ensure the system's operability.
Sample sinks are provided to periodically collect samples and analyze the clarified water quality.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.2.8.5 Instrumentation Requirements

The raw water treatment system is furnished with a control panel located in the water treatment building which is designed for all remote pushbutton control of the clarification process. Automatic control of the clarification, chemical injection, and filtering of the raw water is included in this system panel.

Flow, turbidity, and pH are all monitored to verify system performance and alarm abnormal conditions.

The clarifier sludge holdup sump is furnished with level switches to indicate high level alarms and to control operation of the discharge pumps. Level switches are also provided on the backwash holding tank for pump control and alarms.

The clarified water storage tank is equipped with level switches to indicate high and low level alarms in the system control panel.

The low level switch also trips the clarified water pumps. Local pressure indicators are provided at the discharge of all pumps in the system for pump head indication.

9.2.9 MAKEUP DEMINERALIZER SYSTEM

9.2.9.1 Design Basis

The makeup demineralizer system has no safety related function and does not convey radioactive materials.

The makeup demineralizer system is designed to provide an adequate supply of demineralized water for the plant operating requirements.

9.2.9.2 System Description

The makeup demineralizer system consists of the following:

a) One makeup demineralizer trailer which may contain cation, anion or mixed bed ion exchangers as provided by the vendor.

b) One activated carbon filter rated for a maximum flow of 240 gpm.

c) One demineralized water storage tank of 50,000 gal capacity.

d) One demineralized water jockey pump.

e) Two demineralized water transfer pumps.

f) Two 18,000 gal capacity rubber lined concrete neutralization basins complete with two 100 percent capacity sample pumps and two 100 percent capacity discharge pumps.

g) Associated piping and controls for all demineralizer operations. The piping is primarily stainless steel, except for the inlet and outlet piping for the carbon filters, which is carbon steel. The system piping is rated at 85 psig and 100^{o}F.

The complete system is depicted on Dwgs. M-118, Sh. 1, M-118, Sh. 2, and M-118, Sh. 3.

Clarified water or domestic water is supplied through an activated carbon filter to the makeup demineralizer trailer under pressure (see Subsection 9.2.8). The flow rate through the demineralizer trailer is regulated by a control valve located at the inlet to the demineralized water storage tank and is inversely proportional to the tank level.

The activated carbon filter preceding the demineralizer removes chlorine residual.

When the ion exchange capacity of the trailer is exhausted, the demineralizer trailer is automatically removed from service. If exhaustion is indicated by conductivity or silica analyzers, a manual rinse of the trailer may be performed. If proper quality is not obtained, the trailer is shut down. Alarm annunciation of exhaustion is indicated in the demineralizer system control panel.

The demineralizer trailer is replaced with a regenerated trailer when any of the following criteria are met:

a) The trailer effluent conductivity is ≥0.1 micromho/cm @25°C.
b) The trailer effluent silica is ≥0.01ppm.
c) The trailer rated process volume has been reached.
d) The trailer has been in service for two months.

The demineralizer trailer is connected to the permanent plant piping via heat traced and insulated flexible stainless steel hoses. Space heaters are placed in the trailer during cold weather for freeze protection.

The neutralization basins collect the trailer rinse water, in addition to chemical wastes pumped from the chemical waste sumps in the water treatment building (circ. water pumphouse). All equipment and process drains on the west side of the water treatment building are routed to the chemical waste sump. All equipment and process drains on the east side of the water treatment building are routed to the water treatment building sumps. All discharges from the neutralization basins are conducted in accordance with the station's NPDES permit.

The demineralized water flows to the 50,000 gal capacity storage tank. Prior to unit operation, demineralized water was used to fill the condensate and refueling water storage tanks, and to fill and flush systems. During normal operation, the demineralized water is used for services such as:

- Various service connections throughout the Reactor, Turbine, Radwaste and Control Buildings, the Drywell and the S&A Building Maintenance Shop
- Reactor and Turbine Building Sample Stations
- Chilled water systems and closed cooling water systems makeup
- CRD Test Pump
- RHR heat exchanger flushing
- Diesel generator jacket cooling water makeup
- Refueling water and condensate water storage tank makeup
- Condenser Hotwell makeup
- Standby liquid control system makeup
- Condensate Filtration System iron injection skid
- Condensate Filtration System polymer and chemical injection skids
- Mobile Radwaste Processing
- Source of water to a tank that provides a passive, backup keepfill function to the ECCS and RCIC pump discharge lines. The tank will be maintained filled with at least 2,000 gallons of water.

A single header from the demineralized water storage tank supplies the demineralized water jockey pump and transfer pumps at a positive suction pressure. The jockey pump is in continuous operation and is controlled by an on-off hand switch. A recirculation line back to the demineralized water storage tank is provided for prevention of pump overheating on low system demands. The two transfer pumps are controlled by on-off-auto hand switches. During normal operation one transfer pump is in the auto position and the other is in the off position. Low pressure on the pumps discharge header will start the transfer pump in the auto position. This pump will stop when a set high pressure is reached. The second transfer pump can be started manually at any time. Recirculation lines are provided for pump protection. A low-low level switch on the demineralized water storage tank will stop the jockey and transfer pumps.

The makeup demineralizer trailer is located outside the Circulating Water Pumphouse and the associated equipment is in the Circulating Water Pumphouse. The demineralized water storage tank is in the yard and is furnished with an electric heater to prevent freezing.

9.2.9.3 Safety Evaluation

Failure of the system will not compromise any safety related system or component or prevent a safe shutdown of the plant.

9.2.9.4 Testing and Inspection Requirements

Since the makeup demineralizer system is in weekly use, no periodic equipment testing is required. All equipment is accessible for observation where inspection during use will ensure the system's operability.

Grab samples from the Demineralized Water Storage Tank are periodically tested to verify demineralizer performance. Trailer effluent samples are tested when a trailer is first placed in service and when alarms are received.

9.2.9.5 Instrumentation Requirements

The makeup demineralizer system is furnished with a control panel, located in the Circulating Water Pumphouse.

The demineralizer trailer effluent is monitored by in-line conductivity and silica monitors. The monitors will alarm and automatically isolate the trailer if their setpoint is exceeded. A flow totalizer is located at the trailer influent.

The neutralization basins are furnished with level switches to indicate high and low level alarms and to control the operation of the sample and discharge pumps.

The demineralized water storage tank is equipped with a level switch that alarms in the main control room to indicate demineralized low water level. This switch also trips the demineralized water jockey and transfer pumps. Local pressure indicators are provided at the discharge of all pumps in the system for pump head indication.

9.2.9.6 Unused Equipment

This section describes original plant components and their function which are no longer in use.

a) Two makeup demineralizer trains with each train rated for 120 gpm. Each train consists of a cation exchanger, an anion exchanger, and a mixed bed exchanger.

b) Demineralizer regeneration system that includes acid and caustic storage tanks, positive displacement pumps, caustic dilution hot water heater and associated piping, valves, and controls.

Design flow through each demineralizer train is 120 gpm. Expected normal flow during station operation is 60 gpm. The demineralizer is capable of either operating two trains in parallel or having one train operating while the other train is regenerating. During normal operation, one train will be on line with the other train on standby. The standby unit will be placed on line by pushbutton as required. The activated carbon filter preceding the demineralizers is capable of providing service flow to one demineralizer train while simultaneously providing regeneration water to the other train.

When the ion exchange capacity of either the mixed bed vessel or the cation-anion vessels is exhausted, the demineralizer train is automatically removed from service. If exhaustion is indicated by conductivity or silica analyzers, the cation-anion bed or mixed bed undergo an automatic timed rinse. If proper quality is not obtained, the train shuts down automatically. Alarm annunciation of exhaustion is indicated in the demineralizer system control panel.

When regeneration of one of the trains is required, the regeneration operation is initiated manually by pushbutton. The regeneration sequences are controlled automatically after initiation. At the end of the demineralizer regeneration, the train goes into the standby position.

The neutralization basins collect the chemical wastes from the regeneration process. Once regeneration is initiated, air mixing of the basin contents automatically begins to aid in the neutralization. Low level switches stop the sampling and discharge pumps and open the inlet valve to accept another regeneration waste influent. The makeup demineralizers and associated equipment are in the water treatment building.

Automatic and manual control of the regeneration and neutralization processes are also included in the system panel. Flow, conductivity, and silica monitors are provided for each demineralizer train to indicate when the ion exchangers are ready for regeneration. High conductivity alarms and high silica content alarms are provided on the makeup demineralizer system control panel to alert the operator to an abnormal condition.

Pressure, temperature, and conductivity are monitored for the acid and caustic regeneration solutions. Level indicators and low level alarms are provided for the acid and caustic storage tanks. Interlocks are provided in the system to prevent regeneration if both basins are full. The system is also furnished with controls to select the empty basin for neutralization if the other basin is full when regeneration is initiated.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.2.10 CONDENSATE STORAGE AND TRANSFER SYSTEM

9.2.10.1 Design Bases

The condensate and refueling water storage system has no safety related function and is designed to perform the following functions:

a) Supply water to fill the reactor well and dryer-separator pool of one unit during refueling operations and to provide storage for this water when refueling is completed.

b) Supply condensate for various processes in the radwaste system and makeup for the Plant systems including the condenser hotwells.

c) Supply condensate to the suctions of the HPCI, RCIC, Core Spray and CRD Pumps associated with Units 1 and 2

d) Provide a minimum storage capacity of 135,000 gal for the RCIC and HPCI Pumps associated with each unit

e) Provide the capability to demineralize the water in the refueling water storage tank by pumping it through the condensate demineralizers and returning it to the storage tank

f) Provide storage for condensate rejected from the cycle

g) Provide storage for condensate returned from the radwaste system

h) Provide the capability to drain the reactor well through the condensate demineralizer and back to the storage tank.

i) Provide the capability for HPCI and RCIC to recycle water during the test mode.

j) Provide a supply to the "keep filled" system for core spray, RHR, HPCI and RCIC pump discharge lines. A backup keepfill function is provided by the Demineralized Water System (Refer to FSAR Section 9.2.9).

k) Supply condensate to the fuel pool as make-up for evaporative losses.

l) Supply condensate for condensate filter vessel fill and for CFS backwash receiving tank, transfer pump, and piping flush.

9.2.10.2 System Description

The condensate storage system is shown in Dwg. M-108, Sh. 1. The various flow paths are listed in Table 9.2-11, which also includes the operating modes to achieve these flow paths.

The system consists of the following:

a) One atmospheric condensate storage tank for each unit, each with a capacity of 300,000 gal

b) Two horizontal centrifugal condensate transfer pumps, each full capacity, and rated at 600 gpm

c) One atmospheric refueling water storage tank with a capacity of 680,000 gal, common to both units

d) Two horizontal centrifugal refueling water pumps, each full capacity, and rated at 1500 gpm

e) Interconnecting piping, valves, instruments and controls.

Condensate Storage Tanks (Units 1 and 2)

These tanks are the preferred source of water for the HPCI and RCIC pumps for both operational use and testing. In addition, they supply water to the core spray pumps which is used for testing.

The condensate transfer pumps also take their suction from these tanks to provide water for various services in the radwaste building, the reactor building, and for backwashing the cleanup filter demineralizers and the fuel pool filter demineralizer.

Each condensate transfer pump is rated at 100 percent capacity; normally only one runs at a time. If the discharge pressure of the operating pump falls, the second pump will start automatically. Both pumps can be operated in parallel. Each pump is controlled from the main control room.

Each condensate storage tank maintains a minimum storage of 135,000 gallons to service the associated HPCI and RCIC Pumps during plant operation by use of standpipes and locked closed valves on all other lines.

Makeup is supplied by the demineralized water transfer pumps.

The tanks also act as surge tanks for the condensate systems by receiving any rejected condensate from and making up any deficiency in the heat cycle under the action of the level controls on the condenser hotwell.

Refueling Water Storage Tank

The refueling water storage tank stores the water that is used to fill the reactor well and dryer-separator pool of either Unit 1 or 2.

During refueling operations water inventory is transferred from the storage tank to the respective reactor well and dryer-separator pool. The refueling water pumps are started and stopped manually to support this evolution. Each pump can be controlled from either the main control room or from the refueling floor thus permitting an operator at either of these locations to operate the pumps. During refueling fill evolutions, both pumps are typically run in parallel.

When refueling is complete the water in the reactor well and dryer-separator pool can be emptied to the refueling water storage tank through a condensate filter-demineralizer. Makeup for the refueling water storage tank is supplied by the demineralized water transfer pumps taking suction from the demineralized water storage tank.

The refueling water storage tank also provides water to fill the spent fuel cask storage pool. This water can be returned to the tank through the condensate filter demineralizer.

During plant shutdown when there is no condenser vacuum, up to 1000 gpm of water is provided to the primary coolant degasifier system for deaeration. The deaerated water is returned back to the refueling and condensate storage tanks.

9.2.10.3 Safety Evaluation

The Unit 1 condensate storage tank and the refueling water storage tank are located outdoors. The area occupied by the two tanks is surrounded by walls designed to retain the total volume of water contained in both the refueling water storage tank and the Unit 1 condensate storage tank if both tanks rupture simultaneously. The Unit 2 condensate storage tank, also located outdoors, is surrounded by a wall designed to retain the total volume of water in the tank if it ruptures.

Water that collects within the retaining walls can be processed to the liquid radwaste system, discharged to the cooling tower blowdown outfall via a tanker or drained directly to the storm sewer. Berm area water discharged to plant outfalls is sampled for radiation and water quality prior to release.

9.2.10.4 Tests and Inspections

The condensate storage and transfer system is used during Plant operation and requires only visual inspections for leakage or deterioration and to verify operation of the various transfer pumps.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.2.10.5 Instrumentation Applications

Condensate Storage Tanks

Each tank is provided with a level transmitter that operates a pen in a recorder located in the control room. Each condensate storage tank has a separate pen. In addition to the level transmitters, each tank has high and low level switches that alarm in the control room and a low level switch that trips the condensate transfer pumps if they are running.

Redundant low and low-low level switches are installed in each tank to provide a permissive to allow the RCIC and HPCI pumps to take suction from the respective reactor suppression pool instead of from the respective condensate storage tank, which is the primary source of water to the HPCI and RCIC systems. A detailed description of the condensate Transfer Pump discharge low pressure alarm and its function with regard to the ECCS/RCIC pump discharge keep filled system is provided in Section 6.3.2.2.5.

Refueling Water Storage Tank

This tank is provided with a level transmitter that operates a third pen on the control room recorder referred to above. In addition the tank has high and low level switches which alarm in the control room and a low level switch that trips the refueling water pumps if they are running.

9.2.11 POTABLE WATER AND SANITARY WASTE SYSTEMS

The potable water system, (a.k.a the domestic water system) is a groundwater-supplied (a.k.a well water) system that provides cold and hot water throughout the station. The domestic water system also serves as the primary source of water for the Clarified Water System (described in

Section 9.2.8.2). The back-up water source for the clarified water system is river water via the station's Reactivator. Domestic water for potable uses has no backup.

The sanitary waste system (a.k.a the Sanitary Waste Treatment System) treats and disposes of waste water from all the station plumbing fixtures except those which could possibly contain chemicals. Note that waste water discharges are managed in compliance with the station's National Pollutant Discharge Elimination System (NPDES) permit.

9.2.11.1 Design Bases

The domestic water system has no safety related function and is designed to prevent radioactive contamination of this system. Before well water enters the station's domestic water distribution system, it is filtered and treated in order to ensure the water is safe to drink. This treatment is described in Subsection 9.2.11.2.3.

With a 500,000 gal Well Water Storage Tank (0T594) the domestic water system is designed to provide up to a maximum of 200 gpm during peak demand periods.

Water heaters are provided to supply hot water to the toilet and shower areas and other locations where needed. The storage capacities of the water heaters are based on the maximum hot water demand which is anticipated to occur during the plant personnel shift change during maintenance and refueling operations.

9.2.11.2 System Description

The domestic water system is supplied from two wells (TW-2 and TW-1), and both wells are located within the same aquifer. Of the two wells, TW-2 has the highest recharge rate, hence serves as the system's primary supply well. TW-1, which has a significantly lower recharge rate, serves as the system's back-up well. The well water system design does not allow groundwater withdrawal from TW-2 and TW-1 simultaneously.

Drinking water treatment is described in Subsection 9.2.11.2.3.

The domestic water system is designated as non-Seismic Category I. (The only exception is that piping inside the Diesel Generator 'E' Building was analyzed to Seismic Category I requirements.) The domestic water system includes the components necessary to draw, treat, and dispense finished potable water for personnel consumption and for use in plant systems.

The domestic water system is shown in Dwgs. M-117, Sh. 3, M-117, Sh. 4, and M-117, Sh. 5.

9.2.11.2.1 Well Water Storage Tank (0T594)

The Well Water Storage Tank (0T594) is a carbon steel tank with a nominal storage capacity of 500,000 gallons. This tank provides the necessary disinfection contact time for the treated well water, and serves as the direct water supply for the domestic water distribution system and the clarified water system and has 180,000 gallons of the tank's nominal storage capacity in reserve for the fire protection water system.

9.2.11.2.2 Domestic Water Jockey Pumps

Two domestic water jockey pumps supply treated (finished) well water to the station via the domestic water distribution system. Normally one pump is in continuous operation, with the second pump on automatic standby. The standby pump starts automatically when the header pressure decreases. The standby pump will stop automatically when reduced demands cause the system pressure to rise.

9.2.11.2.3 Domestic Water Treatment

Sodium hypochlorite is injected into the well water to: (1) disinfect the well water, and (2) oxidize soluble iron to render it insoluble prior to entering the Green Sand Filter (0F805). As the chlorinated well water passes through the green sand filter, any insoluble iron in the well water is filtered/removed. Additionally, a pH additive is injected into the well water in order to reduce copper and lead levels.

Following this direct treatment, the well water is stored inside a 500,000 gallon capacity Well Water Storage Tank (0T594) to ensure the well water receives adequate contact time with chlorine prior to entering the Domestic Water Distribution System.

9.2.11.2.4 Green Sand Filter

The green sand filter (0F805) removes the insoluble iron through the use of filter media.

9.2.11.2.5 Hot Water Storage Heaters

Electric storage domestic water heaters are provided in various buildings, where there is a requirement for domestic hot water, such as the Control Structure, the Service and Administration Building, the Radwaste Building, the North Gatehouse, the Circ. Water Pump House, the Security Control Center, the South Gatehouse, the South Building, the North Building, and the Warehouse. As required depending on the application, the pressure tanks of certain water heaters are constructed and stamped in accordance with the applicable ASME Code Section IV. All water heaters are wired in accordance with the National Electric Code and are UL listed.

9.2.11.2.6 Valves

ASME code-rated and approved relief valves are provided on all electric storage water heaters for temperature and pressure relief.

Self-actuated pressure reducing regulators are provided in the branch lines supplying each building. Pressures are set to ensure that no plumbing fixture or equipment connection is subjected to a static pressure greater than 65 psig or less than 15 psig.

9.2.11.2.7 Piping

Piping materials used in the potable water distribution system will prevent the introduction of objectionable tastes, odors, discoloration and toxic conditions into the system, and conform to the provisions of the Uniform Plumbing Code.

Piping sizes were designed to limit the flow velocity to a maximum of 8 fps and thus minimize noise, system shock and water hammer. Water hammer arresters, approved and certified by the Plumbing and Drainage Institute, are installed at appropriate locations.

9.2.11.2.8 Sanitary Waste Disposal

All wastes from plumbing fixtures that have no potential for radioactive, oil or chemical contamination are conveyed to the station's Sewage Treatment Plant.

The sewage treatment plant combines, pulverizes, and aerates the influent sewage and then clarifies it by settling the sludge. The treatment plant then removes the sludge and disinfects the effluent that discharges to the Susquehanna River. The effluent water quality from the Sewage Treatment Plant is managed in compliance with the station's NPDES permit.

The sewage treatment system is shown schematically in Figure 9.2-10.

9.2.11.3 Safety Evaluation

The Domestic Water and Sanitary Waste Treatment Systems are not safety-related and are not designed to Seismic Category I requirements, with the exception of piping inside the Diesel Generator 'E' Building which was analyzed to Seismic Category I requirements. Failure of this system will not compromise any safety-related system or component or prevent safe shutdown of the plant.

Contamination of the potable water system will be prevented by a combination of air gaps, vacuum breakers and backflow preventers of the reduced pressure zone type or double check valve assembly type.

The chlorination units which were used to treat clarified water when it was used as plant potable water have been taken out of service. Therefore, backflow preventers are installed on the clarified water/well water crosstie line to prevent untreated clarified water from entering the potable water.

Backflow preventers are provided on both the 1-1/2 in. hot and 2 in. cold water branch lines supplying the Laundry Room and the 1 in. hot and cold water branch lines supplying the Radiation Chemical Laboratory in the Control Structure.

The 2-in. cold water lines that will supply water to the decontamination showers and lavatories in Units 1 and Unit 2 Reactor Buildings are provided with backflow preventers before they enter the buildings.

Backflow preventers are also provided on the 1-1/2 in. hot and cold water lines that will supply water to the decontamination showers and lavatories, clothes washers, service sink and the flushing nozzles of the Radwaste Solidification System in the Radwaste Building.

Decontamination lavatories are provided with faucets that are photocell actuated to automatically close whenever the hands are removed and/or with foot-operated faucets. The spout location provides an air gap of 6-1/2-in. from the flood level. All hose bibb connections to the clothes washers are provided with vacuum breakers. All sink faucets with hose connections are also provided with vacuum breakers. The flushing spray nozzles for the radwaste solidification system discharge to atmospheric pressure and are controlled by normally closed, fail closed valves in addition to the 1-1/2-in. backflow preventer.

Sanitary waste is disposed of in accordance with the requirements of the Pennsylvania Department of Environmental Protection. Potentially contaminated waste from the decontamination showers and lavatories, laundry room, and chemical laboratory is directed to the radwaste treatment system.

9.2.11.4 Tests and Inspections

The potable water piping was subjected to a hydrostatic test pressure of 100 psig. The system was disinfected with 50 ppm chlorine for 24 hours. The system was then drained and flushed with potable water. The sanitary waste piping was subjected to a hydrostatic test pressure of not less than a ten-foot head of water.

Inspection of the entire system for compliance with the provisions of the Uniform Plumbing Code was performed.
Periodic tests on the potable water were performed to determine the residual ppm chlorine content. The sanitary waste is tested periodically to determine the settable solids and pH of the effluent and the dissolved oxygen at the beds.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.2.11.5 Instrumentation Application

Pressure controllers are provided to start and stop the domestic water Jockey pumps as described in Subsection 9.2.11.2.2. Thermostats, high-temperature limit switches, and temperature gauges are installed on hot water storage heaters. Alarm units, activated upon operation of emergency showers and eyewash units, register local alarms.

A flow meter measures, records and totalizes the effluent flow of the sewer system. An electrical control panel with on-off pushbuttons and indicator lights for all blower motors, surge tank pump, spray pumps, chlorinator and all other motors of the sewage treatment plant is installed in the sewage treatment control house. Trouble alarm for any motor failure in the treatment plant, including trouble with the motor or compressor of the surge tank effluent pump, and the air pressure shall be transmitted to the main plant control room with local indication of the particular malfunction.

9.2.12 CHILLED WATER SYSTEMS

9.2.12.1 Control Structure Chilled Water System

9.2.12.1.1 Design Bases

The control structure chilled water system is designed to supply chilled water at 44°F to the control room floor cooling system, computer room floor cooling system, and the control structure H&V system. These systems maintain design air temperatures inside the control structure during all modes of plant operation.

The control structure chilled water system also supplies chilled water to the Unit 1 reactor building emergency switchgear room air handling system emergency cooling coils during normal operation, a loss of coolant accident, a loss of offsite power and, when temperature rises above 102°F in the emergency switchgear room (initiated by temperature switch). The control structure chilled water system is designed so that a single failure of any active component, assuming loss of both offsite power and normal source of cooling water, cannot result in loss of chilled water to the above air conditioning systems during all modes of plant operation.

Codes and standards applicable for the system are listed in Table 3.2-1.

The control structure chilled water system has three subsystems.

a) The chilled water circulation subsystem is safety related and designed to meet Seismic Category I requirements.

   The pressure vessels, piping, pumps, valves, and tanks in this subsystem are designed to quality group D, in accordance with Safety Guide 26, March 1972.
   The system was not designed to quality group C (ASME Section III, Class 3), since the purchase orders for the main components (centrifugal chillers and air handling units) were placed in May and July 1974. Regulatory Guide 1.26 (September 1974), provides an option to design the control room chilled water system to quality group D for the plants whose docket date of application precedes January 1, 1975. Since the system is Q-listed and Seismic Category I, the design meets Regulatory Guide 1.26 with the above exception.

b) The emergency condenser cooling water subsystem.

   This subsystem has a safety related function and is designed to meet Seismic Category I requirements.

   The pressure vessels, piping, pumps, and valves in this subsystem are designed to quality group C (ASME Section III, Class 3) to comply with the design basis of the emergency service water system.

c) The normal condenser cooling water subsystem.

   This subsystem has no safety related function and is not Seismic Category I.

   The pressure vessels, piping, pumps, and valves in the subsystem are designed to quality group D in accordance with Safety Guide 26, March 1972.

9.2.12.1.2 System Description

9.2.12.1.2.1 General Description

The system is common to Units 1 and 2. The system consists of two identical 100 percent capacity chilled water trains. Each train consists of a centrifugal chiller, a chilled water pump, one normal condenser water pump, one emergency condenser water pump, seven cooling coils, closed expansion tank, chemical addition tank, air separator, interconnecting piping, valves instrumentation, and controls. The system is shown schematically on Dwgs. M-186, Sh. 1, M-186, Sh. 2 and M-111, Sh. 2. Dwgs. M-186, Sh. 1 and M-186, Sh. 2 show the 'A' Control Structure Chilled Water subsystem. The 'B' subsystem is similar.

Heat from the seven space cooling coils is transferred to the chiller by the circulating chilled water. The heat gained is removed from the chilled water in the chiller evaporator, by a flow of refrigerant which in turn is cooled by the condenser cooling water.

During normal plant operation the source of condenser cooling water is the non-safety related service water system. Whenever emergency conditions prevail, the safety related Emergency Service Water System (ESWS) provides condenser cooling water.

The normal makeup water supply to the chilled water circulation system is through the manually controlled valve provided in the makeup demineralized water system. The ESWS provides a redundant source of makeup water through a manual control valve.

The chemical addition subsystem, provided to minimize piping corrosion and scale buildup, is manually controlled and is normally isolated. This subsystem is not safety related. The components of the system are located in the control structure building.

An air separator and an expansion tank are provided to accommodate expansion and contraction in the system due to temperature fluctuations.

9.2.12.1.2.2 Component Description

Design data for major components of the control structure chilled water system are listed in Table 9.2-14.

9.2.12.1.2.3 System Operation

One of the two chilled water trains will be in operation during all modes of plant operation including LOCA. Starting a chilled water pump from the control room initiates the operation of that train. Under normal conditions, one chilled water train will be operating and the other train will be on standby.

Chilled water outlet temperature will be maintained at 44^{o}F by automatically positioning the compressor inlet vanes that are controlled by the temperature of the chilled water line leaving the evaporator.

Each of the air handling systems is provided with a thermostatically controlled chilled water three way valve modulated by a temperature controller to match the cooling load requirement. Operation of the standby control structure chilled water train will be automatic on failure of the operating train.

The control structure chilled water system is powered from the emergency power supply system. On loss of offsite power the lead chilled water train will restart automatically according to the diesel generator loading sequence. The chiller is capable of restarting approximately 4-1/2 minutes after power is restored.

If the water level in the closed expansion tank falls below the low level, this condition will be annunciated in the control room.

In the event of a control room evacuation manual control of the 'A' train can be taken at the Control Structure HVAC Alternate Control Panel. At this panel, the 'A' train chiller, the chilled water circulating pump, the chilled water emergency condenser water circulating pump, and the ESW supply valve can be manually operated. Operation from this panel provides input to the Bypass Indication System.

9.2.12.1.3 Safety Evaluation

The control structure chilled water system is housed within the Seismic Category I control structure. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

The components of the system required for emergency operation are designed to Seismic Category I requirements. The components and supporting structures that are not Seismic Category I, and whose collapse could result in a loss of a required function of the chilled water system through either impact or flooding, are analytically checked to verify that they will not collapse when subject to seismic loading from the Safe Shutdown Earthquake.

Adequate chilled water system capacity was selected to allow the air conditioning system to maintain design ambient air temperatures inside the control structure building, and the system is tested to ensure adequate capacity. In addition, the chilled water system capacity is adequate to provide cooling to the ESF - SWGR air handling units during a LOOP and LOCA condition.

Two separate 100 percent capacity independent systems provide mechanical redundancy. This, together with the redundancy of electrical design, ensures that a failure of any single active component cannot result in a loss of both trains of engineered safety feature chilled water. Therefore, cooling is assured for the equipment needed to safely shut down the plant.

For a failure mode and effect analysis of the Control Structure chilled water system, refer to Table 9.2-15.

9.2.12.1.4 Tests and Inspection

The system was preoperationally tested in accordance with the requirements of Chapter 14.

Provision is made for periodic inspection of major components to ensure the capability and integrity of the system. Local display devices are provided to indicate pressures and temperatures for tests and inspections. During normal plant operation, when the Emergency Service Water System is available, the emergency condenser water pump of the operating chiller can be test operated. A test switch located in the control room can simultaneously stop the normal condenser water pump and start the emergency condenser water pump without stopping the chiller.

9.2.12.1.5 Instrument Applications

The hand control switches of the chilled water pumps and the status indicating lights of the major components of the chilled water systems are located in the control room. A chilled water train is started or set in a standby mode through the control switch of the chilled water pump.

Hand control switches for the chilled water circulating pump, the emergency condenser circulating pump, the chiller, and the Emergency Service Water control valve are located on the Control Structure HVAC Alternate Control Panel along with their respective status indicating lights. Manual operation from this panel isolates control from the control room.

The chilled water system instrumentation is redundant and seismically qualified. Power supplies to the instruments are redundant and connected to the emergency buses.

Indicators for the chilled water temperature and flow as well as the emergency condenser water flow are provided in the control room and will monitor the operation of the chilled water loop during emergency conditions.

The following abnormal conditions are alarmed in the control room:

a) Failure of the chilled water pump/loss of FSL-08621A/B control power.

b) Failure of the normal condenser water pump.

c) Failure of the emergency condenser water pump.

d) High and low water levels at the expansion tank.

e) Chilled water high temperature.

f) CSHVAC alternate control switches in emergency position.

9.2.12.2 Turbine Building Chilled Water System

9.2.12.2.1 Design Bases

The turbine building chilled water system has no safety related function.

During normal operation the turbine building chilled water system is designed to supply chilled water for maintaining design ambient air temperatures in various areas throughout the turbine building. The system is designed to permit periodic inspection, testing, and maintenance of principal components with a minimum loss of normal operation.

Codes and standards applicable for the system are listed in Table 3.2-1.

9.2.12.2.2 System Description

9.2.12.2.2.1 General Description

Unit 1 turbine building chilled water system supplies chilled water to supply unit cooling coils, recirculation unit cooling coils, condensate pump room unit coolers, condenser compartment unit coolers, and access control unit cooling coils. The Unit 2 system is identical except that the access control cooling load is met by the Unit 1 system. Units 1 and 2 systems also provide chilled water to their respective mechanical vacuum pump seal water coolers during startup. The following is a description of the Unit 1 system.

The system consists of two centrifugal water chillers, two evaporator chilled water circulating pumps, two condenser water circulating pumps, two chilled water loop circulating pumps, an air separator, an expansion tank, a chemical addition tank, air cooling coils, interconnecting piping, instrumentation and controls. One chilled water loop circulating pump, one evaporator chilled water circulating pump, one condenser water circulating pump, and one chiller normally operate, while the others remain on automatic standby. However, if the cooling load exceeds the full capacity of one chiller, the standby chiller will automatically pick up a portion of the load.

The system is shown schematically on Dwg. M-188, Sh. 1.

Heat gained by the circulating chilled water is removed in the chiller evaporator by a flow of refrigerant which in turn is cooled by the condenser cooling water.

Condenser cooling water is provided by the service water system.

The makeup water supply to the Turbine Building Chilled Water System is through the manual valve provided in the makeup connection from the demineralized water system.

The chemical addition subsystem provided to minimize piping corrosion and scale buildup is manually controlled.

An air separator and an expansion tank are provided to accommodate expansion and contraction in the system due to temperature change.

The components of the system are located in the turbine building.

9.2.12.2.2.2 Component Description

Design data for major components of the turbine building chilled water system are listed in Table 9.2-16.

9.2.12.2.2.3 System Operation

The Turbine Building Chilled Water System operates on a year-round basis. Chilled water is circulated through the supply loop to the air cooling coils. The return chilled water is cooled by the chiller and recirculated.

One chilled water loop circulating pump and one chiller, with its associated evaporator water circulating pump and condenser water circulating pump (a "chiller loop"), normally operate. The other chilled water loop circulating pump and the other chiller loop are normally placed in automatic standby. Either chiller loop may be operated with either chilled water loop circulating pump.

The system is manually started from local panels by starting a selected chilled water loop circulating pump, then an evaporator water circulating pump, which also starts the corresponding condenser water circulating pump, and then the corresponding chiller.

The standby chilled water loop circulating pump will automatically start if the operating pump fails.

The standby chiller loop will automatically start if the operating chiller loop cannot meet demand. If the chilled water return temperature exceeds its setpoint, either because the cooling load exceeds the capacity of the operating chiller or because the operating chiller fails, or if the operating chiller or a circulating pump fails, the standby chiller loop components automatically start, to pick up the load.

Two temperature sensors located downstream of the chillers in the chilled water supply main modulate the compressor inlet guide vanes of their respective chillers to maintain a constant chilled water supply temperature in the loop.

The chiller condensor cooling water outlet temperature is maintained constant by mixing the cooling water supply and return flow using two butterfly valves under the control of the Condenser Leaving Water Temperature Controller.

Three way mixing valves regulate chilled water flow rate through the supply unit cooling coils, recirculation unit cooling coils, and access control H/V unit cooling coils.

When the temperature of air upstream of any of the cooling coils in the turbine building supply unit or access control H/V unit drops below the set value of the temperature switches, this is annunciated locally as indication of failure of the upstream heating coil. Further drop of air temperature in the Access Control H/V Unit will be detected by another temperature switch which will isolate chilled water to the unit cooling coils and open drain valves to prevent freezing. A vacuum breaker provides automatic venting for this automatic drain function. Manual isolation, vent, and drain valves, and demineralized water connections, permit manual isolation, drain, and fill of the Turbine Building Supply Unit Cooling Coils and of the Access Control H/V Unit Cooling Coils; or refill of the Access Control H/V Unit Cooling Coils after an automatic drain for freeze protection. Isolation, vent and drain valves permit drain and fill of unit coils, and of sections of the remainder of the Turbine Building Chilled Water System. Manual switches and valves are provided to permit coil drain system testing, if required.

High and low levels of the expansion tank are annunciated locally and retransmitted as a trouble alarm to the control room. The tank is filled, drained, and pressurized through manual valves.

9.2.12.2.3 Safety Evaluation

Since the turbine building chilled water system has no safety design basis, no safety evaluation is provided. However the system includes some features that ensure its reliable operation during normal plant operation. These features include redundant components for equipment such as chillers and pumps.

9.2.12.2.4 Test and Inspections

The system was preoperationally tested in accordance with the requirements of Chapter 14.

Provision is made for periodic inspection of major components to ensure the capability and integrity of the system. Local display devices are provided to indicate pressures and temperatures for tests and inspections.

9.2.12.2.5 Instrument Applications

Operation of the water chillers and chilled water pumps will be initiated manually from local control panels. Automatic standby operation of chillers and pumps is provided.

Indicators on the local panel provide operation status of chillers and pumps. Local indicators display pressures and temperatures required to monitor operation of the chillers and pumps.

The following abnormal conditions are alarmed at the local control panel and retransmitted to the control room as a trouble alarm:

a) Failure of any pump

b) Failure of any chiller

c) High and low water level in the expansion tank

d) Low temperature at the upstream face of the cooling coil in the access control heating/ventilating unit and turbine building supply unit.

9.2.12.3 Reactor Building Chilled Water System

9.2.12.3.1 Design Bases

Portions of the Reactor Building Chilled Water System have safety related functions. The safety related portions include the primary containment piping penetrations and containment isolation valves. The safety related portions are designed to meet Seismic Category I requirements.

The chilled water piping inside the drywell is supported to ensure that it will have no adverse effects on adjacent safety related equipment in the event of an earthquake.

During normal operation the Reactor Building Chilled Water System is designed to maintain normal design air temperatures in various areas in the reactor building, including the emergency switchgear and load center room and the drywell.

The system is also designed to supply chilled water to the reactor recirculation pump motor coolers inside the drywell to maintain motor temperature within allowable limits.

The Reactor Building Chilled Water System is designed to permit periodic inspection, testing, and maintenance of principal components with a minimum loss of normal operation.

The Reactor Building Closed Cooling Water System provides a backup to the portion of the Reactor Building Chilled Water System that serves the primary containment, to maintain drywell temperatures and provide reduced cooling to the recirculation pump motor coolers during loss of offsite power or failure of the Reactor Building Chilled Water System.

Codes and standards applicable for the System are listed in Table 3.2-1.

9.2.12.3.2 System Description

9.2.12.3.2.1 General Description

Unit 1 Reactor Building Chilled Water System supplies chilled water at approximately 50°F to the Zones I and III air supply unit cooling coils, emergency switchgear and load center room air handling units, reactor recirculation pump motor coolers, and drywell unit coolers. The Unit 2 system is identical except that Zone I (Unit 1 portion of the cooling load) is replaced by Zone II for Unit 2.

The following discussion is applicable for the Unit 1 system.

The system consists of two centrifugal water chillers, two evaporator chilled water circulating pumps, two condenser water pumps, two chilled water loop circulating pumps, an air separator, an expansion tank, a chemical addition tank, air-cooling coils, interconnecting piping, instrumentation, and controls. Each of the chillers and pumps is sized for 100 percent of system capacity.

The system is shown schematically on Dwgs. M-187, Sh. 1 and M-187, Sh. 2.

Heat gained by the circulating chilled water is removed in the chiller evaporator by a flow of refrigerant, which in turn is cooled by the condenser cooling water.

Cooling water to the chiller condensers is provided from the plant Service Water System. Makeup water supply is through a manual valve provided in the branch connection from the demineralized water supply system.

The chemical addition subsystem, provided to minimize piping corrosion and scale buildup, is manually controlled and is not safety related.

An air separator and an expansion tank are provided to accommodate expansion and contraction in the system due to variations in temperature. The components of the system are located in the reactor building.

During plant outages the heat load on the Reactor Building Chilled Water System is greatly reduced. If the Reactor Building Chillers remain in service, they may experience cycling due to the reduced load. To prevent this cycling, a temporary outage chiller system may be installed and operated, thereby allowing the Reactor Building Chillers to be shutdown. The temporary equipment is sized for the lower heat loads present during outage conditions. The temporary outage chiller system will be connected to the Reactor Building Chilled Water System return header in such a manner as to supply chilled water to all the normal Reactor Building Chilled Water System loads. The temporary outage chiller system can remain in service throughout the outage and during plant startup until such time sufficient heat load exists to place the Reactor Building Chillers in service.

9.2.12.3.2.2 Component Description

Design data for major components of the Reactor Building Chilled Water System are listed in Table 9.2-17.

9.2.12.3.2.3 System Operation

The Reactor Building Chilled Water System operates continuously. Chilled water is circulated through the supply loop to the air cooling coils. The return chilled water is cooled by the chiller and recirculated.

One chilled water loop circulating pump and one chiller, with its associated evaporator water circulating pump and condenser water circulating pump (a “chiller loop”), normally operate. The other chilled water loop circulating pump and the other chiller loop are normally placed in automatic standby. Either chiller loop may be operated with either chilled water loop circulating pump.

The system is manually started from local panels by starting a selected chilled water loop circulating pump, then an evaporator water circulating pump, which also starts the corresponding condenser water circulating pump, and then the corresponding chiller.

The standby chilled water loop circulating pump will automatically start if the operating pump fails.

The standby chiller loop will automatically start if the operating chiller loop cannot meet demand. If the chilled water return temperature exceeds its setpoint, or if the operating chiller or a circulating pump fails, the standby chiller loop components automatically start, to pick up the load.

Two temperature sensors located downstream of the chillers in the chilled water main supply header modulate the compressor inlet guide vanes of their respective chillers to maintain a constant chilled water supply temperature in the loop.

A temperature controller maintains constant chiller condenser cooling water outlet temperature by modulating temperature control valves on the cooling water return and recirculaton lines.

Three way valves are used for regulating the chilled water flow rate through the cooling coils except those in the drywell unit coolers and recirculation pump motor coolers, which are balanced for constant flow.

The Zone I, Zone II, and Zone III cooling coils are drained and isolated during the winter months to prevent the coils from freezing. During the fall and spring seasons when the cooling coils are still functional, the coils are protected from freezing by low temperature switches mounted on the face of each coil. If the air temperature upstream of the cooling coils drops below the setpoint of the low temperature switches, maximum chilled water flow is routed through the cooling coils.

The Zone III cooling coils are also protected from freezing by energizing the Zone III heaters when outside air temperatures drop below 40°F. This is accomplished by providing the outside air temperature as a second control signal for Zone III heater operation.

There are two sets of unit coolers with seven unit coolers in each set for the drywell. Each set is on a separate piping loop. Two separate piping connections supply chilled water to recirculation pump motor coolers A and B.

An alternate supply of cooling water to the drywell coolers is available from the Reactor Building Closed Cooling Water System. It will be connected automatically under the following conditions: low flow in chilled water loop, high temperature in chilled water loop, or loss of power to chilled water circulating pumps. The cooling can be returned to normal after one of the chillers is restored and the chilled water flow and temperature return to normal.

During a DBA, there will be no chilled water or reactor building closed cooling water supply to the drywell, because the containment isolation valves will be closed.

9.2.12.3.3 Safety Evaluation

The operation of the Reactor Building Chilled Water System has no safety related function. Containment penetration and containment isolation portions of the system are safety related as described in Subsection 6.2.4.

The chilled water piping inside the drywell has been examined to ensure that in the event of a SSE it will have no adverse effects on adjacent safety related equipment.

9.2.12.3.4 Test and Inspections

The system was preoperationally tested in accordance with the requirements of Chapter 14. Provision is made for periodic inspection of major components to ensure the capability and integrity of the system. Local display devices are provided to indicate pressures and temperatures for tests and inspections.

9.2.12.3.5 Instrument Applications

Operation of the water chillers and chilled water pumps will be initiated manually from local control panels. Automatic standby operation of chillers and pumps is provided. Indications are displayed at the local control panel to show operation status of chillers and pumps. Local indicators display pressures and temperatures required to monitor operation of the chillers and pumps.

Chilled water flow into and out of the containment will be isolated by valves which close on an isolation signal, or on power failure at the valve. For a complete discussion of containment isolation, refer to Section 6.2.4.

The following abnormal conditions are alarmed at the local control panel and retransmitted to the control room as a trouble alarm:

a) Failure of any pump

b) Failure of any chiller

c) High and low water level at the expansion tank

d) Drywell cooling coils outlet water high temperature

9.2.12.4 Radwaste Building Chilled Water System

9.2.12.4.1 Design Bases

The Radwaste Building Chilled Water System has no safety related function.

The Radwaste Building Chilled Water System is designed to supply chilled water at 48ºF to maintain design ambient air temperatures in various areas of the Radwaste Building. Water at 48ºF is supplied first to four coils in the Off Gas System Area Unit Coolers, and thence, in series, to six cooling coils in the Air Supply Unit. Water to the six Air Supply Unit Cooling Coils will be at 56.7ºF or less, with design heat load on the Off Gas System Area Cooling Coils.

The system is designed to permit periodic inspection, testing, and maintenance of principal components with a minimum loss of normal operation.

Codes and standards applicable for the system are discussed in Table 3.2-1.

9.2.12.4.2 System Description

9.2.12.4.2.1 General Description

The system is common to both Units 1 and 2. It consists of two centrifugal water chillers, two evaporator chilled water circulating pumps, two condenser water pumps, two chilled water loop circulating pumps, an air separator, an expansion tank, a chemical addition tank, air cooling coils, interconnecting piping, and controls. Each chiller and pump is sized for 100 percent of nominal system capacity. The system is shown schematically on Dwgs. M-189, Sh. 1, M-189, Sh. 2, M-189, Sh. 3, and M-189, Sh. 4.

Heat gained by the circulating chilled water is removed in the chiller evaporator refrigerant which in turn is cooled by the condenser cooling water.

Cooling water to the chiller condenser is provided from the normal Service Water System.

The makeup water supply to the Radwaste Building Chilled Water System is through the manual valve provided in the makeup connection from the demineralized water system.

The chemical addition subsystem provided to minimize piping corrosion and scale buildup is manually controlled.

An air separator and an expansion tank are provided to accommodate expansion and contraction in the system due to temperature change.

The components of the system are located in the radwaste building.

9.2.12.4.2.2 Component Description

Design data for major components of the Radwaste Building Chilled Water System are listed in Table 9.2-18.

9.2.12.4.2.3 System Operation

The Radwaste Building Chilled Water System is started manually when needed. Chilled water is circulated through the supply loop to the air cooling coils. The return chilled water is cooled by the chiller and recirculated.

One chilled water circulating pump and one chiller, with its associated evaporator water circulating pump and condenser water circulating pump (a "chiller loop"), are normally operated. The other chilled water loop circulating pump and the other chiller loop are normally placed in automatic standby. Either chiller loop may be operated with either chilled water circulating pump.

The system is manually started from local panels by starting a selected chilled water loop circulating pump, then an evaporator water circulating pump, which also starts the corresponding condenser water circulating pump, and then the corresponding chiller.

The standby chilled water loop circulating pump will automatically start if the operating pump fails.

The standby chiller loop will automatically start if the operating chiller loop cannot meet demand. If the chilled water return temperature exceeds its setpoint, or if the operating chiller or a circulating pump fails, the standby chiller loop components automatically start, to pick up the load.

An available feature permits the system to be started automatically when the outside air temperature reaches 52ºF, if desired, by preselecting a chilled water loop circulating pump and a chiller loop. The selected chilled water loop circulating pump will then automatically start on increasing outside air temperature; and the selected evaporator water circulating pump, condenser water circulating pump, and chiller will automatically start in sequence when chilled water loop flow reaches a flow switch setpoint.

Two temperature sensors located downstream of the chillers in the chilled water supply main modulate the compressor inlet guide vanes of their respective chillers to maintain a constant chilled water supply temperature in the loop.

A temperature controller maintains constant chiller condenser cooling water outlet temperature by modulating a three-way valve between the cooling water supply and return line.

Three-way valves are also provided for regulating the chilled water flow rate through the air supply unit and off-gas area unit cooling coils. When the temperature of air upstream of any of the air supply unit cooling coils drops below the set value of the temperature switches, this is annunciated at the local control panel as indication of failure of the upstream heating coil. Further drop of air temperature will be detected by another set of temperature switches, which, together with actuation of a low chilled water flow switch, will initiate the isolation and draining of water in the cooling coils to prevent freezing. . Vacuum breakers provide automatic venting for this drain function. Manual isolation, vent, and drain valves, and a demineralized water connection, permit manual isolation, drain, and fill of the Radwaste Building Supply Unit Cooling Coils; or refilll of the coils after an automatic drain for freeze protection. Manual switches and valves are provided to permit coil drain system testing, if required.

High and low levels of the expansion tank are annunciated locally and as a trouble alarm to the control room. The tank is filled, drained, and pressurized through manual valves.

9.2.12.4.3 Safety Evaluation

Because the Radwaste Building Chilled Water System has no safety design basis, no safety evaluation is provided. However, the system has features that ensure its reliable operation during plant normal operation. These features include redundant equipment such as chillers and pumps. Additional features include fail-safe positions on the system controls and equipment safety controls.

9.2.12.4.4 Tests and Inspections

The system was preoperationally tested in accordance with the requirements of Chapter 14.

Provision is made for periodic inspection of major components to ensure the capability and integrity of the system. Local display devices are provided to indicate pressures and temperatures for tests and inspections.

9.2.12.4.5 Instrument Applications

Operation of the chilled water system will be initiated manually from local control panels. Automatic standby operation of chillers and pumps is provided.

Indications displayed on the local control panel give the operating status of chillers and pumps. Local indicators display pressures and temperatures required to monitor operation of the chillers and pumps.

The following abnormal conditions are alarmed at the local control panel and retransmitted to the control room as a trouble alarm:

a) Failure of any pump

b) Failure of any chiller

c) High and low water level in the expansion tank

d) Low air temperature at the upstream side of the air supply unit cooling coils

9.2.13 References

9.2-1 Schofield, F., "Nuclear Power Plant Heat Rejection in an Arid Climate," M.S. Thesis, Univ. of Ariz., 1971

9.2-2 Moore, W. E., "Spray Pond Keeps River Within 5^{o}F Rise Limit," Elec. World, 169:14, Apr. 1, 1968, pp. 33-35.

9.2-3 Brannen, Glenn W. "Spray Pond Testing at Canady's Station," South Carolina Electric and Gas Co., Columbia, S.C. Unpublished.

9.2-4 Schrock, V. E. and Trezek, G. J., "Rancho Seco Nuclear Service Spray Ponds Performance Evaluation," report submitted to Sacramento Municipal Utility District, October, 1974.

9.2-5 Letter from R.J. Clark (NRC) to R.G. Byram (PP&L), “Hydrostatic Testing of D-Augmented Piping in the Offgas System, Susquehanna Steam Electric Station, Units 1 and 2” (PLA-3546) (TAC Nos. M86433 and M86434), dated June 22, 1993.

TABLE 9.2-1

LIST OF COOLERS SUPPLIED COOLING WATER BY THE SERVICE WATER SYSTEM

1.	Generator Stator Coolers
2.	Generator Hydrogen Coolers
3.	Alterrex Air Coolers
4.	Iso-Phase Bus Coolers
5.	Gaseous Radwaste Recombiner CCW Heat Exchangers
6.	Turbine Building CCW Heat Exchangers
7.	Turbine Lube Oil Coolers
8.	Reactor Feed Pump Turbine Lube Oil Coolers
9.	Reactor Recirculation Pump M-G Set Fluid Coolers
10.	Reactor Building CCW Heat Exchangers
11.	Fuel Pool Heat Exchangers
12.	Pipe Tunnel Coolers
13.	Turbine Building Chillers
14.	Reactor Building Chillers
15.	Control Structure Chillers
16.	Radwaste Building Chillers
17.	Radwaste Evaporator Condensers[1]
18.	Containment ILRT Aftercooler and Air Dryer
19.	Degasifier Seal Water Cooler

[1] Permanently valved out of service

TABLE 9.2-2

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TABLE 9.2-3

DEFINITION OF ESW FLOWS FOR UNITS 1 & 2

Component	Number of Users Per Loop U1	U2	Minimum Required ESW Flow per User (GPM)	Minimum Required ESW Flow For DBA and 1 Loop Failed	Typical Minimum ESW Loop Flow Non-Accident with 1 Loop Operating and Service Water Available	Typical Minimum(5) ESW Safe Shutdown Flow 2 Loops Operating and Both Units Service Water Not Available A(B)	B(A)
1) Standby(4) Diesel Generator Heat Exchangers	4 common total		1029 (A & C) 922 (B & D) 1282 (E)(3)	3902 (A,B,C,D) 4155 (B,C,D,E) 4262 (A,B,C,E)	3902 (A,B,C,D) 4155 (B,C,D,E) 4262 (A,B,C,E)	3902(2) 4155(2) 4262(2)	- - -
2) RHR Pump Room Unit Coolers	2	2	90	360	360	360	360
3) RHR Pump Motor Bearing Oil Cooler (7)	3	3	7.5	45	45	30	30
4) Core Spray Pump Room Unit Coolers	2	2	15	60	60	60	60
5) HPCI Pump Room Unit Coolers	1	1	10	20	20	20	20
6) RCIC Pump Room Unit Coolers	1	1	10	20	20	20	20
7) Control Structure Chiller	1 common per loop		737	737	-	737	-
8) Emergency Switch-gear Cooling Condensing Unit	-	1	110	110	-	110	-
9) RBCCW Heat Exchanger(1)	1	1	900	-	-	-	See Note 1
10) TBCCW Heat Exchanger (1)	1	1	100	-	-	-	See Note 1
11) Makeup to Fuel Pools(6)	1	1	35	70	-	70	-
TOTAL Loop Flow (GPM)			-	5254(2) 5507(2) 5614(2)	4407(2) 4660(2) 4767(2)	5239(2) 5492(2) 5599(2)	490

TABLE 9.2-3

DEFINITION OF ESW FLOWS FOR UNITS 1 & 2

NOTES:

1) One loop only. Not required to meet the system design function. This equipment is aligned when permitted by operating procedures to assist in shutdown operations. Per procedure, RBCCW is not aligned to ESW if a spray pond bypass valve fails.

2) Values shown are dependent on the combination of Diesel Generators operating, since flow rates for the 'A' & 'C' Diesel Generators are different from flows for the 'B' & 'D' Diesel Generators and required flows for the 'E' Diesel Generator are different from all the others.

3) The 'E' Diesel Generator flow rate shown on this table is based on the continuous duty rating of the Diesel Generator (5000 kw).

4) Both loops of ESW are aligned to the Diesel Generators. It is preferred that one pump per loop be run during normal operations. However, in the event of a DBA and a single failure in ESW, one loop will be available to supply the design flow to the Diesel Generator.

5) This column illustrates the ESW systems ability to supply DBA flows in addition to supplying TBCCW and RBCCW with both loops operating. The actual flow rates in each loop will vary slightly because of the crosstie at the diesels (that is, the 'B' loop will pass some flow to the Diesel Generators).

6) The make-up rate shown here is conservatively based on a non-mechanistic boiling spent fuel pool (See Subsection 9.1.3.3). The flow rate for make-up of evaporative losses during RHR fuel pool cooling operation would be significantly less.

7) Both loops of ESW are aligned to RHR pump motor bearing oil coolers 1E217C, 1E217D, 2E217C and 2E217D. With one loop operating, ESW will provide cooling to three Unit 1 and three Unit 2 RHR pump motor bearing oil coolers.

TABLE 9.2-4

Security-Related Information
Text Withheld Under 10 CFR 2.390

TABLE 9.2-4

Security-Related Information
Text Withheld Under 10 CFR 2.390

Table Rev. 54

TABLE 9.2-5

ESW COOLING DUTY FOLLOWING DBA FOR MAXIMUM WATER LOSS CASE (LOSS OF ALL AUXILIARY POWER FOLLOWED BY A SINGLE UNIT LOCA)

Time	Operating Safeguards	LOCA Unit	S/D Unit	Cooling Duties On ESW	Number in Use LOCA Unit	Number in Use S/D Unit	Total ESW Cooling Duty* ($x10^6$ BTU/Hr)
0 – 10 Mins.	1) RHR Pumps	4-LPCI	0	1) Diesel-generator	4-Common		42.49
	2) RHR Hx's	0	0	Hx			
				2) Control Structure	1-Common		3.67
	3) CS Pumps	4	0	Chiller			
				3) Emergency	1-Unit 2		0.63
				Switchgear	Only		
	4) RCIC Pumps	1	1	Cooling			
	5) HPCI Pumps	1	0	Condensing Unit			
	6) RHR SW Pumps	0	0	4) RBCCW Hx	1	1	15.4**
				5) TBCCW Hx	1	1	0.48**
	7) ESW Pumps	All 4 Running	All 4 Running	6) RHR Room Cooler	4	--	2.01
				7) RHR Motor Oil	4	--	0.22
	8) Diesels	4 Running	4 Running	Cooler			
				8) C.S. Room Cooler	4	--	0.79
				9) HPCI Room Cooler	1	-	.140
				10) RCIC Room Cooler	1		0.20
						TOTAL	66.03
10 Mins to 3Hrs.	1) RHR Pumps	2-Pool Cool	2-Pool Cool	1) Diesel-generator	4-Common		42.49
	2) RHR Hx's	2	2	Hx	1-Common		3.67
				2) Control Structure			
	3) CS Pumps	4	0	Chiller			
				3) Emergency	1-Unit 2		0.63
				Switchgear	Only		
	4) RCIC Pumps	1	1	Cooling			
	5) HPCI Pumps	1	0	Condensing Unit			
	6) RHR SW Pumps	2	2	4) RBCCW Hx	1	1	15.4**
				5) TBCCW Hx	1	1	0.48**
	7) ESW Pumps	All 4 Running	All 4 Running	6) RHR Room Cooler	2	2	2.01
	8) Diesels	4 Running	4 Running	7) RHR Motor Oil	2	2	0.22
				Cooler			
				8) C.S. Room Cooler	4	--	0.79
				9) RCIC Room Cooler	1	1	0.20
				10) HPCI Room Cooler	1	--	0.14
						TOTAL	66.08

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TABLE 9.2-5

ESW COOLING DUTY FOLLOWING DBA FOR MAXIMUM WATER LOSS CASE (LOSS OF ALL AUXILIARY POWER FOLLOWED BY A SINGLE UNIT LOCA)

Time	Operating Safeguards	LOCA Unit	S/D Unit	Cooling Duties On ESW	Number in Use LOCA Unit	Number in Use S/D Unit	Total ESW Cooling Duty* ($x10^6$ BTU/Hr)
Approx. 3 hrs. to 30 days	1) RHR Pumps	2-Pool Cool	Shutdown Cool 1 - FPC	1) Diesel-generator Hx	4-Common 1-Common		42.49
	2) RHR Hx's	2	2	2) Control Structure Chiller			3.67
	3) CS Pumps	4	0	3) Emergency Switchgear Cooling Condensing Unit	1-Unit 2 Only		0.63
	4) RCIC Pumps	0	0	4) RBCCW Hx	1	1	15.4**
	5) HPCI Pumps	0	0	5) TBCCW Hx	1	1	0.48**
	6) RHR SW Pumps	2	2	6) RHR Room Cooler	2	2	2.01
				7) RHR Motor Oil Cooler	2	2	0.22
	7) ESW Pumps	All 4 Running	All 4 Running				
	8) Diesels	4 Running	4 Running	8) C.S. Room Cooler	4	--	0.79
						TOTAL	65.69

NOTE:

* Value with the "E" Diesel Generator Unit in service as a replacement for one of the diesel generators A,B, C or D. Heat loads shown for Diesel Generator "E" are based on the continuous duty rating of the diesel generator (5000 KW)

** This equipment is not required to meet the system design function.

TABLE 9.2-6

ULTIMATE HEAT SINK COMPONENTS

	Details
Emergency Service Water Pumps	
Quantity	4 pumps
Type	Vertical, wet-pit, centrifugal
Rated capacity/total head (each)	6000 gpm/230 ft
Brake horsepower	450
Speed, rpm	1780
RHR Service Water Pumps	
Quantity	4 pumps, 2 per unit (1 each is on standby)
Type	Vertical, wet-pit, centrifugal
Rated capacity/total head (each)	9000 gpm/222 ft
Brake horsepower	600
Speed, rpm	1180

Note: Performance data is approximate. Refer to design documents for exact values.

TABLE 9.2-7 SPRAY POND DESIGN DATA	
	Details
Spray Nozzles	
Number	484/loop, two loops
Type	Hollow-cone spray pattern
Capacity each, gpm	53
Spray Pond	
Size, surface area	8 acres
Capacity, gal	25 x 10^6 gals
Lining	Concrete

TABLE 9.2-8
SUSQUEHANNA POND WATER ALLOWANCES

LOSS DESCRIPTION		WATER ALLOWANCE ($x10^6$ GAL.)
a)	Evaporation due to heat dissipation duty for maximum water loss case. Includes maximum solar evaporation losses.	14.96
b)	Drift from wind for maximum water loss case.	3.28
c)	System charging volume.	Negligible
d)	Losses resulting from wave action.(1)	0
e)	Fuel pool makeup and boundary valve leakage(5)	3.0
	TOTAL POND VOLUME REQUIRED	21.24
	TOTAL POND VOLUME PROVIDED(4)	22.2

(1) Based on design provisions for protection from this loss.

(2) Deleted

(3) Deleted

(4) Based on the Technical Specification low level limit. Volume accounts for 6 in. of pond depth lost due to sedimentation, which is conservative allowance between cleaning periods.

(5) A conservative value of 70 gpm over the 30-day transient is used to account for potential boundary valve leakage in the ESW system. No fuel pool makeup is required since pool cooling per RHR fuel pool cooling mode is assumed for the maximum water loss case.

TABLE 9.2-9

MINIMUM HEAT TRANSFER METEOROLOGY - SITE DATA
FIRST OF THE TWO WORST CONSECUTIVE DAYS
AUGUST 2, 1975

TIME (HR)	WET BULB TEMP (°F)	DRY BULB TEMP(°F)	DEW POINT TEMP (°F)	WIND SPEED (MPH)	CLOUD COVER* (TENTHS)
0	70	71	70	2.2	0
1	70	71	70	2.2	--
2	70	70	70	1.8	--
3	69	69	69	2.4	--
4	68	69	69	1.3	0
5	68	68	68	1.5	--
6	68	68	68	1.5	--
7	68	68	68	1.0	3
8	69	70	69	1.5	--
9	70	71	70	1.7	--
10	71	73	70	2.7	0
11	75	80	73	2.0	--
12	77	86	74	2.1	--
13	78	88	75	2.5	2
14	78	89	74	3.2	--
15	77	89	73	2.2	--
16	77	89	73	1.6	2
17	78	89	74	1.1	--
18	77	88	73	2.0	--
19	77	85	74	1.7	1
20	78	80	77	2.3	--
21	77	77	77	2.2	--
22	75	75	75	2.3	0
23	74	74	74	1.7	--
24	73	73	73	1.3	0

* Avoca Airport data used for cloud cover.

TABLE 9.2-9 (Continued)

MINIMUM HEAT TRANSFER METEOROLOGY - SITE DATA
WORST DAY
AUGUST 16, 1978

TIME (HR)	WET BULB TEMP (°F)	DRY BULB TEMP(°F)	DEW POINT TEMP (°F)	WIND SPEED (MPH)	CLOUD COVER* (TENTHS)
25	72	76	70	1.2	0
26	71	74	70	1.1	0
27	71	73	70	1.2	0
28	70	72	69	1.0	3
29	69	71	68	1.3	2
30	69	71	68	1.2	2
31	70	73	69	1.1	3
32	72	75	71	1.3	2
33	74	78	72	3.1	3
34	74	80	71	4.0	3
35	74	82	71	3.8	3
36	75	84	72	4.5	3
37	75	84	71	5.7	3
38	75	86	70	6.4	3
39	75	86	70	4.8	2
40	75	85	71	4.4	3
41	74	85	70	4.7	1
42	75	84	71	3.3	2
43	73	82	70	3.5	3
44	73	80	70	2.8	7
45	73	80	71	3.6	4
46	74	79	72	4.2	2
47	73	78	71	2.3	0
48	72	78	70	2.3	0

* Avoca Airport data used for cloud cover.

TABLE 9.2-9 (Continued)

MINIMUM HEAT TRANSFER METEOROLOGY - SITE DATA
SECOND OF THE TWO WORST CONSECUTIVE DAYS
AUGUST 3, 1975

TIME (HR)	WET BULB TEMP (°F)	DRY BULB TEMP(°F)	DEW POINT TEMP (°F)	WIND SPEED (MPH)	CLOUD COVER* (TENTHS)
49	72	72	72	1.5	--
50	70	70	70	2.7	--
51	69	70	69	2.2	0
52	68	69	68	1.7	--
53	68	69	68	1.7	--
54	68	68	68	2.6	2
55	68	68	68	2.1	--
56	69	70	68	1.6	--
57	71	72	71	1.7	0
58	74	77	73	1.9	--
59	76	83	74	1.9	--
60	78	86	75	2.3	1
61	76	88	72	3.2	--
62	76	90	71	4.2	--
63	74	91	67	3.1	0
64	73	89	66	2.8	--
65	75	87	71	2.8	--
66	76	86	72	2.0	4
67	77	83	75	1.7	--
68	77	80	76	4.3	--
69	73	79	71	3.6	0
70	70	76	67	2.5	--
71	70	75	68	3.7	--
72	70	74	68	3.2	0

* Avoca Airport data used for cloud cover.

TABLE 9.2-9 (Continued)

MINIMUM HEAT TRANSFER METEOROLOGY - SITE DATA
WORST 30 CONSECUTIVE DAYS
30-DAY AVERAGES BY TIME OF DAY
JULY 8, 1979 THROUGH AUGUST 6, 1979

TIME (HR)	WET BULB TEMP (°F)	DRY BULB TEMP(°F)	DEW POINT TEMP (°F)	WIND SPEED (MPH)	CLOUD COVER* (TENTHS)
73	65	67	64	1.8	2
74	64	66	63	1.9	2
75	64	66	63	1.9	1
76	64	65	63	2.0	1
77	63	65	62	1.8	2
78	63	65	62	1.8	2
79	64	66	63	1.9	2
80	66	68	65	2.1	2
81	68	71	66	2.7	2
82	69	74	66	2.9	3
83	70	77	66	3.5	3
84	70	78	66	3.7	2
85	70	80	65	4.1	4
86	70	80	65	3.9	4
87	70	80	65	4.1	4
88	70	80	65	3.9	4
89	70	79	65	3.7	4
90	69	78	65	3.1	4
91	69	77	65	2.4	3
92	69	74	66	2.1	3
93	68	72	66	2.0	3
94	67	70	65	1.8	2
95	66	69	65	1.9	2
96	65	68	64	1.8	1

* Avoca Airport data used for cloud cover.

** Data of this 24-hour period is repeated 27 times to constitute the balance of the 30-day meteorology.

TABLE 9.2-10

MAXIMUM WATER LOSS METEOROLOGY
AVOCA AIRPORT DATA

HOURLY AVERAGE DATA FOR WORST 30 DAYS
MARCH 6, 1951 THROUGH APRIL 4, 1951

TIME (HR)*	DRY BULB TEMP (°F)	WET BULB TEMP (°F)	WIND SPEED (mph)	DEW POINT TEMP (°F)	RELATIVE HUMIDITY (%)	CLOUD COVER (Tenths)
0	35.033	32.433	11.740	27.733	75.633	1
1	34.567	32.233	10.512	27.800	77.000	1
2	34.000	31.700	10.282	27.400	77.500	0
3	33.767	31.533	10.858	27.167	77.533	1
4	33.300	31.133	10.090	26.867	78.067	1
5	33.167	30.967	11.548	26.667	77.633	1
6	32.833	30.700	10.781	25.933	75.467	1
7	33.667	31.133	11.165	26.167	74.867	2
8	35.100	32.167	11.088	26.967	73.333	2
9	36.733	33.300	13.045	27.233	69.867	2
10	38.767	34.800	13.965	27.900	66.267	2
11	40.633	35.900	14.464	28.233	62.767	2
12	42.233	36.900	16.191	28.600	60.833	3
13	42.867	37.367	17.073	28.967	60.033	2
14	43.367	37.800	17.303	29.133	59.233	3
15	43.433	37.767	17.342	29.133	59.200	3
16	42.900	37.633	15.730	29.633	61.500	2
17	41.933	36.933	14.119	29.333	62.900	2
18	40.367	36.267	12.508	29.633	67.233	2
19	38.867	35.167	11.970	28.967	69.100	2
20	37.700	34.467	12.968	28.967	72.067	1
21	36.567	33.767	12.201	28.933	74.900	2
22	36.200	33.533	11.932	28.967	76.000	1
23	35.833	33.033	12.277	28.200	74.733	1

* Data of this 24-hour period is repeated 30 times to constitute the balance of the 30-day meteorology.

TABLE 9.2-11

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TABLE 9.2-12
SUMMARY OF PEAK TEMPERATURE VALUES
AND FINAL POND WATER INVENTORY

Parameter	Maximum Water Loss	Minimum Heat Transfer
Peak pond temperature	N/A	97
Calculated water inventory @ 30 days	0.97×10^6 gal	3.99×10^6 gal

TABLE 9.2-13

CONDENSATE & REFUELING WATER STORAGE FLOW PATHS

MODE	VALVE NUMBER																																							
	008001	008003	008004	008011	008009	008016	008038	008037	208034	008035	008039	008034	108028	008032	008081	008033	008078	008077	008079	008084	008083	008029	008036	008040	008050	008048	008057	008093	008074	008028	008F009A	008F009B	008002	008094	008102	008100	008095	008103	008111	008113
From Refueling Storage Tank																																								
1	0	0	0	0	0	0	0	0					0																				0							
2	0	0	0	0	0	0	0	0	0																								0							
3	0	0	0	0	0	0	0			0		0										0											0						0	
4	0	0	0	0	0	0					0						0	0		0													0							
5	0	0	0	0	0	0					0																							0						
6	0	0	0	0	0	0					0						0																		0					
7	0											0				0						*0								*0			0						0	
8	0						0			0	0					0	0	0		*0	*0												0							
9	0											0				0							0	0	0								0						0	
From Reactor Well Unit 1																																								
10		0	0	0	0	0		0		0	0		0			0																		0						
11		0	0	0	0	0		0		0	0		0			0	0																		0					
12							0	0			0		0																					0						
13							0	0			0		0				0																		0					
14	0							0		0			0			0																	0							
15								0		0		0	0									0																	0	
16							0	0			0		0				0	0		0																				
From Reactor Well Unit 2																																								
17																																								
18																																								
19																																								
20	Same as 10 - 16 except Valve 108028 closed and Valve 208034 open																																							
21																																								
22																																								
23																																								

0 - Valve

* - Open either valve depending on level in tank

TABLE 9.2-13

CONDENSATE & REFUELING WATER STORAGE FLOW PATHS

MODE	008001	008003	008004	008011	008009	008016	008038	008037	208034	008035	008039	008034	108028	008032	008081	008033	008078	008077	008079	008084	008083	008029	008036	008040	008050	008048	008057	008093	008074	008028	008F009A	008F009B	008002	008094	008102	008100	008095	008103	008111	008113
From Condensate Storage Tank - Unit 1																																								
24																						0	0	0	0	0	0		0											
25																						0	0	0	0	0	0	0												
26																	0					0	0	0	0	0	0	0						0	0					
27																	0	0		0		0	0	0	0	0	0	0						0						
28	0						0			0	0					0						0	0	0	0	0	0	0					0	0						
29																			0	*0	*0	*0	0							*0						0				
30	0											0				0						0											0						0	
31																															0									
From Condensate Storage Tank - Unit 2																																								
32																			0	0	*0			0	0	0	0		0							0				
33																			0	0	*0			0	0	0	0	0								0				
34																	0		0	0	*0			0	0	0	0	0						0	0	0				
35							0			0	0	0							0	0	*0	0		0	0	0	0	0						0		0			0	
36	0						0			0	0					0			0	0	*0			0	0	0	0	0					0	0		0				
37																			0	0	*0	0	0							*0						0				
38	0											0				0			0	0	*0		0										0			0			0	
39																																0								
From Condensate Filter Demineralizer - Unit 1																																								
40	0											0				0						*0								*0			0				0		0	0
41	0						0			0	0					0	0	0		*0	*0												0				0			0
42	Direct-By Opening Valves at Demineralizer																																				0			0
43	0											0				0							0	0	0								0				0		0	0
44	0	0	0	0																													0				0			0
From Condensate Filter Demineralizer - Unit 2																																								
45																																								
46																																								
47	Same as 40 - 44 but in addition open valve 008103 and close valve 008095																																							
48																																								
49																																								

0 - Valve

* - Open either valve depending on level in tank

TABLE 9.2-13

CONDENSATE & REFUELING WATER STORAGE FLOW PATHS

MODE	VALVE NUMBER																																							
	008001	008003	008004	008011	008009	008016	008038	008037	208034	008035	008039	008034	108028	008032	008081	008033	008078	008077	008079	008084	008083	008029	008036	008040	008050	008048	008057	008093	008074	008028	008F009A	008F009B	008002	008094	008102	008100	008095	008103	008111	008113
To & From Hotwell Makeup & Reject Station - Unit 1																																								
50														0																										
51														0					0	*0	*0	*0	0							*0						0				
52	0											0		0		0						*0								*0			0						0	
To & From Hotwell Makeup & Reject Station - Unit 2																																								
53															0				0	*0	*0	*0	0							*0						0				
54															0																									
55	0											0			0	0			0	*0	*0		0										0			0			0	

0 - Valve
* - Open either valve depending on level in tank

NOTES:

FROM REFUELING STORAGE TANK

Mode

1. To Reactor Well - Unit 1
2. To Reactor Well - Unit 2
3. To Cond. Storage Tank - Unit 1 Via Refueling Water Pumps
4. To Cond. Storage Tank - Unit 2 Via Refueling Water Pumps
5. To Cond. Filter Demin. - Unit 1
6. To Cond. Filter Demin. - Unit 2
7. To Cond. Storage Tank - Unit 1
8. To Cond. Storage Tank - Unit 2
9. To Cond. Transfer Pumps

TABLE 9.2-13

CONDENSATE & REFUELING WATER STORAGE FLOW PATHS

FROM REACTOR WELL - UNIT 1

Mode

10. To Cond. Filter Demin. - Unit 1 Via Refueling Water Pumps
11. To Cond. Filter Demin. - Unit 2 Via Refueling Water Pumps
12. To Cond. Filter Demin. - Unit 1
13. To Cond. Filter Demin. - Unit 2
14. To Refueling Storage Tank
15. To Cond. Storage Tank - Unit 1
16. To Cond. Storage Tank - Unit 2

FROM REACTOR WELL - UNIT 2

Mode

17. To Cond. Filter Demin. - Unit 1 Via Refueling Water Pumps
18. To Cond. Filter Demin. - Unit 2 Via Refueling Water Pumps
19. To Cond. Filter Demin. - Unit 1
20. To Cond. Filter Demin. - Unit 2
21. To Refueling Storage Tank
22. To Cond. Storage Tank - Unit 1
23. To Cond. Storage Tank - Unit 2

FROM CONDENSATE STORAGE TANK - UNIT 1

Mode

24. To Radwaste Equipment
25. To Cond. Filter Demin. - Unit 1 Via Cond. Transfer Pumps
26. To Cond. Filter Demin. - Unit 2 Via Cond. Transfer Pumps
27. To Cond. Storage Tank - Unit 2 Via Cond. Transfer Pumps
28. To Refueling Storage Tank Via Cond. Transfer Pumps
29. To Cond. Storage Tank - Unit 2
30. To Refueling Storage Tank
31. To RCIC & HPCI - Unit 1

FROM CONDENSATE STORAGE TANK - UNIT 2

Mode

32. To Radwaste Equipment
33. To Cond. Filter Demin. Unit 1 Via Cond. Transfer Pumps
34. To Cond. Filter Demin. - Unit 2 Via Cond. Transfer Pumps
35. To Cond. Storage Tank - Unit 1 Via Cond. Transfer Pumps
36. To Refueling Storage Tank Via Cond. Transfer Pumps
37. To Cond. Storage Tank - Unit 1
38. To Refueling Storage Tank
39. To RCIC & HPCI - Unit 2

FROM CONDENSATE FILTER DEMINERALIZER - UNIT 1

Mode

40. To Cond. Storage Tank - Unit 1 Via Refueling Water Storage Tank
41. To Cond. Storage Tank - Unit 2 Via Refueling Water Storage Tank
42. To Refueling Storage Tank
43. To Cond. Transfer Pumps Via Refueling Water Storage Tank
44. To Refueling Water Pumps Via Refueling Water Storage Tank

FROM CONDENSATE FILTER DEMINERALIZER - UNIT 2

Mode

45. To Cond. Storage Tank - Unit 1 Via Refueling Water Storage Tank
46. To Cond. Storage Tank - Unit 2 Via Refueling Water Storage Tank
47. To Refueling Storage Tank
48. To Cond. Transfer Pumps Via Refueling Water Storage Tank
49. To Refueling Water Pumps Via Refueling Water Storage Tank

TO & FROM HOTWELL MAKEUP & REJECT STATION - UNIT 1

Mode

50. Cond. Storage Tank - Unit 1 - Direct
51. Cond. Storage Tank - Unit 2 Via Unit 1 Condensate Storage Tank
52. Refueling Storage Tank Via Unit 1 Condensate Storage Tank

TO & FROM HOTWELL MAKEUP & REJECT STATION - UNIT 2

Mode

53. Cond. Storage Tank - Unit 1 Via Unit 2 Condensate Storage Tank
54. Cond. Storage Tank - Unit 2 - Direct
55. Refueling Storage Tank Via Unit 2 Condensate Storage Tank

TABLE 9.2-14

CONTROL STRUCTURE CHILLED WATER SYSTEM DESIGN DATA

Centrifugal Water Chillers	
Quantity	2
Type	Centrifugal
Capacity, tons	230
Motor, hp	351
Entering water temperature	54°F
Leaving water temperature	44°F
Chilled Water Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	565
Head, ft	78
Motor, hp	30
Condenser Water Pumps (Normal Service Water)	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	740
Head, ft	65
Motor, hp	20
Closed Expansion Tank	
Quantity	2
Capacity, gal	33
Design pressure, psig	125
Air Separator	
Quantity	2
Design pressure, psig	125
Flow rate, gpm	565
Chemical Addition Tank	
Quantity	2
Design pressure, psig	100
Capacity, gal	15
Condenser Water Pumps (Emergency Service Water)	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	740
Head, ft	54 (Rated)
Motor, hp	20

TABLE 9.2-15

CONTROL STRUCTURE CHILLED WATER SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power supply	Total loss of offsite power (LOOP)	None. The two redundant systems are powered from separate diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Chilled water loop circ pumps (OP-162)	Pump failure	None. The standby chiller train automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Chiller units (OK-112)	Chiller failure	None. When the chiller fails it trips the chilled water loop circulating pump and the standby chiller train automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Emergency condenser water circ pumps (OP-171)	Pump failure	None. When the pump fails it trips the chilled water loop circulating pump and the standby chiller train automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Emergency condenser water loop 3-way valves (TV-08612)	Valve failure	None. Eventually, the chiller will trip and in turn trip the chilled water loop circulating pump and the standby chiller train will automatically start.	Alarm in the control room	No loss of safety function

TABLE 9.2-15 (Continued)

CONTROL STRUCTURE CHILLED WATER SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (LOCA or LOCA + LOOP)	Emergency condenser water loop valves (HV-08613)	Valve failure	None. The valves fail "as is". If the valve fails fully closed it may result in a complete loss of condenser water and cause the chiller to trip. The standby chiller will automatically start. If the valve fails at any intermediate position the chiller will eventually trip through its safety circuit. The standby chiller will also automatically start.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Chilled water piping	Rupture or leak in the piping	None. Loss of water in the loop is detected at the expansion tank and is alarmed in the control room. Major loss of water will automatically start the standby chiller.	Alarm in the control room	No loss of safety function

TABLE 9.2-16

TURBINE BUILDING CHILLED WATER SYSTEM DESIGN DATA (PER UNIT)

Centrifugal Water Chillers*	
Quantity	2
Type	Centrifugal
Capacity, tons	800
Motor, hp	1080
Entering water temperature, °F	64
Leaving water temperature, °F	49
Chilled water supply temperature to the cooling coils, °F	52
Evaporator Chilled Water Circulation Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	1280
Head, ft	50
Motor, hp	25
Condenser Water Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	2500
Head, ft	70
Motor, hp	60
Closed Expansion Tank	
Quantity	1
Capacity, gal	64
Design pressure, psig	125
Air Separator	
Quantity	1
Design pressure, psig	125
Flow rate, gpm	2300
Chemical Addition Tank	
Quantity	1
Design pressure, psig	100
Capacity, gal	15
Chilled Water Loop Circulation Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	2300
Head, ft	70
Motor, hp	60

* These temperatures are calculated operating values for maximum design cooling load on the Turbine Building Chilled Water system, for one chiller operating at its design 800-ton load, and with the second chiller removing the remainder of the system design load. Chillers were purchased for nominal 65°F entering and 50°F leaving temperatures to support a nominal 50°F chilled water supply temperature.

TABLE 9.2-17

REACTOR BUILDING CHILLED WATER SYSTEM DESIGN DATA

(PER UNIT)

<u>Centrifugal Water Chillers</u>	
Quantity	2
Type	Centrifugal
Capacity, tons	715
Motor, hp	904
Entering water temperature	68°F
Leaving water temperature	50°F
Chilled water supply temperature to the Cooling Coils	50°F
<u>Evaporator Chilled Water Circulation Pumps</u>	
Quantity	2
Type	Horizontal Centrifugal
Flow Rate, gpm	960
Head, ft.	40
Motor, hp	15
<u>Condenser Water Pumps</u>	
Quantity	2
Type	Horizontal Centrifugal
Flow Rate, GPM	1860
Head, ft.	65
Motor, hp	40
<u>Closed Expansion Tank</u>	
Quantity	1
Capacity, gal.	64
Design pressure, psig	125
<u>Air Separator</u>	
Quantity	1
Design pressure, psig	125
Flow Rate, gpm	1265
<u>Chemical Addition Tank</u>	
Quantity	1
Design Pressure, psig	100
Capacity, gal.	15
<u>Chilled Water Loop Circulation Pumps</u>	
Quantity	2
Type	Horizontal Centrifugal
Flow Rate, gpm	1265
Head, ft.	85
Motor, hp	40

TABLE 9.2-18

RADWASTE BUILDING CHILLED WATER SYSTEM DESIGN DATA

Centrifugal Water Chillers	
Quantity	2
Type	Centrifugal
Capacity, tons	250
Motor, hp	350
Entering water temperature, °F	70
Leaving water temperature, °F	48
Chilled water supply temperature to the Offgas Area Cooling Coils, °F	48
Chilled water supply to Supply Cooling Coils from Offgas Area Cooling Coil outlet and bypass, °F (max.)	56.7
Evaporator Chilled Water Circulation Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	275
Head, ft	38
Motor, hp	5
Condenser Water Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	605
Head, ft	44
Motor, hp	10
Closed Expansion Tank	
Quantity	1
Capacity, gal	23
Design pressure, psig	125
Air Separator	
Quantity	1
Design pressure, psig	125
Flow rate, gpm	275
Chemical Addition Tank	
Quantity	1
Design pressure, psig	100
Capacity, gal	15
Chilled Water Loop Circulation Pumps	
Quantity	2
Type	Horizontal centrifugal
Flow rate, gpm	275
Head, ft	90
Motor, hp	10

TABLE 9.2-19

DECAY HEAT GENERATION
ANSI/ANS-5.1-1979, 4031 MWt
FOR ONE CORE

Time, min.	Decay Heat, %	Decay Heat, MBtu/hr.
0	7.22	993.3
10	2.45	337.1
30	1.85	254.5
180	1.04	142.9
250	0.95	130.8
500	0.80	110.1
1000	0.67	92.8
1500	0.61	84.1
2500	0.54	74.8
43200	0.24	33.5

TABLE 9.2-20

EMERGENCY SERVICE WATER SYSTEM HEAT LOADS (BOTH UNITS)
(X 10^6 BTU/HR)

I. Minimum Heat Transfer (MHT) Case*			
Time	Loop A	Loop B	Diesels Operating
0 – 10 min.	21.84	37.36	4
10 min. – 3 hrs.	22.19	37.71	4
3 hrs. – 30 days	49.14	0.00	4
II. Maximum Water Loss (MWL) Case*			
Time	Loop A	Loop B	Diesel Operating
0 – 10 min.	34.08	32.82	4
10 min. – 3 hrs.	34.43	33.17	4
3 hrs. – 30 days	34.33	32.93	4

* Heat loads include the ESW and RHRSW pump work heat equivalent.

TABLE 9.2-21

RHR AND RHR SERVICE WATER SYSTEM FLOW RATES (GPM)
MINMUM HEAT TRANSFER CASE

TIME	PARAMETER	LOCA	S/D
10-180 min.	Core Spray (2 loops)	12,700	0
	Safety Relief valves & RCICS	0	(1)
	RHRHX (tube side) Flow, Loop A	8,000	8,000
	RHRHX (tube side) Flow, Loop B	8,000	8,000
	RHRHX (shell side) Flow, Loop A	10,000	10,000
	RHRHX (shell side) Flow, Loop B	10,000	10,000
180 min. – 30 days	Core Spray (1 loop)	6,350	0
	RHRHX (tube side) Flow, Loop A	8,000	8,000
	RHRHX (tube side) Flow, Loop B	0	0
	RHRHX (shell side) Flow, Loop A	10,000	10,000
	RHRHX (shell side) Flow, Loop B	0	0

Note: (1) The flow rate is determined by the cooldown rate.

(2) LOCA Unit RHR Flow Rates denote the suppression pool cooling mode of operation.

(3) S/D Unit RHR Flow Rates denote the suppression pool cooling mode of operation for approximately the first three hours of the transient followed by the shutdown cooling mode of operation for the remainder of the thirty-day period.

TABLE 9.2-22

EMERGENCY SERVICE WATER SYSTEM FLOW RATES (GPM)

I. Minimum Heat Transfer (MHT) Case		
Time	Loop A	Loop B
0 – 3 hrs.	2186	3043
3 hrs. – 30 days	4974	0.00
II. Maximum Water Loss (MWL) Case		
Time	Loop A	Loop B
0 – Approx. 3 days	6058	4968
Approx. 3 days – 30 days	8040	2985

TABLE 9.2-23
INITIAL CONDITIONS

	Unit 1 (LOCA)	Unit 2 (FORCED SHUTDOWN)
Reactor Vessel		
Temperature, °F	211	551
Water Mass, lbm.	358,000	663,000
RPV Mass, Metal, lbm.	2.49×10^6	2.49×10^6
RPV Specific Heat, Btu/lbm °F	0.11	0.11
RPV Heat Capacity, Metal, Btu/°F	2.74×10^5	2.74×10^5
Drywell Floor		
Temperature, °F	231	N/A
Water Mass, lbm	467,000	N/A
Suppression Pool		
Temperature, °F	156	101
Water Mass, lbm.	7.101×10^6	7.672×10^6
Spray Pond Initial Temperature, °F	85.5° Min. Heat Dissipation Case (1)	

(1) Allows 0.5°F for instrument error.

TABLE 9.2-24

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TABLE 9.2-25

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TABLE 9.2-26

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TABLE 9.2-27

SIZE COMPARISON OF SPRAY PONDS INVESTIGATED

	Canadys	SSES	Rancho Seco
Water Flow Rate, gpm	180,000	55,968 (max)	16,500
Nozzles	1,800 @ 100 gpm	1,056 @ 53 gpm	304 @ 53 gpm
Water Pressure at Nozzle, psig	7	7	7
Pond Length, feet	-	1,250	330
Width, feet		525 to 225	165
Depth, feet	10	10.5	5
Volume (approx.) x 10^6 gallons	32.4	25.0	5.7
Area Acres	10	8	1.3

TABLE 9.2-28

PERFORMANCE COMPARISON OF CANADYS STATION AND MODEL RESULTS

T_{DB}/T_{WB}, °F	T_h, °F	T_c, °F	WS, mph	Meas. Eff., %	Model Eff., %
98/77.8	114	102.85	5.68	35.2 ± 3.47	30.81
75.7/70.9	111	98.91	6.25	34.3 ± 3.13	30.15
78.5/70.4	111	98.08	7.96	37.2 ± 3.09	34.53
71/62.3	97	86.99	8.52	34.6 ± 3.63	28.86
78/65.3	101	92.83	5.11	28.7 ± 3.59	22.87
97/79.7	112	101.75	6.25	35.1 ± 4.07	33.50

T_{DB} = dry bulb temperature

T_{WB} = wet bulb temperature

T_h = hot water temperature before spraying

T_c = sprayed water temperature just before entering pond

WS = wind speed

Meas. Eff. = measured efficiency

Model Eff. = calculated efficiency using model

* The uncertainty ranges were calculated by considering the likely accuracy of the instrumentation.

TABLE 9.2-29

PERFORMANCE COMPARISON OF RANCHO SECO TEST RESULTS AND MODEL RESULTS

Date	Time	T_{WB}, °F	T_{DB}, °F	W.S., MPH	T, °F	Rancho Seco % Efficiency	Model Prediction Efficiency
5/19/73	1424	61.0	81.5	13.0	79.8	41.4	41.35
5/19/73	1615	61.5	81.5	12.5	80.0	47.1	42.62
5/20/73	0400	51.0	55.0	4.9 (5.3)*	77.4	33.9	27.12
5/20/73	0630	48.5	52.0	2.8	77.4	28.8	22.95
5/20/73	1000	56.6 (56.5)*	65.0	6.2 (6.0)*	77.6	30.8	29.65
5/20/73	1148	57.5	71.0	6.2 (6.5)*	78.6	34.7	31.52
5/18/73	1500	72.4	95.0	7.0	80.0	38.3	37.46
5/18/73	1700	69.7	93.0	6.5 (6.6)*	81.1 (81.2)*	36.6	36.55
5/18/73	1900	66.6	85.7	8.5 (8.4)*	80.7	50.8	38.90
5/18/73	2200	60.9	72.3	3.4 (3.8)*	80.1 (80.3)*	33.6	25.56
7/19/73	2300	60.2	69.3	2.6 (3.8)*	79.7	28.5	25.66
5/20/73	2300	54.2	58.0	1.0	101.4	37.4	30.89
5/20/73	2330	53.0	57.0	1.2 (1.6)*	98.5 (100.0)*	36.5	34.13
5/20/73	2400	52.0	56.0	1.2 (1.3)*	97.8 (97.9)*	38.3	31.49
5/20/73	0330	49.0	53.0	1.4 (1.0)*	101.7	36.7	29.75
5/20/73	0415	48.0	51.0	0.80 (0.59)*	97.4	36.1	26.04

* Values in parentheses are the values used in the model prediction.

TABLE 9.2-30

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TABLE 9.2-31

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TABLE 9.2-21a

RHR AND RHR SERVICE WATER SYSTEM FLOW RATES (GPM)
MAXIMUM WATER LOSS CASE

Time	Parameter	LOCA	S/D
10 – 30 min.	Core Spray (2 loops)	12,700	0
	Safety Relief valves & RCICS	N/A	(1)
	RHRHX (tube side) Flow, Loop A	9,000	9,000
	RHRHX (tube side) Flow, Loop B	9,000	9,000
	RHRHX (shell side) Flow, Loop A	10,000	10,000
	RHRHX (shell side) Flow, Loop B	10,000	10,000
30 min. – 30 days	Core Spray (1 loop)	6,350	0
	RHRHX (tube side) Flow, Loop A	9,000	9,000
	RHRHX (tube side) Flow, Loop B	9,000	9,000
	RHRHX (shell side) Flow, Loop A	10,000	10,000
	RHRHX (shell side) Flow, Loop B	10,000	10,000

Note: (1) The flow rate is determined by the cooldown rate.

(2) LOCA Unit RHR Flow Rates denote the suppression pool cooling mode of operation.

(3) S/D Unit RHR Flow Rates denote two divisions of suppression pool cooling operation for approximately the first three hours of the transient followed by one division of shutdown cooling operation and one division of fuel pool cooling operation for the remainder of the thirty days.

FIGURE 9.2-2 REPLACED BY DWG. M-113, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-2 REPLACED BY DWG. M-113, SH. 1

FIGURE 9.2-2, Rev. 55

AutoCAD Figure 9_2_2.doc

FIGURE 9.2-3 REPLACED BY DWG. M-114, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.2-3 REPLACED BY DWG. M-114, SH. 1 FIGURE 9.2-3, Rev. 55

AutoCAD Figure 9_2_3.doc

FIGURE 9.2-4 REPLACED BY DWG. M-131, SH. 1

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FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-4 REPLACED BY DWG. M-131, SH. 1

FIGURE 9.2-4, Rev. 49

AutoCAD Figure 9_2_4.doc

FIGURE 9.2-6 REPLACED BY DWG. M-112, SH. 1

FSAR REV. 65

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UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-6 REPLACED BY DWG. M-112, SH. 1

FIGURE 9.2-6, Rev. 51

AutoCAD Figure 9_2_6.doc

FIGURE RENUMBERED FROM 9.2-8 TO 9.2-8-1

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UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE RENUMBERED FROM 9.2-8 TO 9.2-8-1

FIGURE 9.2-8, Rev. 54

AutoCAD Figure 9_2_8.doc

FIGURE 9.2-9 REPLACED BY DWG. M-108, SH. 1

FSAR REV. 65

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UNITS 1 & 2
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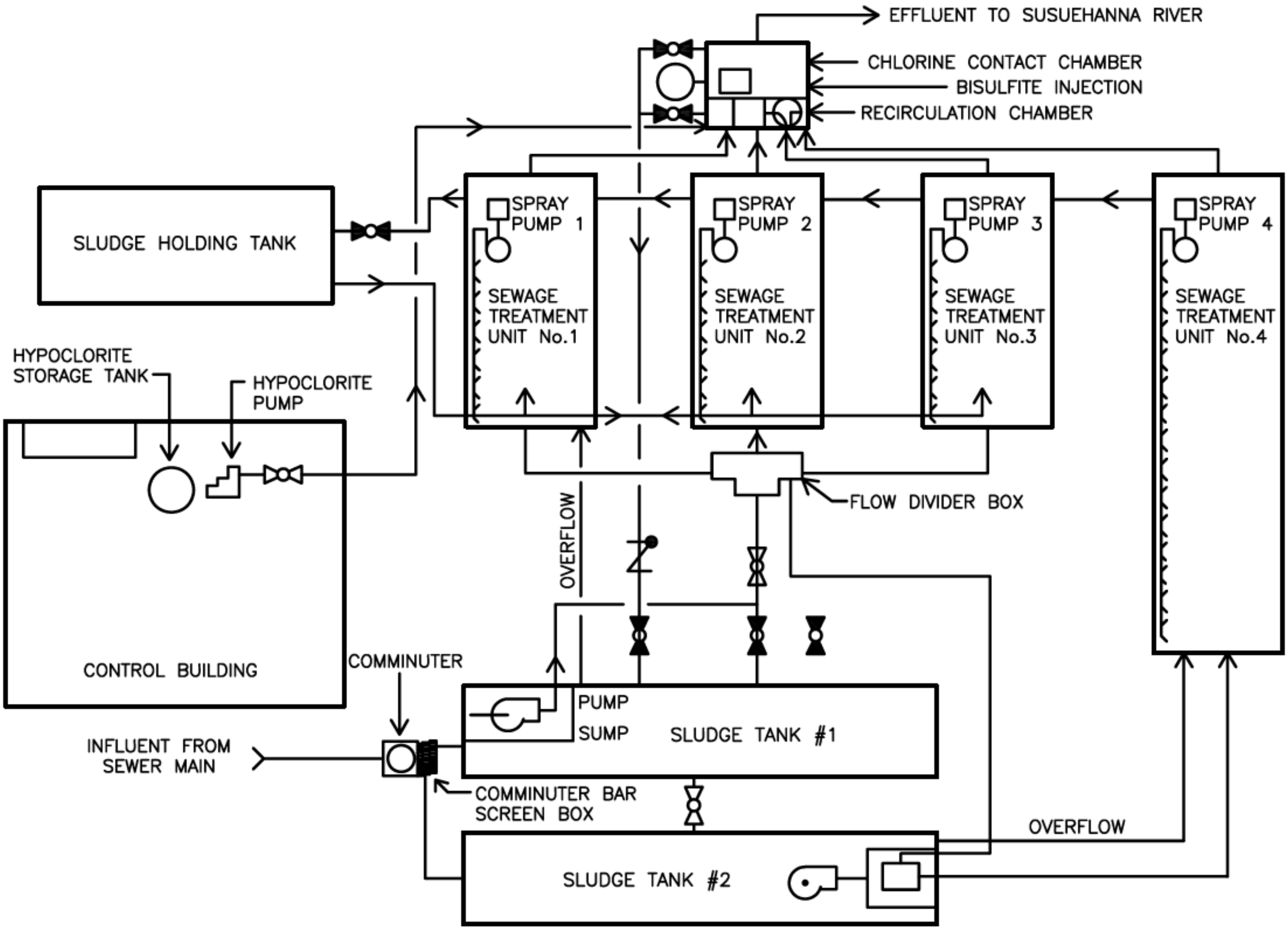
FIGURE 9.2-9 REPLACED BY DWG. M-108, SH. 1

FIGURE 9.2-9 Rev. 56

AutoCAD Figure 9_2_9.doc



NOTE:
TREATMENT PLANT CONSISTS OF THREE 15,000 gpd CAPACITY AND ONE 35,000 gpd CAPACITY EXTENDED AERATION TYPE PACKAGE PLANTS EACH CONSISTING OF AN AERATION TANK AND ONE CLARIFIER. TOTAL PLANT CAPACITY– 80,000 gpd.

FSAR REV.65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
SEWAGE TREATMENT PLANT FLOWSHEET
FIGURE 9.2-10, Rev 50

AutoCAD: Figure Fsar 9_2_10.dwg

FIGURE RENUMBERED FROM 9.2-11 TO 9.2-11-1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE RENUMBERED FROM 9.2-11 TO 9.2-11-1

FIGURE 9.2-11, Rev. 54

AutoCAD Figure 9_2_11.doc

FIGURE 9.2-12 REPLACED BY DWG. M-188, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.2-12 REPLACED BY DWG. M-188, SH. 1

FIGURE 9.2-12, Rev. 48

AutoCAD Figure 9_2_12.doc

FIGURE RENUMBERED FROM 9.2-14 TO 9.2-14-1

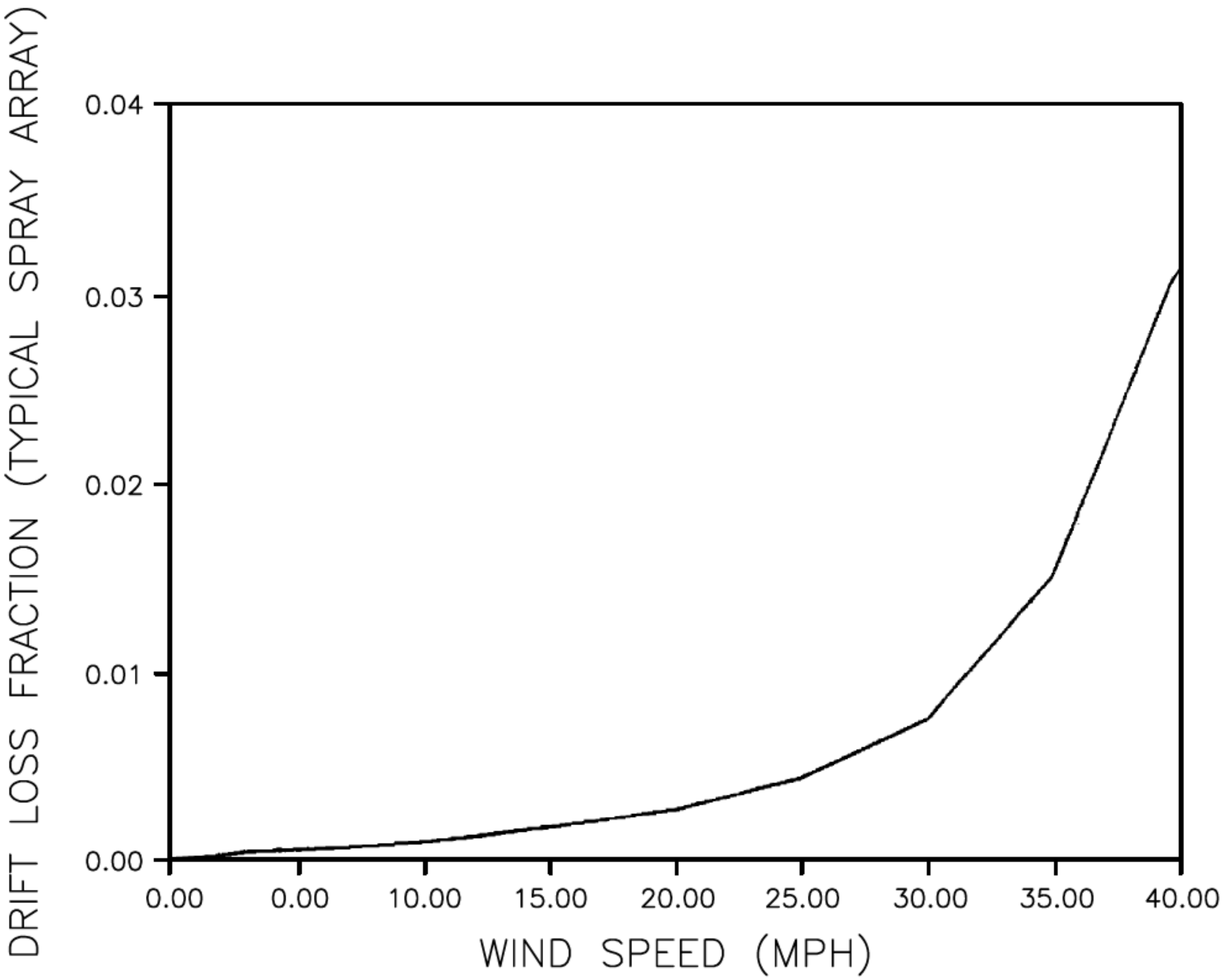
FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE RENUMBERED FROM 9.2-14 TO 9.2-14-1

FIGURE 9.2-14, Rev. 54

AutoCAD Figure 9_2_14.doc



NOTE: This curve is representative of a typical array. Actual values used in evaluation of drift losses are based on analytical computations for specific array conditions.

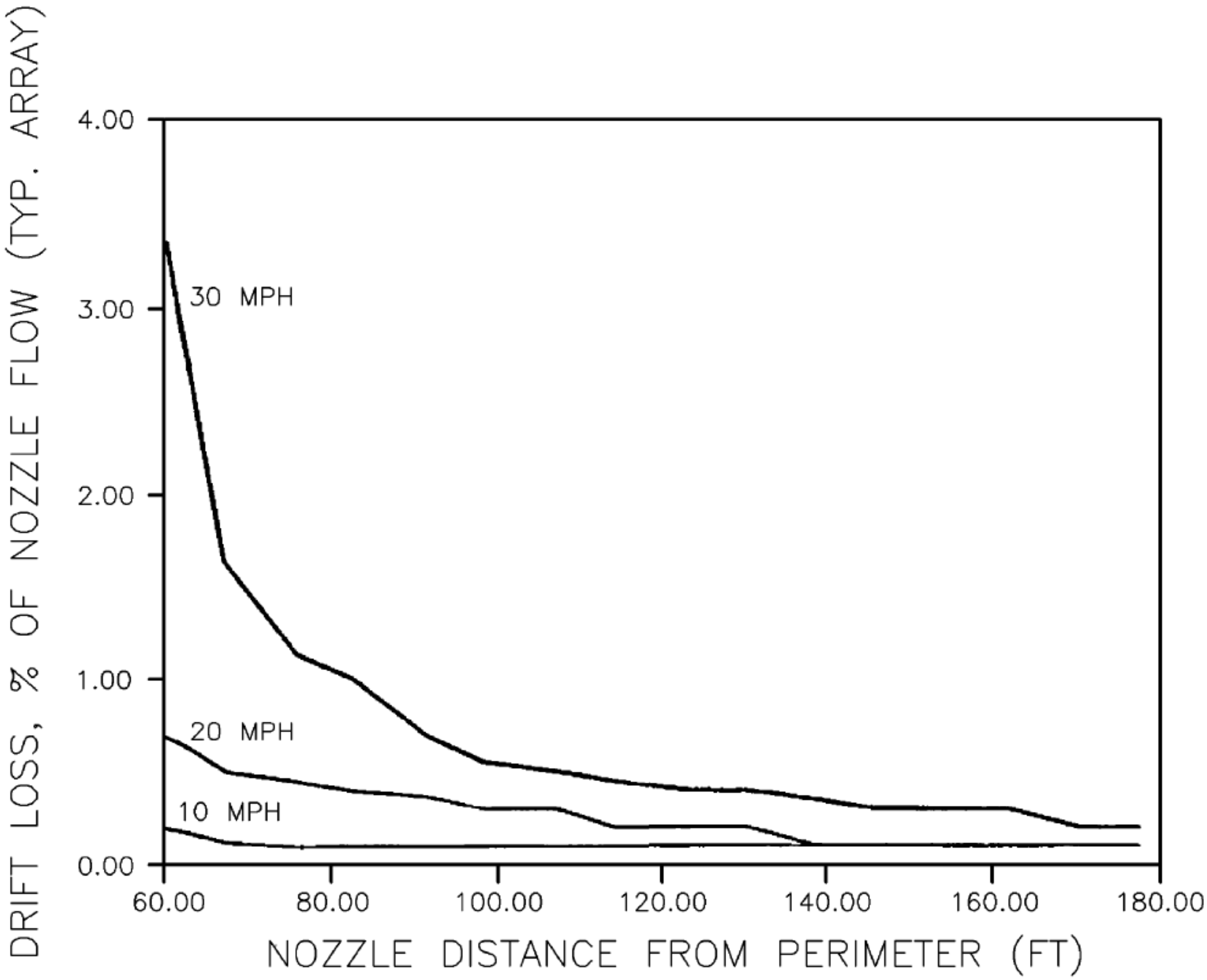
FSAR REV.65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

DRIFT LOSS
VS.
WINDSPEED

FIGURE 9.2-15, Rev 51

AutoCAD: Figure Fsar 9_2_15.dwg



NOTE: This curve is representative of a typical array. Actual values used in evaluation of drift losses are based on analytical computation for specific array conditions.

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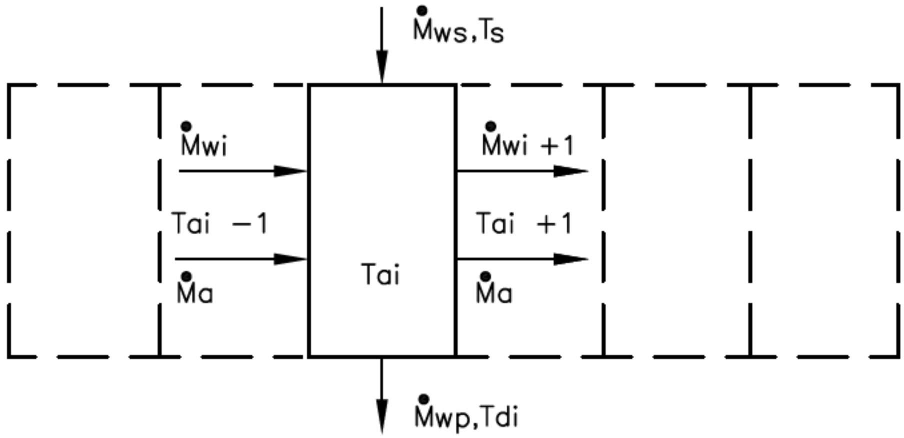
DRIFT LOSS
VS.
PERIMETER DISTANCE

FIGURE 9.2-16, Rev 51

AutoCAD: Figure Fsar 9_2_16.dwg



$\dot{M}ws$ = mass flow rate of spray water in increment

$\dot{M}wi$ = mass flow rate of vapor into increment

$\dot{M}a$ = mass flow rate of air

$\dot{M}wp$ = mass flow rate of water into pond

Tai = dry bulb air temperature in increment

Tdi = temperature of water entering the pond

Ts = water temperature at nozzle

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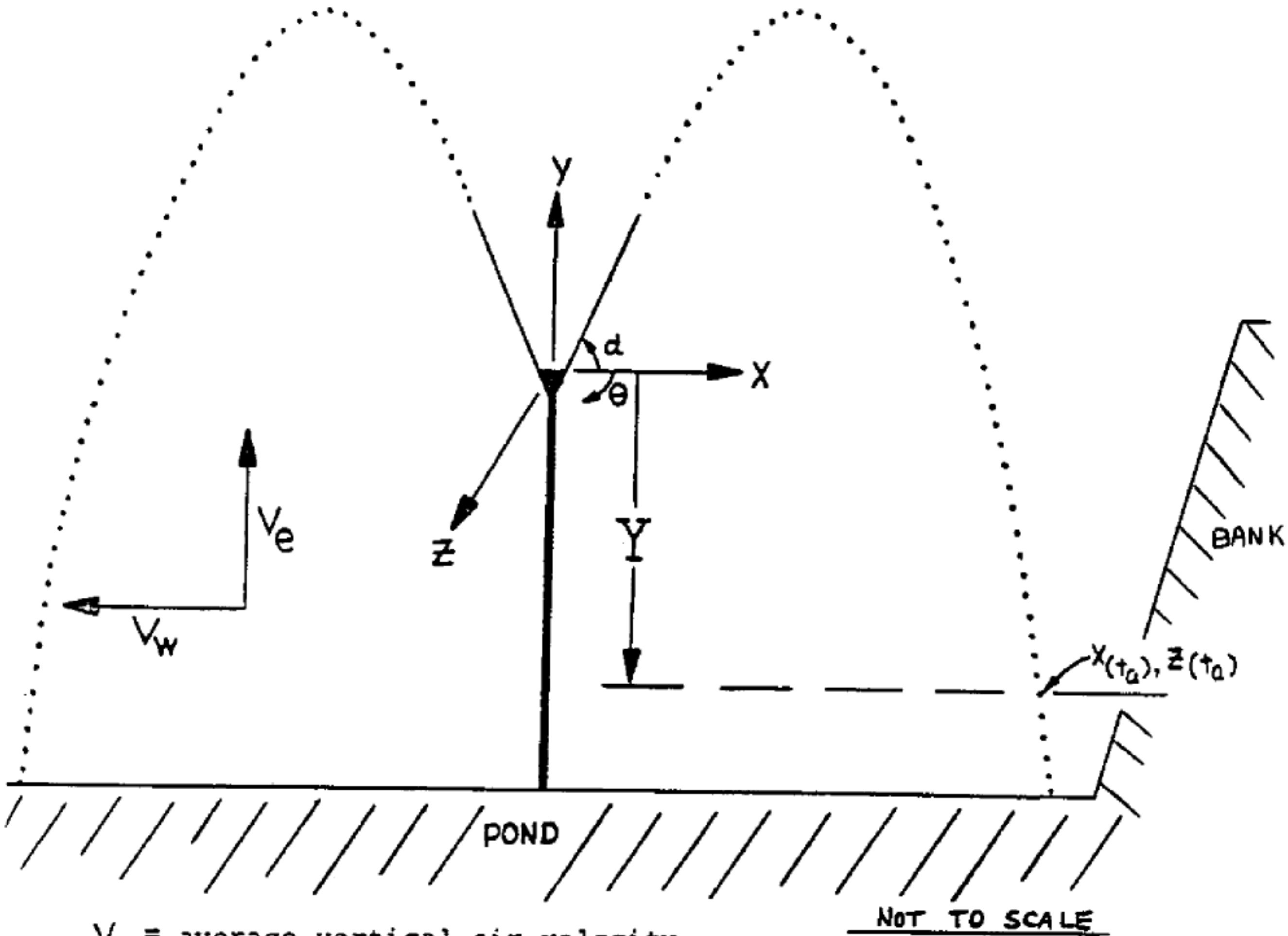
SPRAY POND
INCREMENTAL MASS & ENERGY
FLOW SCHEMATIC

FIGURE 9.2-17, Rev 49

AutoCAD: Figure Fsar 9_2_17.dwg



V_e ≡ average vertical air velocity
V_w ≡ wind velocity
t_a ≡ time for drop to reach elevation necessary for loss
d ≡ angle of departure
Y ≡ elevation of nozzle above elevation necessary for loss
θ ≡ azimuthal angle (used in definition of initial direction)

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SPRAY POND
DROPLET TRAJECTORY
PARAMETERS

FIGURE 9.2-18, Rev 49

AutoCAD: Figure Fsar 9_2_18.dwg

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FIGURE 9.2-19, Rev. 51

AutoCAD Figure 9_2_19.doc

FIGURE RENUMBERED FROM 9.2-1A TO 9.2-1A-1

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FIGURE RENUMBERED FROM 9.2-1A TO 9.2-1A-1

FIGURE 9.2-1A, Rev. 54

AutoCAD Figure 9_2_1A.doc

FIGURE 9.2-1B REPLACED BY DWG. M-110, SH. 1

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FIGURE 9.2-1B REPLACED BY DWG. M-110, SH. 1

FIGURE 9.2-1B, Rev. 53

AutoCAD Figure 9_2_1B.doc

FIGURE 9.2-1C REPLACED BY DWG. M-2110, SH. 1

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FIGURE 9.2-1C REPLACED BY DWG. M-2110, SH. 1

FIGURE 9.2-1C, Rev. 53

AutoCAD Figure 9_2_1C.doc

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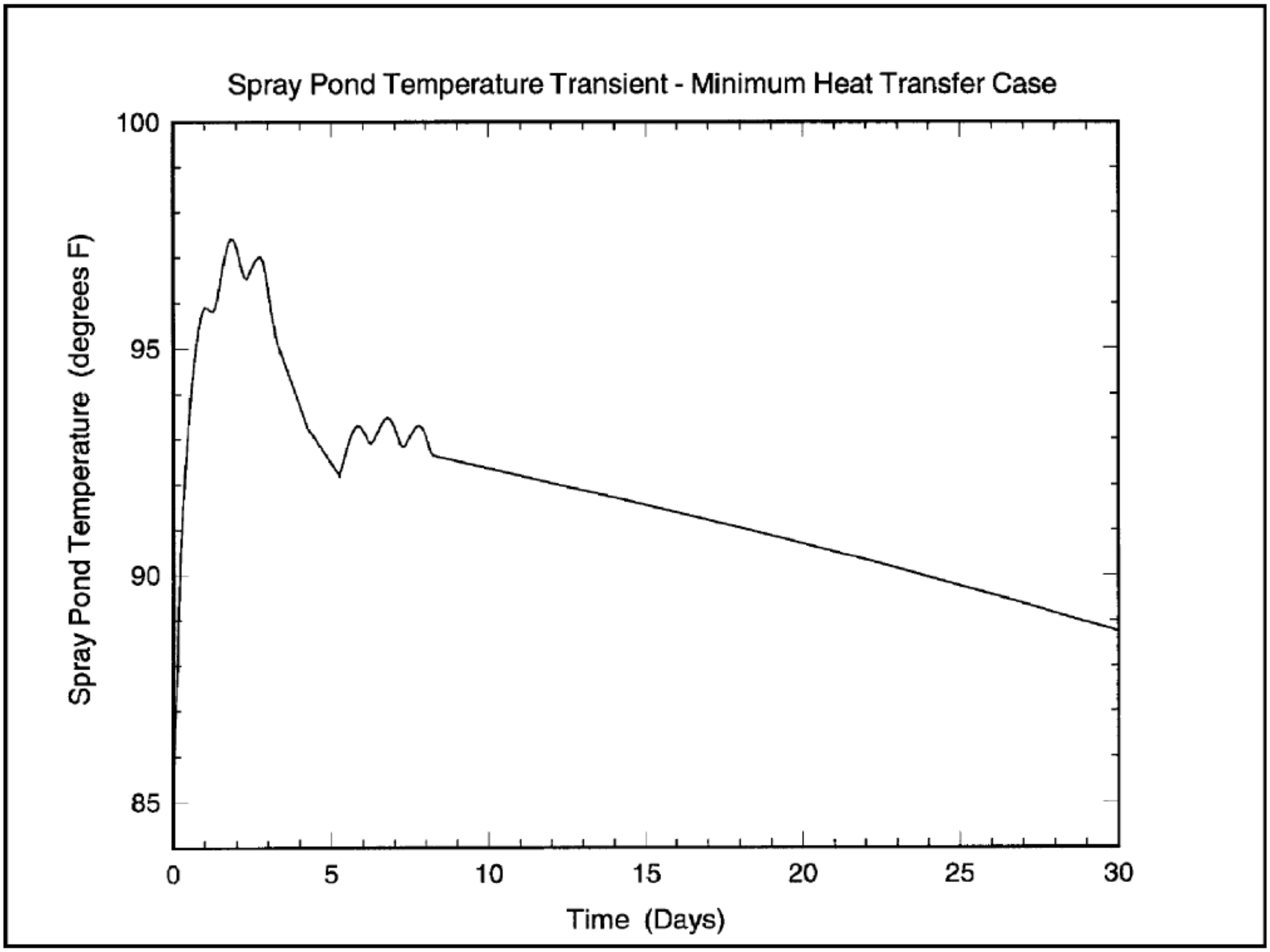
FIGURE 9.2-20, Rev. 51

AutoCAD Figure 9_2_20.doc



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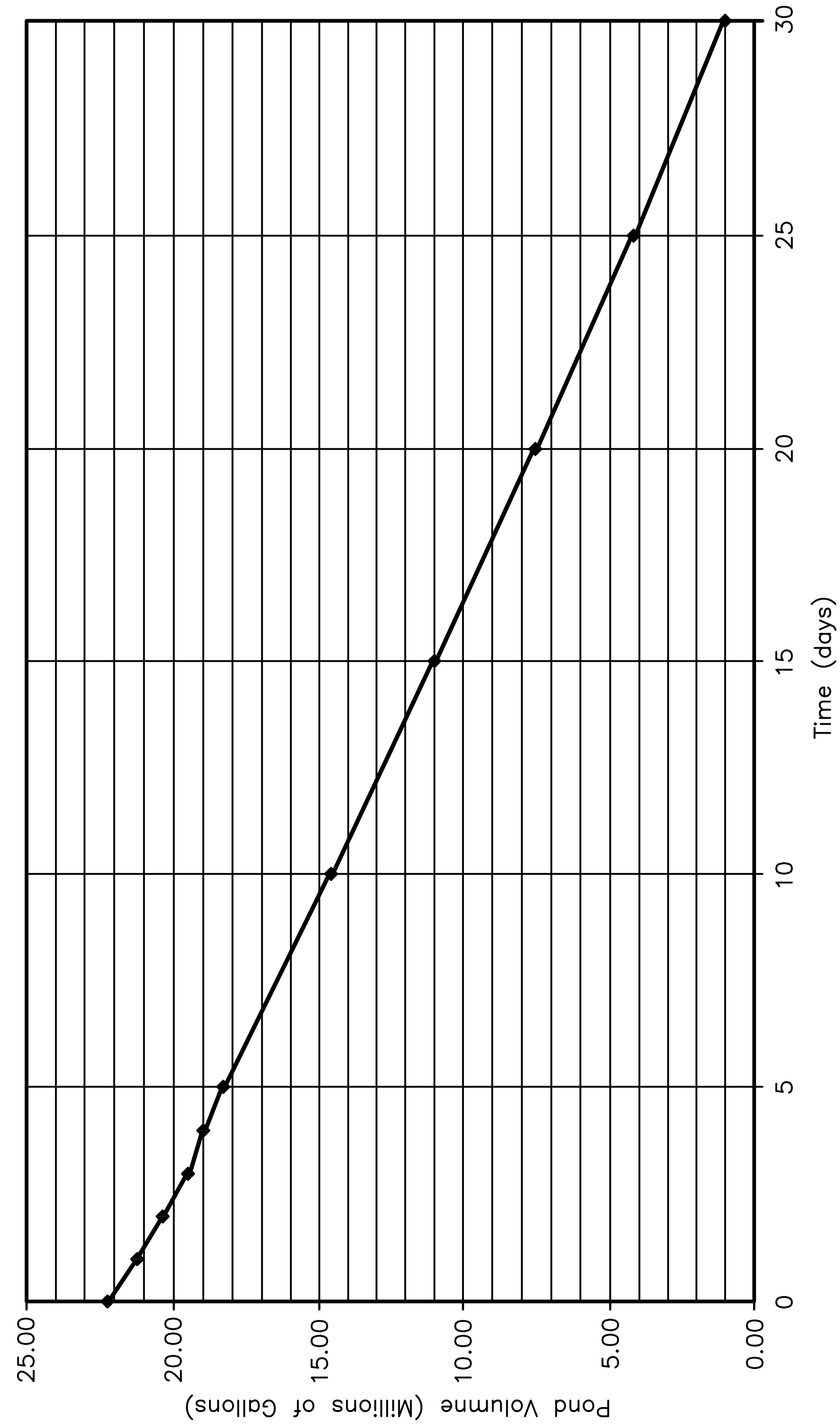
SPRAY POND TEMPERATURE
TRANSIENT MINIMUM HEAT
TRANSFER CASE

FIGURE 9.2-21, Rev 54

AutoCAD: Figure Fsar 9_2_21.dwg



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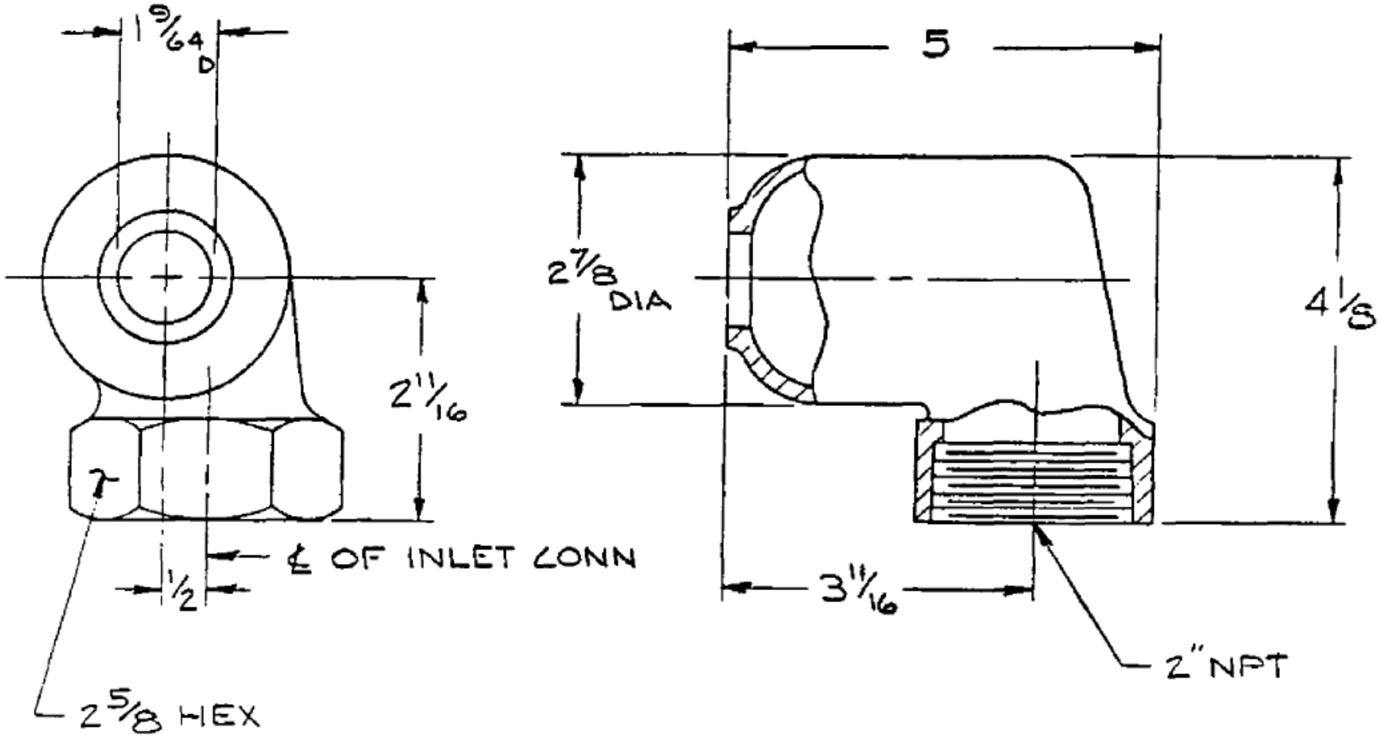
SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
SPRAY POND WATER INVENTORY MAXIMUM WATER LOSS CASE FIGURE 9.2-22, Rev 56

AutoCAD: Figure Fsar 9_2_22.dwg



NOTE: ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.

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SPRAY POND SPRAY NOZZLE

FIGURE 9.2-23, Rev 51

AutoCAD: Figure Fsar 9_2_23.dwg

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FIGURE 9.2-25, Rev. 51

AutoCAD Figure 9_2_25.doc

FIGURE 9.2-5A REPLACED BY DWG. M-111, SH. 1

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FIGURE 9.2-5A REPLACED BY DWG. M-111, SH. 1

FIGURE 9.2-5A, Rev. 57

AutoCAD Figure 9_2_5A.doc

FIGURE 9.2-5B REPLACED BY DWG. M-111, SH. 2

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FIGURE 9.2-5B REPLACED BY DWG. M-111, SH. 2

FIGURE 9.2-5B, Rev. 56

AutoCAD Figure 9_2_5B.doc

FIGURE 9.2-5C REPLACED BY DWG. M-111, SH. 3

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FIGURE 9.2-5C REPLACED BY DWG. M-111, SH. 3

FIGURE 9.2-5C, Rev. 51

AutoCAD Figure 9_2_5C.doc

FIGURE 9.2-5D REPLACED BY DWG. M-111, SH. 4

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.2-5D REPLACED BY DWG. M-111, SH. 4
FIGURE 9.2-5D, Rev. 3

AutoCAD Figure 9_2_5D.doc

FIGURE RENUMBERED FROM 9.2-7A TO 9.2-7-1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE RENUMBERED FROM 9.2-7A TO 9.2-7-1

FIGURE 9.2-7A, Rev. 54

AutoCAD Figure 9_2_7A.doc

FIGURE RENUMBERED FROM 9.2-7B TO 9.2-7-2

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE RENUMBERED FROM 9.2-7B TO 9.2-7-2

FIGURE 9.2-7B, Rev. 54

AutoCAD Figure 9_2_7B.doc

FIGURE 9.2-13A REPLACED BY DWG. M-187, SH. 1

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FIGURE 9.2-13A REPLACED BY DWG. M-187, SH. 1

FIGURE 9.2-13A, Rev. 55

AutoCAD Figure 9_2_13A.doc

FIGURE 9.2-13B REPLACED BY DWG. M-187, SH. 2

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FIGURE 9.2-13B REPLACED BY DWG. M-187, SH. 2

FIGURE 9.2-13B, Rev. 48

AutoCAD Figure 9_2_13B.doc

FIGURE 9.2-7-1 REPLACED BY DWG. M-117, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.2-7-1 REPLACED BY DWG. M-117, SH. 1

FIGURE 9.2-7-1, Rev. 55

AutoCAD Figure 9_2_7_1.doc

FIGURE 9.2-7-2 REPLACED BY DWG. M-117, SH. 2

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.2-7-2 REPLACED BY DWG. M-117, SH. 2

FIGURE 9.2-7-2, Rev. 55

AutoCAD Figure 9_2_7_2.doc

FIGURE 9.2-7-3 REPLACED BY DWG. M-117, SH. 3

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FIGURE 9.2-7-3 REPLACED BY DWG. M-117, SH. 3

FIGURE 9.2-7-4 REPLACED BY DWG. M-117, SH. 4

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FIGURE 9.2-7-4 REPLACED BY DWG. M-117, SH. 4

FIGURE 9.2-7-4, Rev. 55

AutoCAD Figure 9_2_7_4.doc

FIGURE 9.2-7-5 REPLACED BY DWG. M-117, SH. 5

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.2-7-5 REPLACED BY DWG. M-117, SH. 5

FIGURE 9.2-7-5, Rev. 55

AutoCAD Figure 9_2_7_5.doc

FIGURE 9.2-8-1 REPLACED BY DWG. M-118, SH. 1

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FIGURE 9.2-8-1 REPLACED BY DWG. M-118, SH. 1

FIGURE 9.2-8-1, Rev. 55

AutoCAD Figure 9_2_8_1.doc

FIGURE 9.2-8-2 REPLACED BY DWG. M-118, SH. 2

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FIGURE 9.2-8-2 REPLACED BY DWG. M-118, SH. 2

FIGURE 9.2-8-2, Rev. 56

AutoCAD Figure 9_2_8_2.doc

FIGURE 9.2-8-3 REPLACED BY DWG. M-118, SH. 3

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FIGURE 9.2-8-3 REPLACED BY DWG. M-118, SH. 3

FIGURE 9.2-8-3, Rev. 55

AutoCAD Figure 9_2_8_3.doc

FIGURE 9.2-11-1 REPLACED BY DWG. M-186, SH. 1

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FIGURE 9.2-11-1 REPLACED BY DWG. M-186, SH. 1

FIGURE 9.2-11-1, Rev. 55

AutoCAD Figure 9_2_11_1.doc

FIGURE 9.2-11-2 REPLACED BY DWG. M-186, SH. 3

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FIGURE 9.2-11-2 REPLACED BY DWG. M-186, SH. 3

FIGURE 9.2-11-2, Rev. 55

AutoCAD Figure 9_2_11_2.doc

FIGURE 9.2-14-1 REPLACED BY DWG. M-189, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.2-14-1 REPLACED BY DWG. M-189, SH. 1
FIGURE 9.2-14-1, Rev. 55

AutoCAD Figure 9_2_14_1.doc

FIGURE 9.2-14-2 REPLACED BY DWG. M-189, SH. 2

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FIGURE 9.2-14-2 REPLACED BY DWG. M-189, SH. 2

FIGURE 9.2-14-2, Rev. 55

AutoCAD Figure 9_2_14_2.doc

FIGURE 9.2-14-3 REPLACED BY DWG. M-189, SH. 3

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FIGURE 9.2-14-3 REPLACED BY DWG. M-189, SH. 3

FIGURE 9.2-14-3, Rev. 55

AutoCAD Figure 9_2_14_3.doc

FIGURE 9.2-14-4 REPLACED BY DWG. M-189, SH. 4

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FIGURE 9.2-14-4 REPLACED BY DWG. M-189, SH. 4

FIGURE 9.2-14-4, Rev. 55

AutoCAD Figure 9_2_14_4.doc

FIGURE 9.2-1A-1 REPLACED BY DWG. M-109, SH. 1

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FIGURE 9.2-1A-1 REPLACED BY DWG. M-109, SH. 1

FIGURE 9.2-1A-1, Rev. 55

AutoCAD Figure 9_2_1A_1.doc

FIGURE 9.2-1A-2 REPLACED BY DWG. M-109, SH. 2

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FIGURE 9.2-1A-2 REPLACED BY DWG. M-109, SH. 2

FIGURE 9.2-1A-2, Rev. 55

AutoCAD Figure 9_2_1A_2.doc

FIGURE 9.2-1A-3 REPLACED BY DWG. M-109, SH. 3

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FIGURE 9.2-1A-3 REPLACED BY DWG. M-109, SH. 3

FIGURE 9.2-1A-3, Rev. 55

AutoCAD Figure 9_2_1A_3.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE DELETED

FIGURE 9.2-22-1, Rev. 51

AutoCAD Figure 9_2_22_1.doc

FIGURE DELETED

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FIGURE DELETED

FIGURE 9.2-22-2, Rev. 51

AutoCAD Figure 9_2_22_2.doc

FIGURE DELETED

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE DELETED FIGURE 9.2-22-3, Rev. 51

AutoCAD Figure 9_2_22_3.doc

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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SUSQUEHANNA STEAM ELECTRIC STATION
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SPRAY POND
PLAN

FIGURE 9.2-2 -1 Rev 5

AutoCAD: Figure Fsar 9_2_2 -1.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

ESSW SPRAY POND NETWORK A1 & B1
PLAN, SECTIONS AND DETAILS

FIGURE 9.2-24-2, Rev 54

AutoCAD: Figure Fsar 9_2_24-2.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

FSAR REV.65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

ESSW SPRAY POND NETWORK A2 & B2
PLAN, SECTIONS & DETAILS

FIGURE 9.2-24-3, Rev 54

AutoCAD: Figure Fsar 9_2_24-3.dwg

9.3 PROCESS AUXILIARIES

9.3.1 COMPRESSED AIR SYSTEMS

9.3.1.1 Instrument Air System

9.3.1.1.1 Design Bases

The instrument air system has no safety-related function. The instrument air system is designed to provide a continuous supply of filtered, dry, and oil free air for all pneumatic instruments and controls in the plant except those described in Subsections 9.3.1.4 and 9.3.1.5.

Each compressor unit is powered from a separate electrical bus.

Codes and standards applicable to the compressed air system are listed in Table 3.2-1. The compressed air system is designed and constructed in accordance with quality group D specifications.

9.3.1.1.2 System Description

General Description

Units 1 and 2 instrument air systems are similar. The following discussion is for the Unit 1 system. The system includes two similar 100 percent capacity compressor trains consisting of an air intake filter silencer, a compressor unit, an aftercooler, a moisture separator and an air receiver. The system continues with three parallel dryer trains consisting of parallel prefilters (two trains have three in parallel and one has two in parallel), a dryer unit (two drying towers per unit) and two parallel afterfilters. The trains are connected by a common header that branches into the instrument air subsystems. All of the above components and a common alarm and control panel for each unit are located in the turbine building. The system is shown schematically in Dwg. M-125, Sh. 1.

The major components and the design data of the compressed air system are presented in Table 9.3-1.

System Operation

During normal unit operation, one of the two instrument air compressors will be selected as the lead compressor for continuous operation, automatically loaded or unloaded in response to the instrument air system demand. The other instrument air compressor will serve as a standby. The standby compressor will start automatically if the lead compressor fails or if its continuous operation cannot meet the instrument air system demand.

The service air compressors serve as backup to the instrument air compressors. There are two normally open manual valves with a pressure control valve controlling pressure between the two systems. The Unit 2 instrument air system also serves as backup to the entire Unit 1 system and vice versa. The interconnecting valves must be operated manually.

The Unit 1 system supplies instrument air to common areas such as the control structure, radwaste building, service and administration building, diesel generator building, circulating water pump house, and chlorination building.

A backup to the 90 PSIG non-safety portion of the containment instrument gas system is provided by an intertie to the instrument air system via two normally closed manually operated valves. A check valve is also in the cross connecting piping to prevent contamination to the instrument air system.

9.3.1.1.3 Safety Evaluation

Most instruments required for the operation of engineered safety features are operated electrically. Instrument air operated components, which are essential for the safe shutdown of the plant, are designed to assume the safe position upon loss of air pressure. Their energy source for safety operation is not the non-safety-related instrument air. The list of such components is shown in Table 9.3-2. The operation of the containment isolation valves is described in Subsection 6.2.4. For a failure mode and effect analysis, see Table 9.3-3.

The compressed air system is switched automatically to the standby ac power supply during a loss of offsite power. Both Unit 1 and 2 compressors are tripped off the standby ac power source upon receiving a "LOCA signal" from either operating unit coincident with loss of offsite power. One or more compressors may be manually restarted 10 minutes after a LOCA/LOOP by turning HS12500C1 to Comp A(B).

9.3.1.1.4 Tests and Inspections

The compressors, aftercoolers, moisture separator, receivers, prefilters, dryer units, afterfilters, and the control panel are shop inspected and tested. Air compressors and associated components on standby are checked and operated periodically. Air filters are periodically inspected for cleanliness, and the air filters are changed out based on differential pressure and the desiccant in the dryer units is evaluated for replacement on a timed basis and through the use of data from continuous dewpoint monitoring.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.3.1.1.5 Instrumentation Application

Instrumentation is provided for each instrument air compressor train to monitor and automatically control each compressor's operation.

Switches monitoring the following parameters alarm and trip their respective compressor: oil low pressure, oil high temperature, discharge air high temperature, cooling water high temperature, cooling water low pressure, and intercooler separator liquid high level. Instrumentation temperature is indicated locally on the compressor discharge and the moisture separator. Local instrument air pressure is indicated on the air receiver. Malfunction of the operating compressor and pressure loss in the main header will be annunciated in the control room. All

of the compressor controls, including start-stop and load-unload are furnished in the local panel. Handswitches for starting or stopping the units are provided in the control room panel.
The instrument air dryer trains have the following controls and instrumentation. The prefilters and afterfilters each have pressure differential indicators. Each of the A, B, C and D dryer towers has a pressure indicator, temperature indicator, and high and low temperature switches for heating element control and low temperature alarm. The E and F dryer towers have pressure indicators and a dedicated diagnostic system. All towers have moisture sensors to monitor dewpoint and initiate tower swaps to maintain acceptable dewpoints. All towers can be operated in a moisture sensing or time dryed mode.

9.3.1.2 Service Air System

9.3.1.2.1 Design Bases

The service air system has no safety-related functions. It is designed to provide compressed air for service air outlets located throughout the plant and as a backup system for instrument air. Service air is also used to pressurize the condensate filter vessels to facilitate the filter element backwash process. The Unit 1 service air system provides purge air to the common offgas recombiner system when in standby to dilute and move hydrogen.

Codes and standards applicable to the service air system are listed in Table 3.2-1. The compressed air system is designed and constructed in accordance with quality group D specifications.

9.3.1.2.2 System Description

9.3.1.2.2.1 General Description

The Unit 1 and Unit 2 service air systems are generally identical with the exception of common plant areas served. The Unit 1 service air system is described below. The Service Air system includes two identical 100 percent capacity air compressing trains, each consisting of an air intake filter/silencer, a compressor unit, an aftercooler, a moisture separator, and an air receiver. The two trains are connected in parallel by a common header that branches into the service air subsystems. The service air used for CFS filter backwash is filtered using one of two (2), 100% coalescing type air filters rated at 1200 SCFM each. These filters prevent particulate from entering the condensate system. Service air provides up to 5 scfm air flow to the common offgas recombiner system when the common recombiner is in standby. All of the above components with their common alarm and control panels are in the turbine building. Service air provides air to the mobile radwaste processing system to support solid waste processing. This portion of the system is located in the Radwaste Building. The system is shown schematically on Dwgs. M-125, Sh. 2, M-125, Sh. 6, and M-125, Sh. 30.

The Unit 2 service air system operation is identical to those of Unit 1, with the exception of the connection to the common offgas recombiner system. The common offgas recombiner connection exists only on Unit 1 service air. The Unit 2 service air system is schematically shown on Dwg. M-2125, Sh. 16. The Unit 2 system serves as backup to the Unit 1 system and vice versa. The interconnecting valve must be operated manually.

The major components of the service air system and their design data are presented in Table 9.3-4.

System Operation

During normal plant operation one of the two compressors will be selected as the lead compressor and will operate, automatically, being loaded or unloaded in response to the service air system pressure. The other service air compressor will serve as a standby. The standby compressor will start automatically if the lead compressor fails, or if its continuous operation cannot meet the service air system demand.

The plant service air systems also supply service air to common areas of the plant which include the diesel generator buildings, circulating water pump house and water treatment building, control structure labs, service and administration building, radwaste building and the chlorine evaporator and sulfuric acid storage building. The service air system serves as a backup to the instrument air compressors.

9.3.1.2.3 Safety Evaluation

As the service air system has no safety design basis, no safety evaluation is provided.

9.3.1.2.4 Tests and Inspections

The compressors, aftercoolers, moisture separator, receivers, and the control panels are shop inspected and tested prior to installation. Air compressors and associated components on standby are checked and operated periodically. Air filters are periodically inspected for cleanliness.

The system will be pre-operationally tested in accordance with the requirements of Chapter 14.

9.3.1.2.5 Instrumentation Application

Instrumentation is provided for each service air compressor train to monitor and automatically control each compressor's operation.

Switches monitoring the following parameters alarm and trip their respective compressor: oil low pressure, oil high temperature, discharge air high temperature, cooling water high temperature, cooling water low pressure, and intercooler separator liquid high level. Local temperature indicators are provided in the compressor discharge. Local pressure indication is located on the service air receiver. Low pressure of the service air header is indicated and annunciated in the control room. All of the compressor controls, including start-stop and load-unload, are furnished in the local panel.

Hand switches for starting or stopping the units are provided in the control room panel. There is also a common trouble alarm in the control room panel.

The flow meter on the Unit 1 service air line to the common offgas recombiner is installed on a local panel.

9.3.1.3 Radwaste Building Low Pressure Air System

9.3.1.3.1 Design Bases

The radwaste building low pressure air system has no safety-related function.

The radwaste building low pressure air system is designed to provide filtered oil free low pressure compressed air for the liquid radwaste filters and the liquid radwaste demineralizer as these processes require.

Codes and standards applicable to the low pressure air system are listed in Table 3.2-1. The low pressure air system is designed and constructed in accordance with quality group D requirements.

9.3.1.3.2 System Description

General Description

The system includes two intake filter silencers, one compressor, one aftercooler with moisture separator, and one air receiver. The system is shown schematically on Dwg. M-125, Sh. 5.

The major components and their design data are presented in Table 9.3-5.

System Operation

The system operates intermittently based on air demand from the liquid radwaste processing system equipment. The demand on the system will be as follows:

a) Demineralizer - 20 min duration, periodically demand 325 scfm

Generally, not more than one of the above demands will occur at a time.

The compressor has an auto dual capacity control system. During periods when air is being used, the compressor runs and is loaded or unloaded automatically in response to the system pressure. When the demand for air ceases, the compressor stops automatically after a set time interval, restarts, and loads and unloads again if the demand resumes. The compressor can be started manually from the radwaste building control room or from the local panel mounted on the compressor skid.

The system is common to both Units 1 and 2.

There is no standby provision because of the intermittent operation of the system.

Any abnormal operating condition of the low pressure air system will be annunciated in the radwaste control room on panel OC-301.

9.3.1.3.3 Safety Evaluation

The low pressure compressed air system has no safety-related function and no safety evaluation is provided.

9.3.1.3.4 Tests and Inspections

The compressor, aftercooler, receiver, and the control panel are shop inspected and tested prior to installation.

The system will be pre-operationally tested in accordance with the requirements of Chapter 14.

9.3.1.3.5 Instrumentation Applications

Instrumentation is provided for the low pressure air compressor train to monitor and automatically control the compressor's operation.

Switches monitoring the following parameters alarm and trip the compressor: oil low pressure, oil high temperature, discharge air high temperature, cooling water high temperature, and cooling water low pressure. Local temperature indication is on the compressor discharge and the moisture separator. Local pressure indication is on the low pressure air receiver. All of the compressor controls, i.e., start-stop and load-unload, are furnished in the compressor package.

9.3.1.4 River Intake Structure Compressed Air System

9.3.1.4.1 Design Bases

The river intake structure compressed air system has no safety-related function. The river intake structure compressed air system provides a continuous supply of dry, filtered, oil free air for pneumatic instruments and controls and for limited service air use inside the river intake structure building.

Codes and standards applicable to the compressed air system are shown in Table 3.2-1. The compressed air system is designed and constructed in accordance with quality group D specifications.

9.3.1.4.2 System Description

General Description

The river intake structure compressed air system is common to both Units 1 and 2. The system includes two identical compressing units, a moisture separator, prefilters, dryers, afterfilters and a system air receiver. Each compressing unit consists of a compressor and motor mounted on an integral air receiver. The compressing units are connected in parallel by a common discharge header. Compressor discharge flow is routed through the moisture separator, prefilters, dryers and afterfilters prior to reaching a common distribution header from which the individual instrument air connections are taken and service air can be drawn for limited maintenance use. All of the above components are located in the river intake structure. The system is shown schematically on Dwg. M-125, Sh. 5.

The major components and their design data are presented in Table 9.3-6.

System Operation

During normal plant operation, one of the compressing units will be selected as the lead unit and will operate automatically being cycled on and off in response to system pressure. The other compressing unit will serve as a standby. The compressing unit selected as the standby unit will start automatically if the lead unit fails or if its continuous operation cannot meet the air system demand.

9.3.1.4.3 Safety Evaluation

The river intake structure compressed air system has no safety function.

For plant availability purposes, there is a redundancy on the compressor train. Failure of this system will not endanger the operation of any safety-related instruments and controls.

9.3.1.4.4 Tests and Inspections

The system will be pre-operationally tested in accordance with the requirements of Chapter 14.

9.3.1.4.5 Instrumentation Application

System instrumentation is provided to monitor and automatically control operation of the compressing units. Local pressure indication is provided on each compressor air receiver. The desiccant type dryer unit has temperature and pressure indicators and controls to support automatic operation of the unit when it is used.

The air header low pressure switch alarms locally and starts the standby compressor. A low-low pressure switch annunciates locally if the standby compressor cannot maintain system pressure. Any trouble alarm in the local panel is transmitted to the control room as a common alarm.

9.3.1.5 Containment Instrument Gas System

9.3.1.5.1 Design Basis

Unit 1 and Unit 2 containment instrument gas systems are generally identical. The Unit 1 system is described in this Subsection.

The containment instrument gas system is designed to provide filtered, dry, oil-free instrument gas to the pneumatic devices located inside the drywell and suppression chamber.

Portions of the containment instrument gas system are safety-related as shown in Dwgs. M-126, Sh. 1 and M-126, Sh. 2.

The safety-related portions included are containment penetrations, the emergency backup nitrogen storage system and the gas distribution piping to the six main steam relief valves that are part of the Automatic Depressurization System (ADS).

The system provides instrument gas at nominal value of 150 psig (140 psig minimal) for the safety-related main steam relief valves with ADS function and at 90 psig for all other pneumatic devices inside the containment. The safety-related backup nitrogen storage system is maintained at 2200 psig.

The safety-related nitrogen storage system contains adequate gas in storage for long term operation of the ADS after a postulated DBA. The nitrogen bottles have a 3 day storage capacity based on the system design leakage rate. After 3 days, the storage bottles can be recharged indefinitely since the charging connections for the bottles are located in areas of the plant that are accessible under post-accident conditions. The normal supply of compressed gas is not safety-related; however, it has 100 percent redundancy on its major components. Each compressor unit is powered from a separate electrical bus.

Codes and standards applicable to the instrument gas systems are listed in Table 3.2-1. All of the instrument gas systems except the safety-related portions are designed and constructed in accordance with quality group D specifications. The instrument gas system containment penetrations are designed and constructed in accordance with quality Group B requirements. The remaining safety-related portions are designed and constructed to quality group C specifications except the storage bottles, and connection fittings. These storage bottles conform to Department of Transportation (DOT) Standards, Title 49, Section 178.37, Specification 3AA. The connection fittings are standard stainless steel tubing connection assemblies.

Although these bottles provide the gas supply for the safety-related function, such bottles complete with shut off valves and connection fittings are not readily available as Q listed and N stamped. However, the manufacturing and testing of these tanks conform to DOT standards, which are in excess of those required by ASME Section III, Class 3.

9.3.1.5.2 System Description

General Description

Containment instrument gas is a recycling system that, for normal operation, takes suction from the drywell atmosphere.

For normal operation the system includes one intake screen filter, one inlet moisture separator, two inlet gas filters, two full capacity gas compressors, two gas aftercoolers with moisture separators, two gas receivers, two gas dryer systems, two outlet gas filters, one pressure reducing station, one instrument gas accumulator, associated piping, valves, controls and instruments.

For emergency operation, the system includes two loops of high pressure bottled nitrogen. Each loop consists of nitrogen storage bottles, pigtails, station valves, manifold, shut off valve, two stage regulator, and other instruments and controls as shown on Dwg. M-126, Sh. 1.

The system is shown schematically on Dwgs. M-126, Sh. 1 and M-126, Sh. 2. Table 9.3-7 is a list of pneumatically operated devices in the Containment Instrument Gas System. Some of these valves are required for safe shutdown, and they assume the safe position in the event of a loss of instrument gas pressure. Some of these valves have individual safety-related accumulators with redundant normal compressed gas supply. Valves designated for ADS function have safety-related individual accumulators with redundant normal compressed gas supply and emergency backup supply.

The major components of the instrument gas system and their design data are presented in Table 9.3-8.

System Operation

During normal unit operation, the compressor controls are designed to permit automatic start and stop operation of one or two compressors in response to system demand. One compressor normally provides the instrument gas needs. The second compressor serves as a standby for abnormal instrument gas demands.

When the normal gas pressure in the piping headers leading to the ADS function relief valves falls below 142.0 psig because of the failure of both of the compressors or because of containment isolation, the high pressure (2200 psig) nitrogen storage bottles automatically provide instrument gas at 142.5 psig to the ADS function main steam relief valves. Instrument gas pressure from the storage bottles is reduced to 142.5 psig for transmission to the ADS function relief valve accumulators.

A backup to the 90 PSIG non-safety portion of the containment instrument gas system is provided by an intertie to the instrument air system via two normally closed manually operated valves. A check valve is also in the cross connecting piping to prevent contamination to the I.A. (Instrument Air) system.

9.3.1.5.3 Safety Evaluation

Failure of the non-safety-related portions of the compressed gas system does not impair the operation of Engineered Safety Feature (ESF) Systems or the integrity of containment isolation during the accidents described in Chapter 15. For a failure mode and effect analysis, see Table 9.3-9.

Pneumatically operated devices, which are essential for the safe shutdown of the plant, are designed to operate in the safe position upon loss of gas pressure or they are provided with individual accumulators and/or a backup source of safety-related high pressure nitrogen gas.

The compressed gas system's non-safety-related compressors are switched automatically to standby electrical power. These compressors are tripped off the standby ac power source upon receiving a LOCA signal from either operating unit coincident with loss of offsite power. The compressors may be started manually when the LOCA signal is no longer present.

The system is housed within the reactor building. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

The compressed gas penetrations of the containment are designed, fabricated, and installed in accordance with the requirements of ASME Section III, Class 2 and Seismic Category I to prevent release of radioactive materials in the event of an accident. These penetrations will function as part of the Containment Isolation System, discussed in Subsection 6.2.4.

Because of the provisions of redundant system components for the safety-related portions of the compressed gas system, the failure of a component or an electric power supply will not interrupt the safety-related function of the Containment Instrument Gas System.

9.3.1.5.4 Tests and Inspections

The compressors, aftercoolers, receivers, prefilters, desiccant chambers, afterfilters, and the control panel are shop inspected or tested prior to installation.

During normal plant operation, gas compressors and associated components on standby are checked and operated periodically. Gas filters are inspected for cleanliness, and the desiccant is inspected for its useful life.

The system will be pre-operationally tested in accordance with the requirements of Chapter 14.

9.3.1.5.5 Instrumentation Applications

Instrumentation is provided for each compressor train to monitor and automatically control each compressor's operation.

A compressor suction line pressure switch shuts down the compressors if the suction line pressure drops, as following a containment isolation. A suction line temperature switch shuts down the compressors if high temperature gas, such as steam from a ruptured pipe inside the containment, is drawn into the suction line.

In the compressor packages, compressor lube oil pressure, gas discharge temperature, and cooling water temperatures and pressure are monitored and will alarm locally and shut down their respective compressor if abnormal conditions are measured. A control room alarm, actuated by low-low pressure, monitors the instrument gas receiver of each compressor. Pressure switches on the header start their respective compressor if the compressor is in standby mode.

A pressure transmitter on each header transmits to a pressure indicator in the main control room. Two local pressure gauges (Unit 1) and one local pressure gauge (Unit 2) indicate the pressure in the manifold of each safety-related instrument gas supply bottle header. A pressure switch on each header annunciates safety-related header low pressure in the main control room. The pressure indicators and pressure switches for each division of the nitrogen bottles are dynamically qualified for the purpose of maintaining the integrity of the instrument gas header pressure boundary.

Reduced pressure instrument gas during normal system operation is provided via a pressure reducing valve. Local and control room indication of this pressure is provided, as well as local pressure indication on the instrument gas accumulator.

9.3.2 PROCESS SAMPLING SYSTEM

The process sampling system is provided to monitor the operation of plant equipment and to provide information needed to make operational decisions.

The process sampling system provides remote sampling facilities and the capability for sampling fluids of various process systems during normal plant power operation and shutdown conditions.

The monitoring of gaseous and liquid process streams for nuclear radiation is covered separately in Section 11.5.

The Water Chemistry Data Acquisition System is provided to collect, process, store, and analyze real time Water Chemistry Analyzer Data from the Water Chemistry Sampling Stations. The information collected is used to monitor and trend the water chemistry in both the Unit 1 and Unit 2 Reactor and Turbine Water Systems. The long term analysis of this data provides for a longer plant operating life through better preventive maintenance, tighter control of water chemistry and reduced exposure of plant personnel to radiation at the Water Chemistry Sampling Stations.

9.3.2.1 Design Bases

9.3.2.1.1 Process Sampling System

The portion of the process sampling system that is connected to the reactor coolant system (Reactor Recirculation sample line) is constructed in accordance with ASME Section III, Class 1 requirements between the process pipe connection and the outboard containment isolation valve. Other sample piping, from the point where it connects to the process system and including the first and second (where installed) process shutoff (or isolation) valves will be the same classification as the system piping to which it connects. Instrument line classification downstream of the root valve will be in accordance with Figure 3.2-2 "Minimum Instrument Line Classifications."

All safety-related ASME Section III sample piping and valves are designed to Seismic Category I requirements.

Lines connected to reactor water systems are of sufficient length to permit decay of short lived nuclides so that sampling personnel will not be unnecessarily exposed to radiation. Additionally, shielding is installed at points on sampling piping to further curtail personnel exposures (as described in Chapter 12) and ensure that they be kept below the limits of 10CFR20.

The process sampling system is designed to ensure that representative samples of all appropriate process fluids will be obtained.

Process sampling system piping is large enough to avoid being clogged by anticipated solids. Piping size is minimized to permit effective line purging with a minimum loss of fluid volume.

The process sampling system is designed so that the sample stations will not affect plant safety.

The process sampling system is designed to provide the capability to conduct continuous analysis as well as analysis of discrete samples (grab samples).

The process sampling system is designed to prevent hazards to operating personnel from high pressure, temperature, or radiation levels of the process fluid during all modes of operation.

The process sampling system for each unit is designed to be functionally similar but operationally independent.

9.3.2.1.2 Water Chemistry Data Acquisition System

The following design bases are incorporated into the Water Chemistry Data Acquisition System (WCDAS):

1. The WCDAS is designed to provide an availability of 99% through good modular design, adequate spare parts inventory and trained maintenance personnel.

2. The WCDAS was designed to operate in a unattended and continuous mode 24 hours per day seven days a week in between scheduled plant outages.

9.3.2.2 System Description

9.3.2.2.1 Process Sampling System

The process sampling system is illustrated schematically by Dwgs. M-123, Sh. 1, M-123, Sh. 2, M-123, Sh. 3, M-123, Sh. 4, M-123, Sh. 5, M-123, Sh. 6, M-123, Sh. 7, M-123, Sh. 8, M-123, Sh. 9, M-123, Sh. 10, M-123, Sh. 11, M-123, Sh. 12, and M-123, Sh. 13. Locations of sample points are shown on the appropriate system piping and instrumentation diagrams for the systems to be sampled. The process sampling system consists of sampling lines, heat exchangers, sample vessels, sample sinks, and analysis equipment and instrumentation.

Sampling stations are located in the reactor, turbine, and radwaste buildings. The liquid radwaste collection sample station and the auxiliary boiler sample station are common for Units 1 and 2. The reactor and turbine building sample stations are operationally independent systems with the exception of the fuel pool filter demineralizer outlet-common sample which is located in the Unit 1 Reactor Building station.

Local grab samples rather than permanently installed sample lines to a control sampling station are provided for process points that require only periodic sampling and are located in radiologically accessible areas of the plant.

Samples of reactor feedwater, reactor recirculation water, RHR heat exchangers outlet, reactor water cleanup inlet and outlets, control rod drive water and fuel pool filter demineralizers inlet and outlet water including common fuel pool are routed to the reactor building sampling station. Samples of condensate are brought to the turbine building sample station of each unit.

The reactor and turbine building stations are equipped with automatic monitors that continuously determine the critical parameters in the samples drawn from process lines.
Grab samples can also be taken periodically from each point at each station to determine chlorides and other components. Portable instruments are also used for periodic calibration of the automatic monitors.

When working with sample station grab samples, the operator is protected by a continuous air flow through the sample station hood and exhausted through the ventilation ductwork.

Sample flow rates to the monitors can be read and adjusted with a valve to provide the following conditions:

a) Ensure turbulence in the sample line to prevent plate-out of radioactive materials

b) Minimize lag time to monitors

c) Slow the sample flow rate as required for the decay of radioactive nitrogen prior to entering the stations

d) Minimize the waste of high purity water as well as input to the radwaste system.

Representative samples are drawn from process lines by sample nozzles extending into or from the process pipe. Where practicable, a sample probe is located after a run of straight process pipe. On horizontal process pipes, the connection is made on the side rather than on the bottom of the pipe. Sample lines are as short as possible, avoiding traps and dead legs upstream of the sample stations. The connecting tubing is sized for optimal flow rates to the stations.

At each station, samples are automatically conditioned for pressure and temperature to the needs of the monitoring instruments and as required for the operators' safety. For the Turbine and Reactor Building Sample Stations a refrigeration chiller and individual “shell and tube” rough and trim coolers are provided to condition the samples. High temperature samples are cooled with rough coolers that are supplied by the building closed cooling water system. Critical high purity water samples are cooled to a reference temperature of 25ºC by trim coolers, that are supplied by the sample station chiller. Condensate sample waste is returned to the condenser hotwell via a vacuum drag/pump system. Failure or bypass of the vacuum drag/pump system diverts the sample wastes to the Liquid Radioactive Waste System. All other sample wastes are returned to the radwaste collection system.

Prior to taking discrete samples, the sample line is purged (to the sample sink) with the fluid to be sampled so that a representative sample may be obtained. Sampling lines used for continuous samples do not require an additional purging prior to taking a sample.

Tubing loops in the sample stations can be purged with demineralized water. The flushing water drains into the piped drain system and is routed to the radwaste processing system.

The Turbine and Reactor Buildings sample stations have sample sinks and analytical equipment. The sample station design provides for quick connect and release during sample module removal and replacement in order to minimize personnel exposure. The radioactive waste sample panel is open in the back with tubing and components visible and accessible, so that leaks are easily detected and repaired.

9.3.2.2.2 Water Chemistry Data Acquisition System

The Water Chemistry Data Acquisition System (WCDAS) consists of four Local Acquisition Modules (LAM) which collect information from Water Chemistry Sample Stations to monitor and trend the water chemistry in the Unit 1 and Unit 2 Reactor and Turbine Water Systems. The LAMs provide data to the Unit 1 and Unit 2 Plant Process Computer (PPC) Systems which collect, process, analyze, store, alarm and display Water Chemistry Data.

The LAMs are located in the reactor and turbine building areas adjacent to the sample stations and the Plant Process Computer (PPC) Servers are located in the Plant Computer Room.

The LAMS collect inputs via individual hardwired signals from analyzers located at Water Chemistry Sample Stations. Each LAM includes an operator interface workstation. A two way data link exists between the operator interface workstation in each LAM and the PPC System for transmitting Water Chemistry data to the PPC and plant data to the LAM operator interface workstation.

The PPC system receives and processes approximately 100 data points from each of the LAMS. WCDAS software running on the PPC provides scan, logic, and alarm functions and allows on-line changes to system operation through an interactive data base management system. The PPC system monitors communications between the LAMs and the PPC and sends an alarm to the Chemistry Alarm Console in the Chemistry Lab upon any failure.

The LAMs also provide a communications pathway to the Plant Process Computer Systems for the Hydrogen Water Chemistry and Condensate Filtration System (see Subsection 10.4.7.5) digital controllers via Ethernet connections.

9.3.2.3 Safety Evaluation

9.3.2.3.1 Process Sampling System

The process sampling lines connected to the reactor coolant system (Reactor Recirculation System sample lines) are designed in accordance with seismic Category I requirements as specified in Section 3.2 through the first isolation valve outside containment. Process sample lines connected to other seismic Category I process piping are seismic Category I from the connection to the process piping through the second fail closed valve. The ductwork and hangers for the Unit 1 RBSS are Seismic Category I. The ductwork is connected directly to the non-seismic sample station. An evaluation showed that any seismic induced failures of the ductwork resulting from the response at the top of the non-seismic sample station would be restricted to the ductwork immediately above the sample station, with no impact on the safety-related functions of the Reactor Building Ventilation systems and no potential for damage to any other safety-related equipment in the area. The Unit 2 RBSS ductwork and hangers are Seismic Category I to the wall of the sample station room. Inside the wall is non-seismic installation. The wall is the transition between the seismic and non-seismic installation. The sample stations are designed non-seismic.

Sample lines that penetrate the containment are provided with isolation valves in accordance with 10CFR50, Appendix A, General Design Criteria 55.

The sampling system is designed to limit the sample line discharge flows, under normal operation and during postulated malfunctions or failures, to preclude any fission-product release leading to exposures that exceed the site boundary limits stipulated in 10CFR20. Adequate safety features are provided to protect personnel and prevent the spread of contamination from the sampling station. The sample station is composed of closed systems; grab samples are taken under a controlled exhaust hood to preclude radiological hazard. The hood maintains a constant air velocity through the hood working face to ensure that airborne contamination does not enter the room under operating conditions. The Radwaste Building, Turbine Building and Reactor Building sample station hood exhaust air is routed to the associated building's filtered exhaust system.

Instrumentation is provided to alarm on high or low air flow for the Reactor Building sample station and low air flow for the Turbine Building sample station.

The ventilation systems in the area of the Turbine and Reactor Building sample stations are balanced for a specific airflow through the sample stations. To maintain a constant airflow with varying degrees of hood sash opening, dampers have been installed in the hood ductwork. Manual pressure operated backdraft dampers are used for the Turbine Building damper and modulating electrically operated bypass dampers are used for the Reactor Building damper. The exhaust air from the two sample stations pass through particulate, charcoal and HEPA filters.

The sampling sinks are provided with demineralized water for washdown. The Reactor Building sample station enables high velocity flushing of the cup sink waste header with demineralized water. Sample line wastes are routed individually at high velocity to the drain to minimize deposition on the sample station. The sinks drain to the liquid radwaste system.

No portion of the Process Sampling System is safety-related. It does interface with safety-related systems such as Reactor Recirculation and RHR, and with ventilation ductwork in the Reactor Building. The piping, valves and ductwork that form the interface between the safety-related system and the Process Sampling System are considered part of the safety-related system.

The process sampling system is not required to function during an accident, nor is it required to prevent or mitigate the consequences of an accident.

9.3.2.3.2 Water Chemistry Data Acquisition System

The Water Chemistry Data Acquisition System is a non-safety system. This system is neither required to function during an accident nor is it required to either prevent or mitigate the consequences of an accident.

9.3.2.4 Testing and Inspection

9.3.2.4.1 Process Sampling System

The system was pre-operationally tested in accordance with approved plant procedures.

Most components are used regularly during power operation, yielding cumulative data that ensures the performance of the sampling system. Also, grab samples are used to periodically test, calibrate, and check instrument response. Plant procedures at the stations provide for:

a) Adjusting pressure, temperature, and sample flow controls

b) Calibrating the monitors

c) Inspecting and cleaning conductivity, pH, turbidity, dissolved oxygen, and other sensors.

9.3.2.4.2 Water Chemistry Data Acquisition System

The system was pretested at the factory prior to shipment. After installation a Site Acceptance Test was performed to recheck the integrity of all the communication links. The system also has built in diagnostics to check for failure in both the communication links and the computer systems.

9.3.2.5 Instrumentation Applications

9.3.2.5.1 Process Sampling System

Local pressure, temperature, and flow indicators are used to facilitate manual operation and to verify sample conditions before process samples are drawn.

The monitors used are solid state electronic instruments of standard industrial design. Selected Turbine and Reactor Building sample station analytical variables are recorded in the main control room; and all Turbine and Reactor Building sample station analytical variables are recorded in the WCDAS and PCS.

Monitored variables have alarm trips that signal when preset limits have been exceeded. Equipment trouble alarms are transmitted to the main control room.

9.3.3 EQUIPMENT AND FLOOR DRAINAGE SYSTEM

The Equipment and Floor Drainage System (EFDS) is provided throughout the plant to collect liquid wastes from their points of origin and transfer them to the Liquid Waste Management System, the plant discharge water treatment facilities, or the Storm Drainage System.

9.3.3.1 Design Bases

The EFDS is capable of handling the maximum expected influent. The turbine, reactor, circulating water pump, and diesel generator A-D building influent is based upon 5 min of Fire Protection System operation. It should be noted that the worst case flood in the reactor building from a postulated pipe crack results in flooding of the reactor building sump pump in the basement of the reactor building. The evaluation takes credit for operator actions to isolate the break within 45 minutes after crack initiation. Refer to section 3.4 for additional information regarding this flood evaluation. For the drywell and radwaste building the maximum expected leakage from equipment provides the design base. The Diesel Generator 'E' Building influent is based upon 30 minutes of fire protection system operation.

The EFDS in the chlorine evaporator and sulfuric acid storage building is designed to drain rainwater from the acid unloading pad and from the open sides of the building.

The transformer gravel pits are sized to retain the oil contained in the transformers, in addition to the water volume from 10 min. operation of the Deluge Fire Protection System. The water treatment building acid unloading pad drainage system is designed to catch all acid leakage from the delivery trucks.

To prevent back flow into the Engineered Safety Features (ESF) equipment rooms, normally closed manual valves are provided in each drain line from those rooms.

Seismic Category I level switches, which are designed per IEEE 279 and 308 standards, alarm in the control room on ESF room high water level.

The EFDS is designed and arranged so that no inadvertent introduction of radioactive or potentially radioactive fluid to the segregated Sanitary and Storm Drainage Systems will occur.

Sump and drain tank pumps are designed to discharge at a flow rate adequate to keep the sumps and drain tanks from overflowing because of the expected influents outlined above. A backup pump is provided for each sump and drain tank, except for the condenser area transfer sump and the pipe tunnel sump. Backup pumps are started if the water level rises above the first pump start level.

The drywell equipment drain tank drains by gravity. The drain tank's discharge valves automatically open when a predetermined high level in the tank is reached. The discharge valves close at a predetermined low level.

Normally closed equipment and piping drains and vents discharging occasionally into the EFDS do not control the sizing of the system.

The inlet pipes to the sumps are submerged by a minimum of 1 ft at all times to maintain a gas-tight seal except where specific analysis demonstrates that less submergence is acceptable.

Vent lines from sumps containing potentially radioactive wastes are connected to the building filtered exhaust ventilation systems. Oil interceptors with oil sumps precede the low conductivity sumps in the turbine and reactor buildings.

Drainage lines from areas that are required to maintain an air pressure differential but drain to the same header are provided with water seals. Sequenced makeup water is provided to the water seals to maintain the air pressure differential. Where they penetrate the containment, the drywell floor drain sump pump and equipment drain tank discharge lines, including the containment isolation valves, are safety-related.

9.3.3.1.1 Codes and Standards

The Equipment and Floor Drainage Systems are designed, fabricated, and installed in accordance with the requirements of the applicable codes and standards shown in Section 3.2, Table 3.2-1.

9.3.3.2 System Description

9.3.3.2.1 General Description

The combined Equipment and Floor Drainage Systems provided for collection of various liquid wastes are shown on Dwgs. M-161, Sh. 1, M-161, Sh. 2, M-161, Sh. 3, M-160, Sh. 1, and M-160, Sh. 2. The chemical waste sump of the water treatment building is shown on Dwg. M-118, Sh. 2.

a) For potentially radioactive liquid wastes:

   1) The Liquid Radwaste (LRW) Collection System collects potentially radioactive liquid wastes at atmospheric pressure from equipment and floor drainage of the drywells, reactor buildings, turbine building and radwaste building.

   2) The Chemical Radwaste (CRW) Collection System collects corrosive, potentially radioactive liquid wastes at atmospheric pressure from the wash-down areas, sample stations, chemical equipment, and floor drains in the reader, control, turbine and radwaste buildings. Non-radioactive, high conductivity wastes from the auxiliary boiler blowdown lines and the turbine building closed cooling water chemical addition tanks, at atmospheric pressure, are also collected by the CRW System.

   3) The Detergent Radwaste (DetRW) Collection System collects potentially radioactive liquid wastes at atmospheric pressure from the wash-down areas, personnel decontamination stations, and laundry facilities in the reactor buildings, control building, and radwaste building.

The drainage sources and expected inputs from areas of potential radioactivity are shown in Table 11.2-1.

b) For non-radioactive liquid wastes:

1) Oily Waste Drainage Systems collect liquid wastes from the non-radioactive equipment areas in which oil is expected to be present. These areas include the circulating water pumphouse, diesel generator buildings, transformer areas, lube and diesel oil storage tank areas, oil circuit breaker areas, and auxiliary buildings.

2) Acid Waste Drainage Systems collect liquid wastes containing non-radioactive chemicals and corrosive substances from equipment and floor drains in the chlorine evaporator and sulfuric acid storage building and the water treatment building.

3) Sanitary Drainage Systems collect liquid wastes from all plumbing fixtures of the plant outside the restricted access areas.

4) Storm Drainage Systems collect water resulting from precipitation on all building roofs and areaways, paved and unpaved surface areas outside the buildings.

The radioactive and non-radioactive EFDS consist of collection piping, equipment drains, floor drains, vents, traps, cleanouts, collection sumps, sump pumps, tanks, oil separators, and instrumentation.

The arrangement is such that the non-radioactive drain systems serve only non-restricted areas where no radioactivity potential is present, exclusive of the water closet and urinal wastes in the access control area that are collected by the Sanitary Drainage System.

The potentially radioactive wastes from personnel decontamination facilities and floor drains in the access control area are collected by the Detergent Radioactive Waste Collection System.

9.3.3.2.2 Component Description

Components of the Equipment and Floor Drainage Systems are described in the following paragraphs. Major components, such as sumps and sump pumps are shown in Table 9.3-10.

In areas of potential radioactivity, the collection system piping for liquid and detergent waste is made of carbon steel; the Chemical Radwaste Collection System piping is made of stainless steel. The horizontal drain piping is installed with a uniform slope such that the waste flow velocity is not less than 2 fps. Equipment drainage piping normally terminates not less than 3 in. above the finished floor at each location where the discharge from equipment is collected. Surface Drain Units (SDU) in the Oily Waste System are provided with backwater valves to prevent spread of potential fires.

All floor drains are installed with rims flush with the low point elevation of the finished floor, except in certain areas where extensions may be used to prevent small amounts of oil from entering the LRW system. Floor drains in areas of potential radioactivity are welded directly to the collection piping and provided with threaded T-handle plugs of the same material. The T-handle plugs are used in the floor drains for pressure testing the drainage systems.

Inlets to all drainage systems (except those in areas of potential radioactivity, and those in rainwater and clean drainage service) are provided with a vented P-trap water seal to minimize entry of vermin, foul odors, and toxic, corrosive, or inflammable vapors into the building. Vent lines to the outside atmosphere are provided downstream of the P-traps to prevent excessive backpressures that could cause blowout or siphonage of the water seal. Normally, traps are not installed on inlets in areas of potential radioactivity in order to reduce the potential for accumulation of radioactivity in the traps, and because of the difficulty of maintaining a water seal in the trap.

Cleanouts are provided (when practicable) in all collection system piping where the change of direction in horizontal runs is 90 degrees, at offsets where the aggregate change is 135 degrees or greater, and at maximum intervals of 50 ft. Cleanouts for the potentially radioactive collection systems are welded directly to the piping.

Rupture discs are installed in the Turbine Building portion of the Control Structure upper and lower cable spreading room floor drain piping systems.

Sources of the Laundry Radwaste and Chemical Radwaste Systems, which are too low in elevation to drain by gravity to the designated collection tank in the radwaste building, drain to local laundry and chemical drain tanks in the turbine building. From these drain tanks, the wastes are pumped to the main laundry and chemical waste tanks in the radwaste building.

All sumps are recessed in concrete located at the lowest elevation of the area served. Except for the drywell sumps, pipe tunnel drain sump, turbine building condenser area and chemical sumps, which are provided with removable steel cover sections, all sumps have access manholes.

Equipment and piping drains are separated by an air gap from the drainage piping to prevent pressurization of the drainage piping.

Where necessary for contamination control, splash guards are provided over air gaps.

9.3.3.2.3 System Operation

The various wastes drain to the appropriate sumps or tanks by gravity. From these sumps or tanks, the drainage is pumped out with the exception of drywell equipment drain tank which drains by gravity. Except for the condenser area sump pump, each sump pump starts automatically when a predetermined high level in its sump is reached; the sump pump stops at a predetermined low water level. Potentially radioactive wastes are pumped to waste collection tanks in the radwaste building.

Unidentified leaks inside the drywell drain to the drywell floor drain sumps. Identified leakages drain to the drywell equipment drain tank. This tank level can be maintained for identification of leaking source.

For valves in the drywell with seal leakoffs, a seal leakoff valve is normally closed to make use of the double seals on the valves except during leakage testing of the primary seals. Leakages through the second seals, which are collected in the drywell floor drain sumps, are not identified to their source.

Floor and equipment drains from the condenser area are routed to the condenser area sump, which overflows to the turbine building central area oil separator. The overflow pipe contains an isolation valve that automatically closes when any of the following conditions occurs:

a) Activation of any of the three wet pipe sprinkler systems in the condenser area

b) High water level in the condenser area sump

c) Oil carry-over into the turbine building central area sump.

In case of condenser area fire sprinkler activation, large oil (EHC) leakage, a large circulating water piping leakage, or operations evolution (i.e. high sump water level), the condenser area transfer sump contents will be identified to determine the influent. If the water quality is acceptable for liquid radwaste, the isolation valve is manually throttled open and the water is allowed to drain normally to the central area oil separator. In the event that the water is unacceptable for liquid radwaste the condenser area transfer pump is started manually and the waste is pumped to the condensate storage tank berm area for storage. The water will then be processed by appropriate means, depending on the amount and types of contaminants.

The Oily Waste System collects liquid that enters surface drain units (SDU) located in areas with no sources of potentially radioactive wastes, and where the possibility for oil spillage exists. The oily wastes are conveyed by gravity to oil separators of either the API or baffle type.

The oily waste in the circulating water pumphouse flows through an API type oil interceptor of 90 percent oil removal efficiency, and the effluent is pumped to a baffle type oil separator. Baffle type oil separators provide an effluent with a total oil concentration of less than 10 ppm, conforming to the requirements of Pennsylvania's Department of Environmental Protection. The clarified effluent discharges to the circulating water pump house sump. Water collected in the sump is discharged to the circulating water pump suction line. Oil collected in the oil separator is periodically pumped into a portable drum for disposal.

Floor and equipment drains from diesel generator A-D bays are collected in the diesel generator A-D building sump after passing through a baffle type oil separator. The clarified effluent is pumped to the storm sewer.

Floor and equipment drains located at EL 676' and up in the diesel generator 'E' building are piped to an underground 25,000 gallon oily waste storage tank. From the tank, drainage flows by gravity to the diesel generator 'E' oil/water separator. On elevation 656'-6", drainage is routed directly to the oil/water separator. Waste water from the separator flows to the diesel generator 'E' building sump where it is then pumped to the Service and Administration Building oil/water separator for further processing. Waste oil from the separator is pumped to an underground waste oil storage tank located outside the diesel generator 'E' building.

Equipment drains from the main turbine bearings and the turbine lube oil conditioners are piped directly to the turbine building outer area oil sumps. The turbine lube oil reservoir rooms are recessed from the normal floor level in order to contain all the lube oil in case of a tank rupture. The drainage from the turbine lube oil reservoir rooms is normally conveyed through the oil interceptor to the oil sump. In the event of an oil tank rupture, the valve position may be reversed to route the oil flow directly to the oil sump.

The Acid Waste System collects liquid waste containing chemicals and corrosive substances discharged by laboratory fixtures and equipment. The Acid Waste System also collects liquid waste through floor drains, which are located in the water treatment building (circ. water pumphouse), and conveys the liquid waste directly or by means of the chemical waste sump pumps to a pair of neutralization basins. Floor drains from the acid storage and chlorine evaporator building (acid and chlorine building) containing acid contamination are collected in a sump and either transferred to a cooling tower basin or pumped to the neutralization basins.

The Sanitary Drainage System collects liquid wastes and some entrained solids discharged by all plumbing fixtures located in areas with no sources of potentially radioactive, oily, or acid wastes and conveys them to a sewage treatment facility described in Subsection 9.2.4.

The drain lines were designed to accommodate fire protection system design flow when actuated.

9.3.3.3 Safety Evaluation

With the exception of the drywell equipment drain and drywell floor drain sump discharge pipe penetrations through the primary containment and the associated isolation valves, the failure of the EFDS cannot affect plant safety. Although the reactor building FRW system is non-seismic category 1, credit is taken for floor drains in the SSES internal flood evalutions. A single failure of a floor drain due to blockage is assumed in these evaluations. Refer to section 3.4 for additional information regarding internal flood evaluations. The drywell floor drain sumps are designed to Seismic Category I requirements and the associated leak detection instrumentation is designed to OBE requirements. Pump operability is not required for the functioning of the differential level Drywell Floor Drain Leak Detection System.

Each of the six pump rooms (ECCS and RCIC) is provided with a separate drain line to the reactor building sump inlet header. A normally closed manual valve is provided in each drain line outside the pump room to prevent backflow. Seismic Category I level instrumentation provides for main control room alarms if the water level in the pump rooms rises above a preset value.

9.3.3.4 Tests and Inspections

All waste collection piping was hydrostatically tested prior to its embedment in concrete. Potentially radioactive drainage piping was tested to 75 psig, in accordance with ANSI B31.1.0. Non-radioactive oily, acid, sanitary, and storm drainage piping was tested to the equivalent of a 10 ft head of water for at least 15 min. The operability of Equipment and Floor Drainage Systems can be checked by normal use and through the instrumentation provided in the sumps and the main control room.

9.3.3.5 Instrumentation Application

High and low level switches are provided in each sump. For sumps having two pumps, the level switch will actuate the second pump at a higher level. The first pump to start is alternated on each pumping cycle to equalize run times. Table 9.3-10 shows the usage factors resulting from this provision.

The drywell equipment drain tank drains by gravity. The drain tank's discharge valves automatically open when a predetermined high level in the tank is reached. The discharge valves close at a predetermined low level.

Oil sumps are equipped with level switches and high level alarms in the main control room. The Diesel Generator 'E' waste oil storage tank is equipped with level switches and will annunciate a general trouble alarm in the control room on high level.

To detect leaks, a level alarm will be provided in the main control room for each ECCS equipment room.

The drywell floor drain sump and the drywell equipment drain tank temperatures are indicated, and a high alarm is annunciated on a local panel in the reactor building of each unit.

The levels in the drywell floor drain sumps and drywell equipment drain tanks are recorded, and a high-high level alarm is annunciated in the main control room. Refer to Subsection 5.2.5 and Section 7.6 for further details of the Leak Detection System.

9.3.4 CHEMICAL AND VOLUME CONTROL SYSTEM

Not applicable to BWR's.

9.3.5 STANDBY LIQUID CONTROL SYSTEM

9.3.5.1 Design Bases

The standby liquid control (SLC) system is sized to deliver enough enriched sodium pentaborate solution ($Na_2O{\bullet}5B_2O_3$) into the reactor to assure reactor shutdown. The SLC System's additional design function is to prevent re-evolution of iodine from the suppression pool in the event of a Design Basis Accident (DBA-LOCA) (see (g) below).

The standby liquid control system is a special safety system and engineered safety feature system and is designed in accordance with Seismic Category I requirements. It shall meet the following safety design bases:

(a) Backup capability for reactivity control shall be provided, independent of normal reactivity control provisions in the nuclear reactor, to be able to shut down the reactor if the normal control ever becomes inoperative.

(b) The backup system shall have the capacity for controlling the reactivity difference between the steady-state rated operating condition of the reactor with voids and the cold shutdown condition, including shutdown margin, to assure complete shutdown from the most reactive condition at any time in core life.

(c) The time required for actuation and effectiveness of the backup control shall be consistent with the nuclear reactivity rate of change predicted between rated operating and cold shutdown conditions. A fast scram of the reactor or operational control of fast reactivity transients is not specified to be accomplished by this system.

(d) Means shall be provided by which the functional performance capability of the backup control system components can be verified periodically under conditions approaching actual use requirements. Demineralized water, rather than the actual neutron absorber solution, can be injected into the reactor to test the operation of all components of the redundant control system.

(e) The neutron absorber shall be dispersed within the reactor core in sufficient quantity to provide a reasonable margin for leakage or imperfect mixing.

(f) The system shall be reliable to a degree consistent with its role as a special safety system; the possibility of unintentional or accidental shutdown of the reactor by this system shall be minimized.

(g) The SLCS system fails to meet all the requirements of a safety-related system in that it is not designed for the single active component failure criteria. Therefore, a failure of a critical component would prevent the system from injecting boron to the suppression pool. Using NRC approved guidelines for the implementation of AST methodology, the SLCS single-failure criteria has been redefined to include component availability in the event of a Design Basis Accident (DAB-LOCA) to assure SLCS flow to maintain the pool pH greater than 7.0. See Section 7.4.1.2.3 for more details of this requirement.

9.3.5.2 System Description

The standby liquid control (SLC) system (see Dwg. M-148, Sh. 1) is manually initiated through a single keylock switch in the main control room to pump a boron neutron absorber solution into the reactor if the operator determines the reactor cannot be shut down or kept shut down with the control rods. The keylocked control room switch is provided to assure positive action from the main control room should the need arise. Procedural controls are applied to the operation of the keylocked control room switch.

The boron solution tank, the test water tank, the two positive displacement pumps, the two explosive valves, the two pump suction valves, and associated local valves and controls are located in the reactor building. The liquid is piped into the reactor vessel and discharged near the bottom of the core shroud so it mixes with the cooling water rising through the core. A SLCS flow transmitter and flow meter indicate that the borated liquid is flowing.

The specified neutron absorber solution is enriched sodium pentaborate ($Na_2O \bullet 5B_2O_3 \bullet 10H_2O$) with a minimum enrichment of 88% B-10. Natural boron is 19.8% B-10, which is the neutron absorbing boron isotope. Solutions enriched with B-10 have a directly proportional greater neutron absorbing capacity that a natural boron solution. The solution is prepared by mixing the required quantities of enriched sodium pentaborate in demineralized water. An air sparger is provided in the tank for mixing. To prevent system plugging, the tank outlet is raised above the bottom of the tank.

The amount of enriched sodium pentaborate solution which must be stored in the system in order to assure reactor shutdown or maintain post – LOCA suppression pool pH above 7.0 depends on the concentration, and is defined by Technical Specification Figure 3.1.7-1, similar to FSAR Figure 9.3-14.

The enriched sodium pentaborate solution must be maintained above the saturation temperature in order to prevent precipitation or crystallization during storage, which could plug lines or reduce the boron available for injection into the reactor. Figure 9.3-15 is the saturation temperature curve for sodium pentaborate. The required temperature above this saturation curve is defined by a minimum temperature-concentration line on Technical Specifications Figure 3.1.7-2. The equipment containing the solution is installed in a room in which the air temperature is to be maintained within the range of 60^{o} to 100^{o}F. In addition, a heater system maintains the solution temperature at 65, to 75, F. High or low temperature, or high or low liquid level, causes an alarm in the control room.

The pump and system design pressure between the explosive valves and the pump discharge is 1500 psig. The two relief valves are set at approximately 1500 psig. These pressures allow SLC to perform its function in its most limiting event, ATWS/LOOP (Section 15.8.4). To prevent bypass flow from one pump in case of relief valve failure in the line from the other pump, a check valve is installed downstream of each relief valve line in the pump discharge pipe.

The two explosive-actuated injection valves provide assurance of opening when needed and ensure that boron will not leak into the reactor even when the pumps are being tested.

Each explosive valve is closed by a plug in the inlet chamber. The plug is circumscribed with a deep groove so the end will readily shear off when pushed with the valve plunger. This opens the inlet hole through the plug. The sheared end is pushed out of the way in the chamber; it is shaped so it will not block the ports after release.

The shearing plunger is actuated by an explosive charge with dual ignition primers inserted in the side chamber of the valve. Ignition circuit continuity is monitored by a trickle current, and an alarm occurs in the control room if either circuit opens. Indicator lights show which primary circuit opened.

The SLC system is actuated by a three-position keylocked switch on the control room console. This assures that switching from the "off" position is a deliberate act. Switching to initiate SLC system starts the selected injection pump actuates both of the explosive valves, and closes the reactor cleanup system outboard isolation valve to prevent loss or dilution of the boron.

A light in the control room indicates that power is available to the pump motor contactor and that the contactor is de-energized (pump not running). Another light indicates that the contactor is energized (pump running). There is also a SLCS flow transmitter and flow meter to indicate that the borated liquid is flowing.

Storage tank liquid level, pump discharge pressure, and loss of continuity on the explosive valves indicate that the system is functioning. The local switch will not have a "stop" position. This prevents the isolation of the pumps from the control room. Pump discharge pressure and valve status are indicated in the control room.

Equipment drains and tank overflow are not piped to the radwaste system but to separate containers (such as 55-gal. drums) that can be removed and disposed of independently to prevent any trace of boron from inadvertently reaching the reactor.

Instrumentation consisting of solution temperature indication and control, solution level, and heater system status is provided locally at the storage tank. Table 9.3-11 contains the process data for the various modes of operation of the SLC.

9.3.5.3 Safety Evaluation

The standby liquid control system is a reactivity control system and is maintained in an operable status whenever the reactor is critical or in Mode 3. An additional SLC system design function is to prevent re-evolution of iodine from the suppression pool in the event of a DBA-LOCA. Controlling suppression pool pH is achieved by using the buffering action of the boron injected to the suppression pool from the SLC system (via the reactor vessel). For this function the SLC system is required to be operable in Mode 3. The system is expected never to be needed for its reactivity control functions because of the large number of independent control rods available to shut down the reactor.

To assure the availability of the SLC system, and to facilitate maintenance and testing, two sets of the components required to actuate the system - pumps and explosive valves - are provided in parallel.

The system is designed to bring the reactor from rated power to a cold shutdown at any time in core life. The reactivity compensation provided will reduce reactor power from rated to zero level and allow cooling the nuclear system to room temperature, with the control rods remaining withdrawn in the rated power pattern. It includes the reactivity gains that result from complete decay of the rated power xenon inventory. It also includes the positive reactivity effects from eliminating steam voids, changing water density from hot to cold, reduced Doppler effect in uranium, reducing neutron leakage from boiling to cold, and decreasing control rod worth as the moderator cools.

The minimum average concentration of natural boron in the reactor to provide adequate shutdown margin, after operation of the SLC system, is 660 ppm natural boron. Calculation of the minimum quantity of enriched sodium pentaborate to be injected into the reactor is based on the required 660 ppm natural boron average concentration in the reactor coolant including recirculation loops, at 70°F and reactor normal water level. The result is increased by 25% to allow for imperfect mixing and leakage. Additional sodium pentaborate is provided to accommodate dilution by the RHR system in the shutdown cooling mode. This concentration will be achieved if the solution is prepared, stored, and maintained above saturation temperature as defined in Subsection 9.3.5.2, and injected into the reactor coolant system as described below.

Cooldown of the nuclear system will require a minimum of several hours to remove the thermal energy stored in the reactor, cooling water, and associated equipment. The controlled limit for the reactor vessel cooldown is 100°F per hour, and normal operating temperature is approximately 550°F. Use of the main condenser and various shutdown cooling systems requires 10 to 24 hours to lower the reactor vessel to room temperature (70°F). At some temperature during the cool down from 550°F to 70°F the condition of maximum reactivity will occur, however, by assuring that a minimum boron concentration equivalent to 660 ppm at 70°F is maintained during the cool down operation adequate shutdown margin will be achieved.

The SLC system is required to be operable in the event of a station power failure, therefore the pumps, heaters, valves, and controls are powered from or connectable to the standby a-c power supply. The pumps and valves are powered from separate buses so that a single electrical failure of either pump or explosive valve will not prevent injection of sodium pentaborate on demand.

The SLC system and pumps have sufficient pressure margin, up to the system relief valve setting of approximately 1500 psig, to assure solution injection into the reactor above the normal pressure in the bottom of the reactor. The nuclear system relief and safety valves begin to relieve pressure above approximately 1100 psig. Therefore, the SLC system positive displacement pumps cannot overpressurize the nuclear system.

One pump capable of performing its intended function independent of the second pump and capable of adding enriched sodium pentaborate solution to the reactor vessel in sufficient quantity to bring reactor power to zero, is required for system operation in accordance with the requirements of 10 CFR 50.62. If a component (e.g., one pump) is found to be inoperable, there is no immediate threat to shutdown capability, and reactor operation can continue during repairs. The time during which one component upstream of the explosive valves may be out of operation should be consistent with the following: the probability of failure of both the control rod shutdown capability and the alternate component in the SLC system; and the fact that nuclear system cooldown takes several hours while liquid control solution injection takes less than one hour. Since this probability is small, considerable time is available for repairing and restoring the SLC system to an operable condition while reactor operation continues. Assurance that the system will still fulfill its function during repairs is ensured by the operable status of the remaining pump.

In the event of a malfunction of the thermostatically-controlled storage tank heater "A" and a drop in the room temperature to less than its specified minimum of 60^{oF}, a temperature alarm would eventually be annunciated in the control room and would alert the operator to control storage tank temperature manually from the local panel by means of the mixing heater "B". A temperature alarm will also annunciate in the control room if there is a malfunction of the suction piping heat tracing. The alarm low setpoint is sufficiently above saturation temperature of the sodium pentaborate solution such that, even in the unlikely event that ambient temperature is below 50°F, sufficient time will be available to enable the operating personnel to take appropriate temporary measures to heat the suction piping before precipitation occurs.

The SLC system is evaluated against the applicable General Design Criteria as follows:

Criterion 2: The SLCS is located in the area outside of the primary containment (drywell) and below the refueling floor. In this location it is protected by the containment and compartment walls from external natural phenomena such as earthquakes, tornadoes, hurricanes and floods and internally from effects of such events and internal postulated events.

Criterion 4: The SLCS is designed for the expected environment in the reactor building and specifically for the compartment in which it is located. In this compartment, it is not subject to the more violent conditions postulated in this criterion such as missiles, whipping pipes, and discharging fluids. This system is called upon to perform a special safety function of providing backup capability for reactivity control under normal operation. A new additional safety function of the system is to prevent re-evolution of iodine from the suppression pool in the event of a Design Basis Accident (DBA-0LOCA) by maintaining the pool pH at greater than 7.0 through sodium pentaborate injection.

Criterion 21: Criterion 21 is applicable to protection systems only. The SLC system is a reactivity control system and should be evaluated against Criterion 29.

Criterion 26: The requirements of this criterion do not apply within the SLCS itself.

Criterion 27: This criterion applies no specific requirements onto the SLCS and, therefore, is not applicable. See the General Design Criteria Section (Section 3.1) for discussion of combined capability.

Criterion 29: The SLCS squib valves are redundant. Two pumps, and two injection valves are arranged and cross-tied such that operation of any one of each results in sodium pentaborate solution being added to the reactor vessel in sufficient quantity to bring reactor power to zero. One pump is required for system operation in accordance with the requirements of 10 CFR 50.62. The SLCS also has test capability. A special test tank is supplied for providing test fluid for the periodic injection test. Pumping capability may be tested at any time. A trickle current continuously monitors continuity of the firing mechanisms of the injection squib valves.

The SLC system is evaluated against the applicable regulatory guides as follows:

Regulatory Guide 1.26 Revision 2: Because the SLCS is a reactivity control system, all mechanical components required for injection are at least Quality Group B. Those portions which are part of the Reactor Cooling Pressure Boundary are Quality Group A. This is shown in Table 3.2-1.

Regulatory Guide 1.29 Revision 1: All GE supplied components of the SLCS which are necessary for injection of neutron absorber into the reactor are Seismic Category I. This is shown in Table 3.2-1.

The SLC system is located within a compartment within the reactor building, such that it is adequately protected from flooding, tornadoes, and internally and externally generated missiles. SLC system equipment is protected from pipe break by providing adequate distance between the seismic and non-seismic SLC system equipment where such protection is necessary. In addition, appropriate distance is provided between the SLC system and other piping systems. Where adequate protection cannot be assured, barriers have been considered to assure SLC system protection from pipe break (see Section 3.6).

It should be noted that the SLC system is not required to provide a safety function during any postulated pipe break events. This system is only required under an extremely low probability event when a sufficient number of control rods can not be inserted to bring the reactor to cold shutdown. Therefore, the protection provided is considered over and above that required to meet the intent of APCSB 3-1 and MEB 3-1.

This system is used in a couple of special plant capability demonstration events cited in Appendix A of Chapter 15. Specifically Events 51 and 53 which are extremely low probability non-design basis postulated incidents. The analyses given there are to demonstrate additional plant safety consideration far beyond reasonable and conservative assumptions.

A system-level, qualitative-type failure mode and effects analysis is presented in Subsection 15A.6.6.

9.3.5.4 Testing and Inspection Requirements

Operational testing of the SLC system is performed in at least two parts to avoid inadvertently injecting boron into the reactor.

With the valves from the storage tank closed and the valves to and from the test tank opened, demineralized water in the test tank can be recirculated by locally starting either pump.

During a refueling or maintenance outage, the injection portion of the system can be functionally tested by valving the suction lines to the demineralized water supply and actuating the system from the control room. System operation is indicated in the control room.

After functional tests, the injection valve shear plugs and explosive charges must be replaced and all the valves returned to their normal positions as indicated.

After closing the SLC injection line maintenance valve, leakage through the outboard containment isolation valve can be detected by pressurizing the test volume between the maintenance valve and the outboard containment isolation valve and opening the test connection located outboard of the containment isolation valve. Position indicator lights in the control room indicate that the injection line maintenance valve is closed for testing or open and ready for operation. Leakage through the inboard containment isolation valve can be detected by pressurizing the test volume between the maintenance valve and the inboard containment isolation valve and opening the test connection located outside containment.

The test tank contains demineralized water for approximately 3 minutes of single pump operation. Demineralized water from the makeup system or the condensate storage system is available for refilling, flushing or testing the system.

Should the boron solution ever be injected into the reactor, either intentionally or inadvertently, then after making certain that the normal reactivity controls will keep the reactor subcritical, the boron is removed from the reactor coolant system by flushing for gross dilution and/or operating various plant systems available to condition reactor water.

The concentration of the sodium pentaborate in the solution tank is determined periodically by chemical analysis. Electrical supplies and relief valves are also subjected to periodic testing.

The SLC system is pre-operationally tested in accordance with the requirements of Chapter 14.

9.3.5.5 Instrumentation Requirements

The instrumentation and control system for the SLC is designed to allow the injection of liquid poison into the reactor and the maintenance of the liquid poison solution well above the saturation temperature. A further discussion of the SLC instrumentation may be found in Chapter 7.

TABLE 9.3-1

INSTRUMENT AIR SYSTEM DESIGN PARAMETERS
(Typical for Unit 1 & 2)

Compressor Units		
Quantity (per unit)	2	
Capacity, each, scfm	440	
Discharge pressure, psig	100	
Cooling water: flow rate, gpm	13.0	
temperature in/out°F	105/125	
Aftercoolers		
Quantity (per unit)	2	
Capacity, each, scfm	440	
Operating pressure, psig	100	
Cooling water: flow rate, gpm	9.5	
temperature in/out°F	105/125	
Receivers		
Quantity (per unit)	2	
Capacity, each, ft^3	223	
Design pressure, psig	125	
Design temperature, °F	450	
Prefilters		
	A,B,C and D	E and F
Quantity (per unit)	2	2
Capacity, each, scfm	440	750
Design pressure, psig	150	150
Dryer Units		
	A,B,C and D	E and F
Quantity (per unit)	2	1
Capacity, each, scfm	440	750
Design pressure, psig	125	150
Leaving dew point, °F	-40	-40
After Filters		
	A,B,C and D	E and F
Quantity (per unit)	2	2
Capacity, each, scfm	440	750
Design pressure, psig	150	150
Efficiency	100% retention of particle size, 1 micron	

TABLE 9.3-2

INSTRUMENT AIR SYSTEM

PNEUMATICALLY OPERATED VALVES WHICH HAVE A SAFETY FUNCTION[(1)]

System and Figure Number	Location	Design Function	Normal Position	Fail Position	Safe Position
Service Water Figure 9.2-1a and 9.2-1b HV-10943A2	Turbine building closed cooling water heat exchanger outlets	Heat removal from turbine building closed cooling water heat exchangers	Closed	Closed	Closed
HV-10943B2	Turbine building closed cooling water heat exchanger outlets	Heat removal from turbine building closed cooling water heat exchangers	Closed	Closed	Closed
HV-10943A3	Turbine building closed cooling water heat exchanger outlets	Heat removal from turbine building closed cooling water heat exchangers	Open	Open	Open
HV10943B3	Turbine building closed cooling water heat exchanger outlets	Heat removal from turbine building closed cooling water heat exchangers	Open	Open	Open
Emergency Service Water Figures 9.2-5a and 9.2-5b HV-11143A	Turbine building closed cooling water heat exchanger inlet	Heat removal from turbine building closed cooling water heat exchangers	Closed	Closed	Closed
HV-11143B	Turbine building closed cooling water heat exchanger inlet	Heat removal from turbine building closed cooling water heat exchangers	Closed	Closed	Closed
Reactor Core Isolation Cooling Figure 9.2-6 HV-1F088	Steam supply	Bypass	Closed	Closed	Closed
HV-1F025	Steam drain line	Isolation	Open	Closed	Closed
HV-1F026	Steam drain line	Isolation	Open	Closed	Closed
LV-1F054	Steam drain line	Bypass	Closed	Closed	Closed
RCIC Turbine-Pump Figure 9.2-6 HV-1F004	Drain line on the RCIC vacuum tank condensate pump	Drain isolation	Closed	Closed	Closed
HV-1F005	Drain line on the RCIC vacuum tank condensate pump	Drain isolation	Open	Closed	Closed
HPCI Turbine Pump Figure 9.2-6 HV-1F026	Drain line on the HPCI turbine pump	Drain isolation	Closed	Closed	Closed
HV-1F025	Drain line on the HPCI turbine pump	Drain isolation	Open	Closed	Closed
Containment Atmos. Control FV-05719	Nitrogen supply line to primary containment	Supply shut-off (isolation)	Closed	Closed	Closed

TABLE 9.3-2

INSTRUMENT AIR SYSTEM

PNEUMATICALLY OPERATED VALVES WHICH HAVE A SAFETY FUNCTION[(1)]

System and Figure Number	Location	Design Function	Normal Position	Fail Position	Safe Position
Control Rod Drive XV-1F011, 1F181	Scram Discharge Volume	Vent Valve Isolation	Open	Closed	Closed
XV-1F010, 1F180	Scram discharge volume	Drain line isolation	Open	Closed	Closed
XV-126	Scram inlet valve	Scram inlet	Closed	Open	Open
XV-127	Scram exhaust valve	Scram exhaust	Closed	Open	Open
FV-1F002A	Man/auto station drive water pump discharge	Flow control	Open	Closed	Closed
FV-1F002B	Man/auto station drive water pump discharge	Flow control	Open	Closed	Closed
Reactor Building HVAC System Figure 9.4-6, 9.4-7, and 9.4-8		Isolation	Open	Closed	Closed
HD-17564A&B	Zone III supply fan (V212A&B) discharge				
HD-17586A&B	Zone I supply fan discharge (1V202A&B)	Isolation	Open	Closed	Closed
HD-17576A&B	Zone I exhaust fan inlet (1V205A&B)	Isolation	Open	Closed	Closed
HD-17502A&B	Zone III exhaust system inlet (1V213A&B)	Isolation	Open	Closed	Closed
HD-17514A&B	Zone III filtered exhaust system (1V217A&B)	Isolation	Open	Closed	Closed
HD-17524A&B	Zone I equipment comp. exhaust system (1V206A&B)	Isolation	Open	Closed	Closed
HD-17508A&B	On duct from drywell purge to SGTS	Isolation	Closed	Closed	Closed
TV-07550A&B	Fire protection isolation valve for SGTS	Isolation	Closed	Closed	Closed
HV-07551A1,2,3&4 HV-07551B1,2,3&4	SGTS drain valves	Drain off fire protection water	Closed	Closed	Closed
HD-17534A thru H	R.B. air locks	Isolation	Open	Closed	Closed
HD-07543A&B	R.B. recirculation system outlet	Interconnection between SGTS & Recirculation System	Closed	Open	Open
HD-17601A&B HD-17602A&B HD-17657A&B	R.B. recirculation system inlet	Interconnection between Recirculation System RB Duct	Closed	Closed	Closed

TABLE 9.3-2

INSTRUMENT AIR SYSTEM

PNEUMATICALLY OPERATED VALVES WHICH HAVE A SAFETY FUNCTION(1)

System and Figure Number	Location	Design Function	Normal Position	Fail Position	Safe Position
PDD-07554A&B	R.B. SGTS inlet from R.B. Recirculation	R.B. negative pressure (No Dilution)	Open	As Is	As Is
HD-07543A&B	R.B. SGTS inlet from R.B. Recirculation	R.B. negative pressure (No Dilution)	Closed	Open	Open
Control Structure HVAC System Figure 9.4-2		Fire protection			
TV-07813A TV-07813B	Water spray to the activated charcoal filters	Water spray isolation	Closed	Closed	Closed
HD-07824A1,B1	Return air to units 0V13A&B	Isolation	Open	Closed	Closed
HD-07802A&B	Outside air to units 0V103A&B	Isolation	Open	Closed	Closed
HD-07833A&B	Control room floor relief fan inlet	Isolation	Open	Closed	Closed
HD-07873A&B	Control room kitchen exhaust fan inlet	Isolation	Open	Closed	Closed
HD-07872A&B	Control room toilet fan inlet	Isolation	Open	Closed	Closed

(1) A complete list of pneumatically operated valves required for containment isolation is found in Table 6.2-12

TABLE 9.3-3

INSTRUMENT AIR COMPRESSORS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (Loss of normal power)	Compressor	Failure of one compressor	None. Standby compressor will start automatically	Alarm in the control room	No loss of safety functions
Emergency (DBA or LOOP + LOCA)	Compressors	Failure of two compressors	None. The pressure control valve between service air and instrument air will open to control pressure.	Alarm in the control room	No loss of safety functions

TABLE 9.3-4

SERVICE AIR SYSTEM DESIGN PARAMETERS (TYPICAL FOR UNITS 1 & 2)

Compressor Units

Quantity	2
Capacity, each, scfm	440
Discharge pressure, psig	125
Cooling water: flow rate, gpm	13
temp. in °F	105
temp. out °F	125

Aftercoolers

Quantity	2
Capacity, each, scfm	440
Operating pressure, psig	125
Cooling water: flow rate, gpm	10.8
temp. in °F	105
temp. out °F	125

Receivers

Quantity	2
Capacity, each ft^3	223
Design pressure, psig	139
Design temperature, °F	450

TABLE 9.3-5

LOW PRESSURE AIR SYSTEM DESIGN PARAMETERS (COMMON TO UNITS 1 & 2)

Compressor

Quantity	1
Capacity, scfm	700
Discharge pressure, psig	35
Cooling water: flow rate, gpm	4.8
temp. inlet °F	105
temp. outlet °F	125

Aftercooler

Quantity	1
Capacity, scfm	700
Operating pressure, psig	35
Cooling water: flow rate, gpm	17.2
temp. inlet °F	105
temp. outlet °F	125

Receiver

Quantity	1
Capacity, ft^3	151
Design pressure, psig	125
Design temperature, °F	650

TABLE 9.3-6

RIVER INTAKE STRUCTURE COMPRESSED AIR
SYSTEM DESIGN PARAMETERS
(COMMON FOR UNITS 1 & 2)

COMPRESSOR UNITS	
Quantity	2
Capacity, each, scfm	15.0
Discharge pressure, psig	100
Receiver capacity, each, gal	80
DRYER PACKAGE UNITS (NOTE)	
Quantity	1
Capacity, scfm	5.5
Air outlet dew point	-40°F
SYSTEM AIR RECEIVER	
Quantity	1
Capacity, FT^3	63
Design Pressure, psig	175
Design Temperature, °F	450

NOTE: Desiccant dryer unit is used as a backup to the membrane dryers.

TABLE 9.3-7

LIST OF INSTRUMENT GAS OPERATED DEVICES

---

1. Four main steam isolation valves.
2. Sixteen main steam relief valves, including six valves with auto depressurizing function (ADF).
3. One recirculation sample line valve.
4. Two RHR check valves.
5. Two equalizing valves for RHR check valves.
6. Two core spray check valves.
7. Two equalizing valves for core spray check valves.
8. Five tip indexing mechanisms.
9. Ten vacuum relief valves.
10. Eight reactor building chilled water valves.
11. One Reactor Core Isolation Cooling (RCIC) steam line equalizing valve.
12. One High Pressure Coolant Injection (HPCI) steam line equalizing valve.

TABLE 9.3-8

CONTAINMENT INSTRUMENT GAS SYSTEM
DESIGN PARAMETERS
(TYPICAL FOR UNITS 1 & 2)

COMPRESSOR UNITS	
Quantity	2
Capacity, each, scfm	40
Discharge pressure, psig	160
Cooling water: flow rate, gpm temperature in/out°F	3 105/110
AFTERCOOLERS	
Quantity	2
Capacity, each, scfm	40
Operating pressure, psig	160
Cooling water: flow rate, gpm temperature in/out°F	1.15 105/125
RECEIVERS	
Quantity	2
Capacity, each, ft^3	20
Design pressure, psig	250
Design temperature, °F	200
INLET MOISTURE SEPARATOR	
Quantity	1
Capacity, each, scfm (max)	80
GAS INLET FILTERS	
Quantity	2
Capacity, each, scfm	80
DRYER UNITS	
Quantity	2
Capacity, each, scfm	40
Operating pressure, psig	160
Leaving dew point, °F	-40

TABLE 9.3-8 (Cont.d)

CONTAINMENT INSTRUMENT GAS SYSTEM
DESIGN PARAMETERS
(TYPICAL FOR UNITS 1 & 2)

AFTER FILTERS	
Quantity	2
Capacity, each, scfm	80
Efficiency	Oil removal – 99.999% Particle size – 0.01 microns
Operating pressure, psig	160
NITROGEN BOTTLES	
Quantity	26 (13 in one bank & 13 in another)
Capacity, each (Minimum)	224 scf
Nominal Charge Pressure	2200 psig
TWO STAGE REGULATOR	
Quantity	2
Operating pressure	2200 psig/150 psig

TABLE 9.3-9

CONTAINMENT INSTRUMENT GAS SYSTEM
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (LOCA + LOOP)	Compressors	Failure of both compressors	None. The safety related devices served by the instrument gas system have their own accumulators backed up by nitrogen bottles.	Alarm in the control room	No loss of safety function
Emergency (LOOP)	Compressor	No failure of compressors	None	None	None
Emergency	Nitrogen bottles	Loss of one bank of bottles	None. Redundant bank of bottles is available to pressurize its group of ADS relief valves. ADS relief valves associated with lost bottle bank have accumulators for storage of motive gas for a short period.	Alarm in the control room	No loss of safety function

TABLE 9.3-10

EQUIPMENT AND FLOOR DRAINAGE SYSTEM
COMPONENT DESCRIPTION

Pumps	Equipment Numbers	Type	Quantity	Material Casing/Imp	Capacity, Each, TDH, gpm	ft	Usage Factor, Normal (1)	Driver Hp	Design Pressure/ Temperature Psig/°F
Drywell Floor Drains	1P-402A; B/1P-403A, B	Vert. Centr. Sump	4	SS/SS	30	12	0.013	1	150/180
Drywell Floor Drains	2P-402A, B/2P-403A, B	Vert. Centr. Sump	4	SS/SS	30	12	0.013	1	150/180
Reactor Building Drains	1P-225A, B	Vert. Centr. Sump	2	CI/N1 Hard	250	50	0.012	10	150/150
Reactor Building Drains	2P-225A, B	Vert. Centr. Sump	2	CI/N1 Hard	250	50	0.012	10	150/150
Turbine Bldg. Outer Area Drains	1P-127A, B	Vert. Centr. Sump	2	CI/N1 Hard	250	50	0.016	10	150/150
Turbine Bldg. Outer Area Drains	2P-127A, B	Vert. Centr. Sump	2	CI/N1 Hard	250	50	0.016	10	150/150
Turbine Bldg. Central Area Drains	1P-129A, B	Vert. Centr. Sump	2	CI/N1 Hard	250	50	0.007	10	150/150
Turbine Bldg. Central Area Drains	2P-129A, B	Vert. Centr. Sump	2	CI/N1 Hard	250	50	0.007	10	150/150
Turbine Bldg. Cond. Area Drains	1P-126	Vert. Centr. Sump	1	CI/N1 Hard	1000	55	0.000	25	150/150
Turbine Bldg. Cond. Area Drains	2P-126	Vert. Centr. Sump	1	CI/N1 Hard	1000	55	0.000	25	150/150
Turbine Bldg. Chemical Drains	1P-126A, B	Vert. Centr. Sump	2	SS/SS	50	30	0.002	2	150/150
Turbine Bldg. Chemical Drains	2P-126A, B	Vert. Centr. Sump	2	SS/SS	50	30	0.002	2	150/150
Chemical Radwaste Drain Tank	OP-132A, B	Horiz. Centr.	2	SS/SS	50	30	0.002	2	150/155
Laundry Radwaste Drain Tank	OP-131A, B	Horiz. Centr.	2	CI/CI	50	30	0.001	2	150/155
Radwaste Building Drains	OP-338A, B	Vert. Centr. Sump	2	CI/NI Hard	100	35	0.007	3	150/150
Radwaste Building Chemical Drains	OP-337A, B	Vert. Centr. Sump	2	SS	50	30	0.002	2	150/150
Pipe Tunnel Drains	1P-120	Vert. Subm. Centr.	1	CI	35	15	0.000	1	125/150
Circ. Water Pump House Drains	OP-549A, B	Vert. Centr. Sump	2	CI/NI Hard	100	90	-(2)	10	150/150
Diesel Gen. 'A-D' Bldg. Drains	OP-553A, B	Vert. Centr. Sump	2	CI/NI Hard	100	35	-(2)	3	150/150
CI and Acid Storage Building Drains	OP-534A, B	Vert. Centr. Sump	2	A20/A20	50	20	-(2)	2	150/150
Water Treatment Bldg. Chem. Drains	OP-522A, B	Vert. Centr. Sump	2	SS/SS	50	30	-(2)	2	150/150
Diesel Gen. 'E' Bldg. Drains	OP-553C, D	Vert. Centr. Sump	2	CI/NI Hard	100	48	-(2)	5	35/105

(1)Usage factors represent the fraction of time an individual pump is operating at the expected average waste input shown in Table 11.2-1
(2)Non-radioactive waste-usage factor not required per Reg. Guide 1.70 Rev. 2 Section 9.3.3.

TABLE 9.3-10

EQUIPMENT AND FLOOR DRAINAGE SYSTEM
COMPONENT DESCRIPTION

SUMPS AND DRAIN TANKS

	Equipment Numbers	Type	Quantity	Material Line/Cover	Sump (Tank) Live/ Nominal Capacity Each, gal.	Manhole	Oil Interceptor Type	Oil Sump Capacity Each, gal.
Drywell Floor Drains	1SP400A&B	Lined Sump	2	SS/-	90/ 150	No	-	-
Drywell Floor Drains	2SP400A&B	Lined Sump	2	SS/-	90/ 150	No	-	-
Drywell Equipment Drains	1T-218	Vert. Tank	1	CS	610/1060	Yes	-	-
Drywell Equipment Drains	2T-218	Vert. Tank	1	CS	610/1060	Yes	-	-
Reactor Building Drains	1SP200	Lined Sump	1	SS/18" Conc.	2510/4050	Yes	API-500 gpm	670
Reactor Building Drains	2SP200	Lined Sump	1	SS/18" Conc.	2510/4050	Yes	API-500 gpm	670
Turbine Bldg. Outer Area Drains	1SP104	Lined Sump	1	SS/9" Conc.	2570/4130	Yes	API-500 gpm	670
Turbine Bldg. Outer Area Drains	2SP104	Lined Sump	1	SS/9" Conc.	2570/4130	Yes	API-500 gpm	670
Turbine Bldg. Central Area Drains	1SP102	Lined Sump	1	SS/9" Conc.	2570/4130	Yes	API-500 gpm	670
Turbine Bldg. Central Area Drains	2SP102	Lined Sump	1	SS/9" Conc.	2570/4130	Yes	API-500 gpm	670
Turbine Bldg. Condenser Area Drains	1SP100	Lined Sump	1	SS/1" CS	- / 692	No	-	-
Turbine Bldg. Condenser Area Drains	2SP100	Lined Sump	1	SS/1" CS	- / 692	No	-	-
Turbine Bldg. Chemical Drains	1SP101	Lined Sump	1	SS/1" CS	486/ 935	No	-	-
Turbine Bldg. Chemical Drains	2SP101	Lined Sump	1	SS/1" CS	486/ 935	No	-	-
Chemical Radwaste Drains	OT-114	Vert. Tank	1	SS	280/ 378	No	-	-
Laundry Radwaste Drains	OT-115	Vert. Tank	1	SS	280/ 378	No	-	-
Radwaste Building Drains	0SP300	Lined Sump	1	SS/12" Conc.	970/1940	Yes	-	-
Radwaste Building Chem. Drains	0SP301	Lined Sump	1	SS/12" Conc.	630/1215	Yes	-	-
Pipe Tunnel Drains	1SP106	Lined Sump	1	SS/1" CS	150/ 360	No	-	-
Circ. Water Pump House Drains	0SP504	Unlined Sump	1	-/15" Conc.	920/1550	Yes	AP & Baffle	250
Diesel Generator Building Drains	0SP502	Unlined Sump	1	-1/4" CS	920/1390	Yes	Baffle	135
C1 and Acid Storage Bldg.	0SP503	Unlined Sump	1	-/12" Conc.	790/4110	Yes	-	-
Water Treat. Bldg. Chem. Drains	Common	Unlined Sump	1	-/15" Conc.	600/1190	Yes	-	-
DG-E Oily Waste Storage Tank	OT598	Horiz. Tank	1	CS	25000/	Yes	Oil Sep.	550 (OT-599)

TABLE 9.3-11

STANDBY LIQUID CONTROL SYSTEM OPERATING PRESSURE/TEMPERATURE CONDITIONS

			Test Modes(a)					
	Standby Mode		**Circulation Test**		**Injection Test (b)**		**Operating Mode**	
Piping	Press. psig (c)	Temp. F	Press. psig (c)	Temp. F	Press. psig (c)	Temp. F	Press. psig (c)	Temp. F
Pump Suction	Storage Tank Static Head	70/110 (d)	Test Tank Static Head (e)	70/100	Test Tank Static Head (e)	70/100	Storage Tank Static Head	70/110 (d)
Pump Discharge to Explosive Valve Inlet	Storage Tank Static Head	70/100	1250	70/100	190 Plus Reactor Static Head	70/100	190 Plus Reactor Static Head to 1250 or less	70/110
Explosive Valve Outlet to but not Including First Isolation Check Valve	Reactor Static Head to 1203 (f)	70/100	Reactor Static Head to 1203 (f)	70/100	< 190 Plus Reactor Static Head	70/100	< 190 Plus Reactor Static Head to 1250 or less	70/110
First Isolation Check Valve to the Reactor	Reactor Static Head to 1203 (f)	70/570 (g)	Reactor Static Head to 1203 (f)	70/570 (g)	Reactor Static Head (b)	125 (b)	Reactor Static Head to 1203 (f)	70/570 (g)

(a) The pump flow rate will be zero (pump not operating) during the standby mode and at rated during the test and operating modes.

(b) Reactor to be at 0 psig and 125 F before changing from the standby mode to the Injection Test mode.

(c) Pressures tabulated represent pressure at the points identified below. To obtain pressure at intermediate points in the system, the pressures tabulated must be adjusted for elevation difference and pressure drop between such intermediate points and the pressure points identified below:

Pump Suction: Pump Suction Flange Inlet

Pump Discharge To Explosive Valve Inlet: Pump Discharge Flange Outlet

Explosive Valve Outlet to But Not Including First Isolation Check Valve: Explosive Valve Outlet

First Isolation Check Valve To The Reactor: Reactor Sparger Outlet

(d) During chemical mixing, the liquid in the storage tank will be at a temperature of 150 F maximum. This temperature is for piping design only.

(e) Pump suction piping will be subject to demineralized water supply pressure during flushing and filling of the piping and during any testing where suction is taken directly from the demineralized water supply line rather than the test tank.

(f) Maximum reactor operating pressure is reactor dome pressure at the second lowest SRV spring setting (nominal) plus reactor static head.

(g) 570 F represents maximum sustained operating temperature based on saturation temperature at ≈1203 psig.

FIGURE 9.3-1 REPLACED BY DWG. M-125, SH. 1

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FIGURE 9.3-1 REPLACED BY DWG. M-125, SH. 1

FIGURE 9.3-1 Rev. 56

AutoCAD Figure 9_3_1.doc

FIGURE 9.3.2 REPLACED BY DWG. M-125, SH. 2

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FIGURE 9.3.2 REPLACED BY DWG. M-125, SH. 2

FIGURE 9.3-2, Rev. 55

AutoCAD Figure 9_3_2.doc

FIGURE 9.3-3 REPLACED BY DWG. M-125, SH. 30

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FIGURE 9.3-3 REPLACED BY DWG. M-125, SH. 30

FIGURE 9.3-3, Rev. 55

AutoCAD Figure 9_3_3.doc

FIGURE 9.3-4 REPLACED BY DWG. M-125, SH. 5

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FIGURE 9.3-4 REPLACED BY DWG. M-125, SH. 5

FIGURE 9.3-4, Rev. 55

AutoCAD Figure 9_3_4.doc

FIGURE RENUMBERED FROM 9.3-7 TO 9.3-6-2

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FIGURE RENUMBERED FROM 9.3-7 TO 9.3-6-2

FIGURE 9.3-7, Rev. 54

AutoCAD Figure 9_3_7.doc

FIGURE RENUMBERED FROM 9.3-8 TO 9.3-6-3

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FIGURE RENUMBERED FROM 9.3-8 TO 9.3-6-3

FIGURE 9.3-8, Rev. 54

AutoCAD Figure 9_3_8.doc

FIGURE RENUMBERED FROM 9.3-9 TO 9.3-6-4

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FIGURE RENUMBERED FROM 9.3-9 TO 9.3-6-4

FIGURE 9.3-9, Rev. 54

AutoCAD Figure 9_3_9.doc

FIGURE RENUMBERED FROM 9.3-10 TO 9.3-10-1

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FIGURE RENUMBERED FROM 9.3-10 TO 9.3-10-1

FIGURE 9.3-10, Rev. 55

AutoCAD Figure 9_3_10.doc

FIGURE RENUMBERED FROM 9.3-11 TO 9.3-10-2

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FIGURE RENUMBERED FROM 9.3-11 TO 9.3-10-2

FIGURE 9.3-11, Rev. 55

AutoCAD Figure 9_3_11.doc

FIGURE 9.3-12 REPLACED BY DWG. M-160, SH. 1

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FIGURE 9.3-12 REPLACED BY DWG. M-160, SH. 1

FIGURE 9.3-12, Rev. 55

AutoCAD Figure 9_3_12.doc

THIS FIGURE IS A DUPLICATE TO FIGURE 7.4-3

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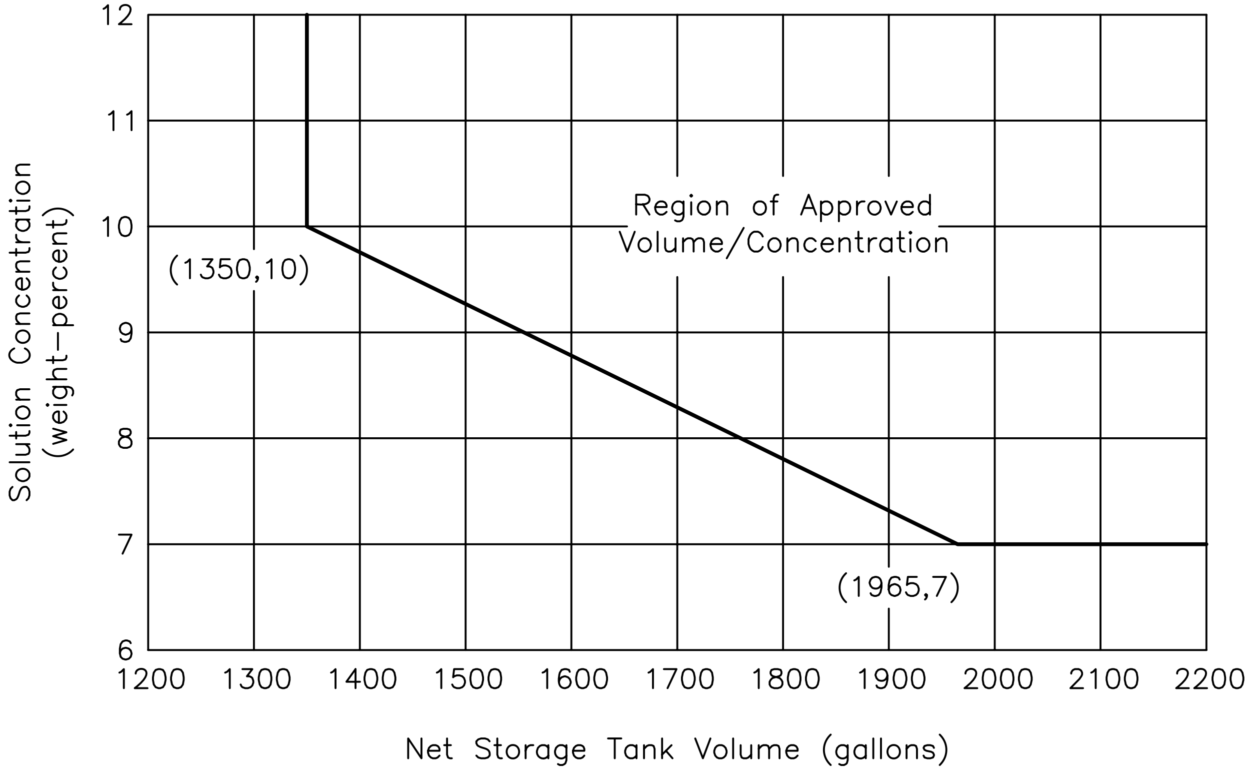
THIS FIGURE IS A DUPLICATE TO FIGURE 7.4-3

FIGURE 9.3-13, Rev. 54

AutoCAD Figure 9_3_13.doc

SODIUM PENTABORATE SOLUTION VOLUME VERSUS CONCENTRATION REQUIREMENTS



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UNITS 1 & 2
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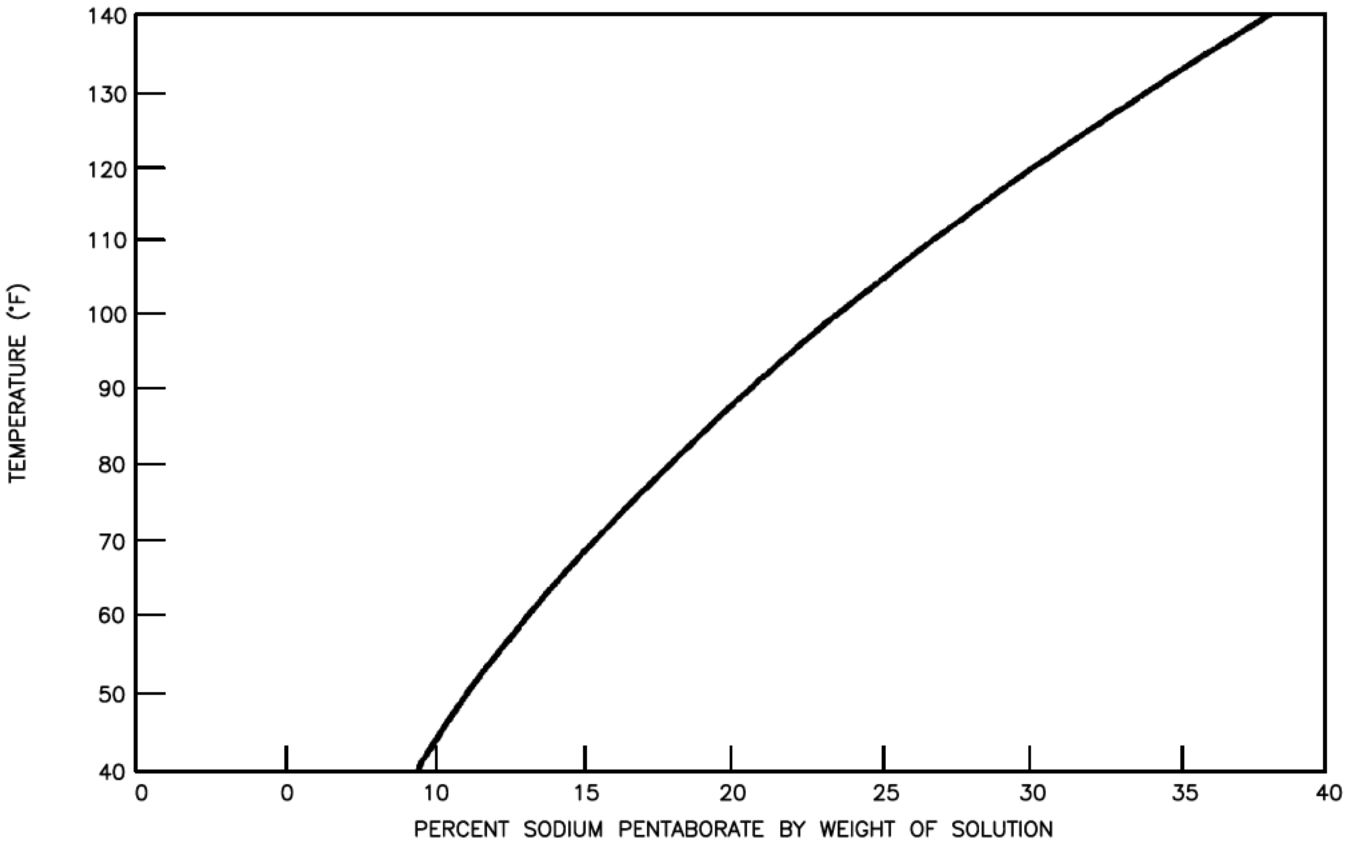
SODIUM PENTABORATE
(Na_2O $5B_2O_3$ $10H_2O$)
VOLUME-CONCENTRATION
REQUIREMENTS

FIGURE 9.3-14, Rev 52

AutoCAD: Figure Fsar 9_3_14.dwg
Ref. Tech. Spec. Figure 3.1.7-1



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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

SATURATION TEMPERATURE
OF
SODIUM PENTABORATE SOLUTION

FIGURE 9.3-15, Rev 47

AutoCAD: Figure Fsar 9_3_15.dwg

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.3-16, Rev. 50

AutoCAD Figure 9_3_16.doc

FIGURE 9.3-2A REPLACED BY DWG. M-125, SH. 6

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-2A REPLACED BY DWG. M-125, SH. 6

FIGURE 9.3-2A, Rev. 50

AutoCAD Figure 9_3_2A.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE DELETED FIGURE 9.3-3A, Rev. 54

AutoCAD Figure 9_3_3A.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
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FINAL SAFETY ANALYSIS REPORT

FIGURE DELETED

FIGURE 9.3-3B, Rev. 54

AutoCAD Figure 9_3_3B.doc

FIGURE RENUMBERED FROM 9.3-9A TO 9.3-6-5

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE RENUMBERED FROM 9.3-9A TO 9.3-6-5

FIGURE 9.3-9A, Rev. 48

AutoCAD Figure 9_3_9A.doc

FIGURE 9.3-12A REPLACED BY DWG. M-160, SH. 2

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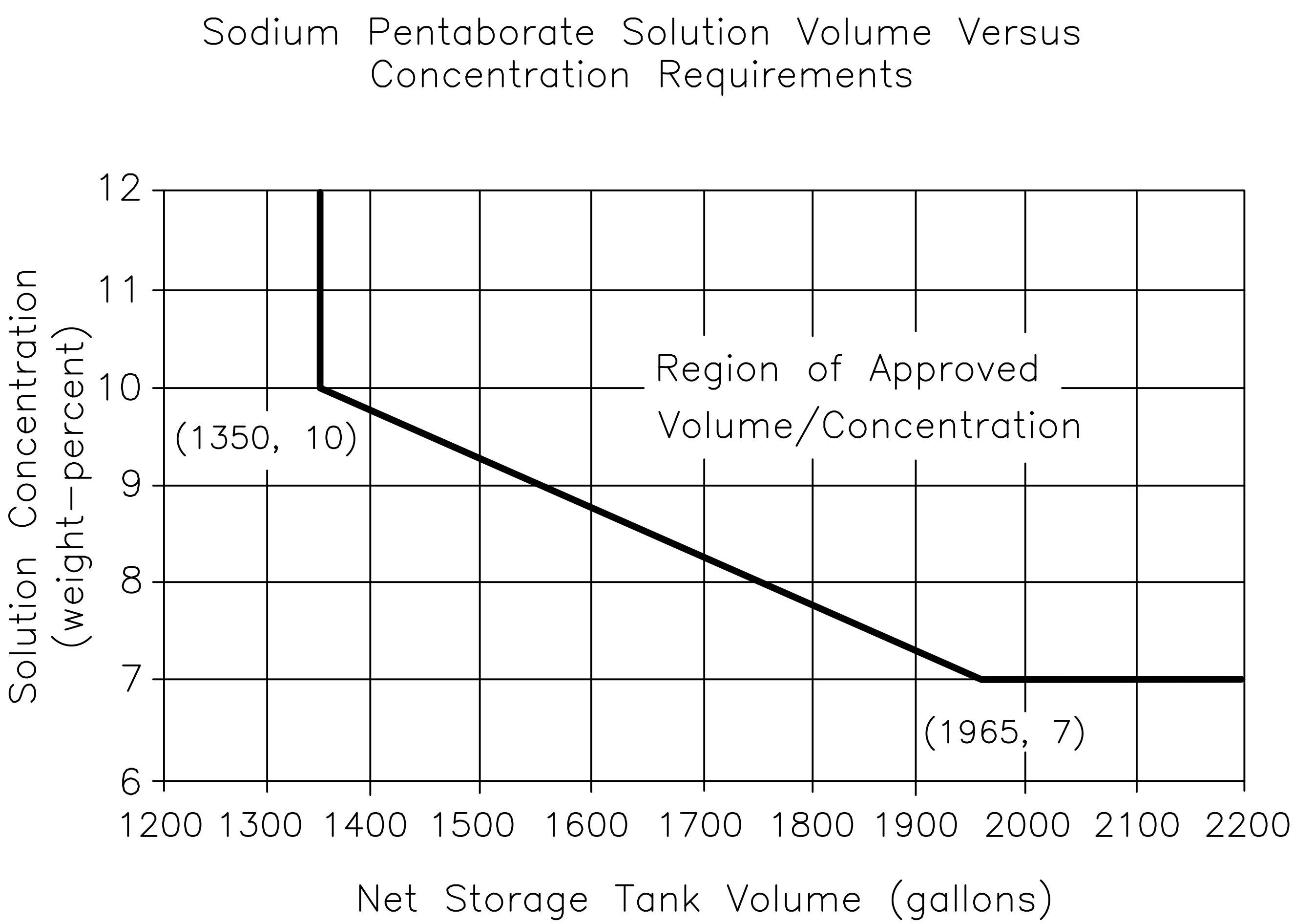
SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-12A REPLACED BY DWG. M-160, SH. 2

FIGURE 9.3-12A, Rev. 55

AutoCAD Figure 9_3_12A.doc



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SUSQUEHANNA STEAM ELECTRIC STATION
UNIT 2
FINAL SAFETY ANALYSIS REPORT

SODIUM PENTABORATE
(Na_2O $5B_2O_3$ $10H_2O$)
VOLUME-CONCENTRATION
REQUIREMENTS

FIGURE 9.3-14A, Rev 1

AutoCAD: Figure Fsar 9_3_14A.dwg
Ref. Tech. Spec. Figure 3.1.7-1

FIGURE 9.3-3-4 REPLACED BY DWG. M-2125, SH. 16

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SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.3-3-4 REPLACED BY DWG. M-2125, SH. 16

FIGURE 9.3-3-4, Rev. 2

AutoCAD Figure 9_3_3_4.doc

FIGURE 9.3-5-1 REPLACED BY DWG. M-126, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.3-5-1 REPLACED BY DWG. M-126, SH. 1

FIGURE 9.3-5-1, Rev. 55

AutoCAD Figure 9_3_5_1.doc

FIGURE 9.3-5-2 REPLACED BY DWG. M-126, SH. 2

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FIGURE 9.3-5-2 REPLACED BY DWG. M-126, SH. 2

FIGURE 9.3-5-2, Rev. 55

AutoCAD Figure 9_3_5_2.doc

FIGURE 9.3-6-1 REPLACED BY DWG. M-123, SH. 1

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FIGURE 9.3-6-1 REPLACED BY DWG. M-123, SH. 1

FIGURE 9.3-6-1, Rev. 55

AutoCAD Figure 9_3_6_1.doc

FIGURE 9.3-6-2 REPLACED BY DWG. M-123, SH. 2

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FIGURE 9.3-6-2 REPLACED BY DWG. M-123, SH. 2

FIGURE 9.3-6-2, Rev. 55

AutoCAD Figure 9_3_6_2.doc

FIGURE 9.3-6-3 REPLACED BY DWG. M-123, SH. 3

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FIGURE 9.3-6-3 REPLACED BY DWG. M-123, SH. 3

FIGURE 9.3-6-3, Rev. 55

AutoCAD Figure 9_3_6_3.doc

FIGURE 9.3-6-4 REPLACED BY DWG. M-123, SH. 4

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FIGURE 9.3-6-4 REPLACED BY DWG. M-123, SH. 4

FIGURE 9.3-6-4, Rev. 55

AutoCAD Figure 9_3_6_4.doc

FIGURE 9.3-6-5 REPLACED BY DWG. M-123, SH. 5

FIGURE 9.3-6-5 REPLACED BY DWG. M-123, SH. 5

FIGURE 9.3-6-6 REPLACED BY DWG. M-123, SH. 6

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FIGURE 9.3-6-6 REPLACED BY DWG. M-123, SH. 6

FIGURE 9.3-6-6, Rev. 55

AutoCAD Figure 9_3_6_6.doc

FIGURE 9.3-6-7 REPLACED BY DWG. M-123, SH. 7

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FIGURE 9.3-6-7 REPLACED BY DWG. M-123, SH. 7

FIGURE 9.3-6-7, Rev. 55

AutoCAD Figure 9_3_6_7.doc

FIGURE 9.3-6-8 REPLACED BY DWG. M-123, SH. 8

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FIGURE 9.3-6-8 REPLACED BY DWG. M-123, SH. 8

FIGURE 9.3-6-8, Rev. 57

AutoCAD Figure 9_3_6_8.doc

FIGURE 9.3-6-9 REPLACED BY DWG. M-123, SH. 9

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FIGURE 9.3-6-9 REPLACED BY DWG. M-123, SH. 9

FIGURE 9.3-6-9, Rev. 56

AutoCAD Figure 9_3_6_9.doc

FIGURE 9.3-10-1 REPLACED BY DWG. M-161, SH. 1

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FIGURE 9.3-10-1 REPLACED BY DWG. M-161, SH. 1

FIGURE 9.3-10-1, Rev. 56

AutoCAD Figure 9_3_10-1.doc

FIGURE 9.3-10-2 REPLACED BY DWG. M-161, SH. 2

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FIGURE 9.3-10-2 REPLACED BY DWG. M-161, SH. 2

FIGURE 9.3-10-2, Rev. 57

AutoCAD Figure 9_3_10_2.doc

FIGURE 9.3-10-3 REPLACED BY DWG. M-161, SH. 3

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FIGURE 9.3-10-3 REPLACED BY DWG. M-161, SH. 3

FIGURE 9.3-10-3, Rev. 56

AutoCAD Figure 9_3_10_3.doc

FIGURE 9.3-6-10 REPLACED BY DWG. M-123, SH. 10

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FIGURE 9.3-6-10 REPLACED BY DWG. M-123, SH. 10

FIGURE 9.3-6-10, Rev. 56

AutoCAD Figure 9_3_6_10.doc

FIGURE 9.3-6-11 REPLACED BY DWG. M-123, SH. 11

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FIGURE 9.3-6-11 REPLACED BY DWG. M-123, SH. 11

FIGURE 9.3-6-11, Rev. 55

AutoCAD Figure 9_3_6_11.doc

FIGURE 9.3-6-12 REPLACED BY DWG. M-123, SH. 13

FSAR REV. 65

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FIGURE 9.3-6-12 REPLACED BY DWG. M-123, SH. 13

FIGURE 9.3-6-12, Rev. 55

AutoCAD Figure 9_3_6_12.doc

FIGURE 9.3-6-9A REPLACED BY DWG. M-123, SH. 12

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FIGURE 9.3-6-9A REPLACED BY DWG. M-123, SH. 12

FIGURE 9.3-6-9A, Rev. 56

AutoCAD Figure 9_3_6_9A.doc

9.4 AIR CONDITIONING, HEATING, COOLING AND VENTILATION SYSTEMS

9.4.1 CONTROL ROOM AND CONTROL STRUCTURE HVAC SYSTEMS

The following systems are covered under this subsection.

a) Control Room Floor Cooling System
b) Computer Room Floor Cooling System
c) Control Structure H&V System
d) Control Structure Emergency Outside Air Supply System (CSEOASS) or (CREOASS)
e) SGTS Equipment Room H&V Systems
f) Battery Rooms Exhaust System
g) Smoke Removal System
h) Access Control and Lab Area Supply System
i) Lab Fume Hood Makeup and Exhaust Systems

All HVAC systems in the control structure are common systems which are shared by two power plant units (Unit 1 and Unit 2).

The Control Room and Control Structure HVAC systems have three basic modes of operation:

(1) Normal - In this mode, normal outside air is processed throughout the control structure envelope. During this mode of operation, the control structure is maintained at a positive pressure over the outside air pressure.

(2) Filtration (pressurization) - In this mode, outside air is processed through the CSEOASS or CREOASS system before circulating in the control structure envelope. However, the purpose of the mode is to remove (filter) radioactive material from outside air so that the control structure remains habitable. Again the control structure is maintained at a positive pressure over the outside air pressure.

(3) Recirculation (isolation) - In this mode, the control structure HVAC is isolated from the outside air. All ventilation is recirculated throughout the control structure envelope.

9.4.1.1 Design Basis

9.4.1.1.1 Control Room Floor Cooling System (0V-117)

This system provides ventilation, cooling, and control of environmental conditions in the control room and associated areas on the 729 ft. elevation, and in the Technical Support Center on the 741 ft. elevation of the control structure. The system is designed to accomplish the following objectives during normal plant operation as well as under emergency conditions:

a) Maintain the space temperature at 75°F ±5°F, to control the air movement for personnel comfort and to ensure the operability of control room equipment and instruments under normal and design basis accident conditions.

b) Maintain the space relative humidity at 50 percent ±10 percent for personnel comfort and equipment performance under normal operation.

c) Divert the outside air supply through the control structure emergency outside air filter system when high radiation is detected in the outside air (filtration mode).

d) Maintain a positive pressure above atmosphere to inhibit air leakage into the control structure envelope during normal and filtration modes.

e) Recirculate and clean up room air (recirculation mode).

f) Monitor radiation in the outside air supply.

g) Operate during normal, shutdown, and design basis accident conditions without loss of function.

The control room floor cooling system (0V-117) has a safety related function and is designed to meet the Seismic Category I requirements. The kitchen exhaust fan (excluding the isolation dampers and the ductwork between these dampers and up to the FPD), toilet exhaust fan (excluding the isolation dampers and the ductwork between these dampers and up to the FPD), reheat coils, and the humidification systems are not safety related. The isolation dampers and the ductwork between these dampers and up to the Fire Protection Damper (FPD) for the kitchen exhaust fan and the toilet exhaust fan is safety related and Q listed.

9.4.1.1.2 Computer Room Floor Cooling System (0V-115)

This system provides ventilation, cooling, and control of environmental conditions for the spaces located on control structure elevation 697'-0" which includes the computer room (C-202), lower relay rooms (C-201 and C-203), computer maintenance rooms (C-206), and Uninterruptible Power Supply (UPS) rooms (C-208 and C-209). The cooling system is designed to:

a) Maintain the space temperature at 75°F ±10°F (except the UPS rooms which are 104°F maximum), to control air movement for personnel comfort and to ensure the operability of the computer equipment under normal conditions.

b) Maintain the space relative humidity at 50 percent ±10 percent as required for computer performance under normal operation.

9.4.1.1.3 Control Structure H&V System (0V-103)

This system (refer to Dwg. M-178, Sh. 1 and M-178, Sh. 2) serves all elevations within the control structure envelope, except elevation 729 ft. (control room floor), elevation 741 ft. (Technical Support Center), and elevation 697 ft. (computer room floor).

The system is designed to accomplish the following objectives during normal plant operation as well as under DBA conditions:

a) Maintain temperatures in the various spaces within specified limits.

b) Meet the specified cooling and ventilation requirements to ensure the operability of the equipment and instruments without loss of function.

c) Maintain a positive pressure above atmosphere to inhibit air leakage into the control structure envelope.

d) Divert the outside air supply through the control structure emergency outside air filter system during accident conditions.

9.4.1.1.4 Control Structure Emergency Outside Air Supply System (0V-101)

This system is designed to:

a) Filter radioactivity from the outside air supply.

b) Maintain the specified outside air supply to the control room and control structure envelope during accident conditions.

c) Maintain a positive pressure above atmospheric to inhibit air leakage into the control structure during initiation in the filtration mode.

d) Operate during and after design basis accident and reactor building isolation mode conditions without loss of function.

e) Provide radiation monitoring of outside air supply.

The control structure emergency outside air supply system has safety related functions and is designed to Seismic Category I requirements.

9.4.1.1.5 SGTS Equipment Room H&V Systems

The SGTS equipment room heating system (0V-144) and ventilation system (0V-118) are designed to:

a) Maintain temperatures in the space within a range suitable for equipment performance.

b) Maintain adequate air flow for ventilation.

The SGTS equipment room is located at Elevation 806 ft. All ductwork and equipment has safety related functions and is designed to Seismic Category I requirements.

9.4.1.1.6 Battery Room Exhaust System (0V-116)

The function of the battery room exhaust system is to maintain design temperature and pressure conditions and provide adequate airflow for ventilation.

The battery room exhaust system is designed to ensure that hydrogen concentrations remain within acceptable limits.

9.4.1.1.7 Smoke Removal Exhaust System (0V-104)

The purpose of the smoke removal system is to exhaust smoke and gas after a fire has been extinguished from areas in the control structure between the elevations of 697 ft-0 in. and 771 ft-0 in. including the control room.

The system has no safety related function. However, the isolation dampers in the top of the duct shaft wall (HD07882) and those located in the control room (HD07889 and HD07890) are of Seismic Category I construction. All ductwork is Class A design.

9.4.1.1.8 Access Control and Lab Area Supply System (0V-105)

This system serves the access control and laboratory area at elevation 676 ft-0 in. of the control structure. This area is located outside the control structure envelope boundary. The equipment that serves this area is located in turbine building Unit 1 at elevation 762 ft-0 in. (H&V equipment room). The system has no safety related function and is designed to accomplish the following objectives during normal plant operation:

a) Maintain temperature in the various areas within personnel comfort limits, (75°F ±5°F).

b) Maintain adequate airflow for comfort and ventilation.

c) Maintain space pressure at approximately atmospheric.

9.4.1.1.9 Lab Fume Hood Makeup and Exhaust Systems (OV-106 and OV-114)

These systems have no safety related function. The design basis is to accomplish the following objectives during normal plant operation:

a) Maintain air balance for fume hoods.

b) Filter contaminated air from fume hoods and exhaust it through turbine building Unit 1 exhaust vent to the atmosphere.

The laboratory fume hoods are located in the control structure at elevation 676 ft-0 in., the filter units at elevation 686 ft-0 in., and the exhaust fan at elevation 806 ft-0 in.

The laboratory fume hood makeup air unit is located in the turbine building Unit 1 H&V equipment room at elevation 762 ft-0 in. All the above lab fume hood systems equipment is located outside the control structure boundary.

9.4.1.2 System Description

9.4.1.2.1 Control Room Floor Cooling System (0V-117) and Computer Room Floor Cooling System (0V-115)

The design of control room floor and computer room floor cooling systems (0V-117 and 0V-115 respectively) is similar. One serves the control room and the other serves the computer room.

Both systems are shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, and VC-178, Sh. 2. Design parameters for the control room floor and computer room floor cooling systems are listed in Table 9.4-2.

Each system is served by two 100 percent capacity redundant air handling units (one operating and one on standby). Each unit contains a ventilation filter bank, chilled water cooling coils, a centrifugal fan, and a fan outlet damper. The two units are connected to a common Seismic Category I supply and return duct system that distributes supply air throughout the space and returns room air to the units. The conditioned air is cooled by water cooling coils. The chilled water supply system is described in Subsection 9.2.12. The control room and the computer room air conditioning equipment is located within a Seismic Category I structure. All equipment in each redundant system is powered from an independent Class 1E power source.

The chilled water for the cooling coils in each system is supplied by a Seismic Category I, independent chilled water supply system. The chilled water systems are interlocked with their respective supply air fans in the same division.

When the chiller train starts, the fans on the same division automatically start. Failure of any of these fans is annunciated in the control room and also trips the chilled water system and the fans in that division. The standby chilled water and air systems start automatically.

Redundant temperature switches are provided at the suction side of the fans of both systems. When the suction trip air temperature for the fans is high, the operating fan and its associated chiller train is tripped and the standby chiller train and its associated fans all started simultaneously.

Fan selector switches in the control room panel allow manual selection of systems.

In the event of a fire in the control room, as evaluated in the FPRR 6.2.25, both trains of the computer Room Floor Cooling System could be disabled. The 'A' train can be manually operated from the CSHVAC Alternate Control Panel. This control is isolated from the control room control circuitry.

Each air system is provided with an air temperature controller that regulates the temperature of the return air. The controller will modulate a three-way mixing valve to control chilled water flows through the cooling coils.

For further description of the chilled water system see Subsection 9.2.12.

Each system supplies a minimum quantity of outside air and recirculates conditioned air to maintain space requirements; space humidity will be controlled during normal operations.

The outside air is taken from an outside air intake system that is described in Subsection 9.4.1.2.4. The control room floor and computer room floor cooling systems are supplied with outside air through a branch duct from the outside air intake system. A preset quantity of outside air is provided for these systems. This branch outside air duct is equipped with an electric duct heater. A duct mounted thermostat regulates a controller to modulate the leaving air temperature to a minimum of 50°F. The duct heater unit is Seismic Category I, but the control for the heater is not safety related. During emergency operation, this heater is not required to operate; the outside air will be heated by the emergency outside air system.

A four step humidification system is provided for the control room and computer room. A humidistat mounted in the control room return air duct regulates a step controller to maintain humidity in the control room. The humidification is designed for normal operation only and is not a safety related system.

The humidification system is supported independently except for the steam distributor which is mounted in the duct. In the event of a DBA if the distributor fails, it will not affect the operation of the control room HVAC system.

The rooms C-401, C-402, C-406, C-410, C-412, C-414 and C-416 are equipped with duct mounted heating coils that operate during normal operation only and are not safety related. These reheat coils are controlled by space thermostats set at 75°F. The heating coils are interlocked with the system supply fan.

The control structure envelope is discussed in FSAR 6.4.2.

The operation of the control room HVAC system during the recirculation phase is described in Subsection 9.4.1.2.4.

9.4.1.2.2 Computer Room Floor Cooling System

See Subsection 9.4.1.2.1 for description of Computer Room Floor Cooling System.

9.4.1.2.3 Control Structure H&V Systems (0V-103)

The system is shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, and VC-178, Sh. 1.
Design parameters are listed in Table 9.4-2.

The system consists of two 100 percent capacity redundant air handling units (one operating and one standby). Each unit contains a ventilation filter bank, two electric heating coils, two chilled water cooling coils, a centrifugal fan, and a fan discharge damper. The units are connected to a common Seismic Category I supply and return duct system that distributes supply air throughout the areas served and returns room air to the units. The control structure H&V equipment is located within a Seismic Category I structure. All components in each redundant system are powered from an independent Class 1E power source.

In the event of a fire in the control room, as evaluated in the FPRR 6.2.25, both trains of the Control Structure HVAC system (0V103) could be disabled. The 'A' train can be manually operated from the CSHVAC Alternate Control Panel. This control is isolated from the control room control circuitry.

The control structure H&V systems supplies a fixed quantity of outside air through the outside air duct system and recirculates conditioned air to maintain space requirements. In each space the return air, exhaust air, and exfiltration will be balanced to:

a) Provide supply air to maintain specified temperature conditions in the battery room floor, elevation 771 ft. and furnish ventilation air to the battery room exhaust system (0V-116). For further discussion see Subsection 9.4.1.2.6.

b) Maintain space temperature conditions in the following areas:

Elevation 783 ft. - H&V equipment room (C-700)

Elevation 753 ft. - Upper relay rooms (C-501 and C-502), upper cable spreading rooms (C-500 and C-507), and electrician's office (C-504)

Elevation 714 ft. - Lower cable spreading rooms (C-300 and C-301)

The control structure H&V system is designed to handle the heating and cooling load for the spaces mentioned above.

The chilled water systems that supply the control structure H&V unit cooling coils and their operation are described in Subsection 9.2.12.

In each fan system air temperature controllers, (one heating and one cooling), sense the temperature in the return air. The heating controller regulates the output of the electric heating coil through an SCR (silicon control rectifier). Chilled water flow through the cooling coil is modulated by a three way mixing valve controlled by the cooling controller.

9.4.1.2.4 Control Structure Emergency Outside Air Supply System (0V-101) (CSEOASS) or (CREOASS)

This system consists of two 100 percent redundant Seismic Category I filter trains complete with fans as described in Subsection 6.5.1.2. Each redundant system is powered from an independent Class 1E power source.

The system as shown on Dwgs. M-178, Sh. 1 and VC-178, Sh. 1. Design parameters are listed in Table 9.4-2.

Each filter train is connected to a common Seismic Category I duct system. The outside air intake to the emergency outside air supply system is a Seismic Category I duct that extends outside from the southeast corner of the Unit 2 Reactor Building to the south wall of the Control Structure as shown on Figure 6.4-2. The rest of the emergency outside air supply system is located within a Seismic Category I Structure.

When the emergency outside supply system is in operation the volume of air flowing in the main supply duct is continuously indicated and recorded in the control room. The upstream HEPA filter pressure differential is also continuously recorded in the control room. The loss of airflow will automatically trip and isolate the operating train and start the standby train. Both loss of airflow and high pressure differential across the above filter are alarmed in the control room. Temperature detectors monitor the temperature of the charcoal adsorber. The pre-ignition temperature (set at 190°F) is alarmed in the control room and indicated locally on the unit's heat detection control panel which is located on elevation 806 ft. The ignition temperature (set at 450°F) is also alarmed in the control room and indicated locally. In addition, the ignition temperature signal will automatically trip the train and enable the fire protection water deluge valves.

The temperature differential across the filter train is also monitored. When this temperature differential increases to 30°F it is alarmed in the control room. When it decreases to approximately 5°F this is also alarmed in the control room and also trips the supply fan. The low temperature differential is normally an indication of the failure of the electric heater.

The outside air for the control room floor cooling system (0V-117), computer room floor cooling system (0V-115), control structure H&V system (0V-103), and the SGTS equipment floor ventilation system (OV-118) are taken from a common outside air intake. The outside air intake is missile protected and connected to Seismic Category I design duct systems.

During normal operation, the outside air is drawn through the ducts and distributed to each system as described in above. When high radiation is detected at the outside air intake, this is annunciated in the control room, and the outside air is automatically diverted through the emergency outside air filter system (0V 101). The isolation dampers at the control room relief air duct are closed and all the non-safety related systems are tripped. The smoke removal system control dampers are normally closed.

After control room isolation is initiated, the emergency outside air system (0V 101) can be started up and operated manually to recirculate and clean up space air in the control room. The outside air intake dampers remain closed during this mode of operation.

When reactor building isolation is initiated, as described in Subsection 9.4.2.1, the emergency outside air system will automatically operate in the radiation filtration mode.

9.4.1.2.5 SGTS Equipment Room Heating and Ventilating Systems (0V-144 and 0V-118)

The equipment in both the heating and the ventilating systems is 100 percent redundant. The systems are shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, and VC-178, Sh. 3. Design parameters are listed in Table 9.4-2. Each redundant system is powered from an independent Class 1E power source.

The redundant equipment is connected to common Seismic Category I ductwork systems. There are two redundant heating system units each containing a ventilation filter, an electric heating coil, and a centrifugal fan with a discharge damper. The two redundant ventilation systems each contain a fan and discharge damper. The heating units (0V 144) recirculate room air and the space thermostat controls the heating coil to maintain a minimum room temperature of 40°F.

The 'A' train of the SGTS equipment room ventilating system (0V118) can be manually operated from the CSHVAC Alternate Control Panel. This control is isolated from the control room control circuitry.

The SGTS equipment room is ventilated by outside air that is introduced into the room through the outside air intake duct systems and exhausted by the ventilation system (0V-118) through the SGTS vent duct to atmosphere. The exhaust fan is controlled by a room thermostat so that the temperature is maintained below 100°F.

9.4.1.2.6 The Battery Rooms Exhaust System (0V-116)

The system consists of redundant exhaust fans and redundant isolation dampers. Each redundant system is powered from an independent Class 1E power source.

The system is shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, and VC-178, Sh. 3. Design parameters are listed in Table 9.4-2.

The individual battery rooms are not equipped with independent fans. The system is designed to operate with one fan on standby and one operating. The branch ducts to each battery room are connected into a common duct system.

The 'A' train of the Battery Room Exhaust System (0V116) can be manually operated from the CSHVAC Alternate Control Panel. This control is isolated from the control room control circuitry.

The battery rooms' makeup air is introduced by the control structure H&V system (0V 103). The exhaust fan (0V 0116) system is designed to exhaust air from each battery room and discharge through the SGTS vent duct to the atmosphere.

9.4.1.2.7 Smoke Removal System (0V-104)

The control structure smoke removal system is composed of two 100 percent capacity redundant centrifugal fans, normally open fire dampers, normally closed control dampers, and associated ductwork and control.

The system is shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, and VC-178, Sh. 2. Design parameters are listed in Table 9.4-2.

The hand control switches and associated status indicating lights of the fans and dampers are located in the control room on the fire protection control panel.

Fire dampers are provided for each floor area under supervisory control. The dampers are normally closed. When fire has been detected and suppressed, the smoke removal fan is manually switched on and the redundant fan is put into automatic standby. Smoke from affected floor areas is then purged by manually opening the appropriate fire dampers. If the operating fan fails it is alarmed in the control room and the standby unit automatically starts. Smoke is exhausted to the turbine building exhaust vent.

The smoke removal system will not be operated during accident conditions.

9.4.1.2.8 Access Control and Lab Area Supply System (0V-105)

The system is shown on Dwgs. M-178, Sh. 1, and M-178, Sh. 2, VC-178, Sh. 2 and M-176, Sh. 1. Design parameters are listed in Table 9.4-2.

The access control and laboratory area supply unit contains a ventilation filter bank, an electric heating coil, chilled water cooling coils, and a centrifugal fan.

The system is designed to maintain a temperature of 75°F ±5°F for personnel comfort and provides makeup air during normal operation.

The control switch, located in a local panel, starts the supply fan. The system discharge air temperature controller directly controls the amount of chilled water flowing into the chilled water cooling coils. This temperature controller also controls the output of the electric heating coil through a step controller.

Control structure isolation signals will shut down the supply fan, which will in turn stop all other interlocked systems (see Subsection 9.4.1.5).

There are seven zones in this system; each zone contains an electric reheat coil. A zone thermostat will maintain each zone temperature. Each zone reheat coil is interlocked with the supply fans.

The control switch and associated status indicating lights and instruments are located in a local control panel installed in the turbine building Unit 1, H&V equipment room.

A unit heater in the personnel access corridor entry at elevation 676 ft-0 in. will temper infiltration from the entrance. The unit heater will maintain temperature under the control of a local thermostat.

9.4.1.2.9 Lab Fume Hood Makeup Air System (0V-106), Contaminated Filter Units Exhaust System (0V-114) and Hood Exhaust Filter Systems

These systems are shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, VC-178, Sh. 2 and M-176, Sh. 1. Design parameters are listed in Table 9.4-2.

The laboratory fume hood makeup air system consists of an air handling unit equipped with a ventilation filter bank, an electric heating coil and a centrifugal fan, with the associated ductwork, dampers and controls. The makeup air supply unit supplies auxiliary air type fume hoods that are located in the control structure laboratories at elevation 676 ft-0 in.

The fan control is interlocked with the contaminated filter units exhaust fans. When the fan is in operation the system discharge air temperature controller controls the output of the electric heating coil, to provide tempered makeup air to the fume hood.

9.4.1.2.10 Control Room Toilet (0V-107), Control Room Kitchen (0V-108), Access Control Area Toilet (0V-112), and Access Control Area General (0V-113) Exhaust Fan Systems

These systems are shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, and VC-178, Sh. 2. Design parameters are listed in Table 9.4-2.

The hand control switches of all the fans are located on the local control panel. The operation of these fans is strictly manual and they will operate only if the access control and lab area supply fan (0V 105) is operating. Since the control room may be directly exposed to the outside environment through the control room toilet and kitchen exhaust systems, fail-closed, redundant isolation dampers in series are installed at the intake of the toilet and kitchen exhaust fans.

These isolation dampers are automatically closed by the high outside air radiation signal.

9. 4.1.2.11 Radiation Chemical Laboratory, Sample Room and Decontamination Area Hood Exhaust Filter Systems

These systems are shown on Dwgs. M-178, Sh. 1, M-178, Sh. 2, VC-178, Sh. 4 and M-176, Sh. 1. Design parameters are listed in Table 9.4-2.

Each hood exhaust filter train consists of a pre-filter, HEPA filter, charcoal filter, fire detection system, filter train inlet and outlet dampers, and associated controls and instrumentation.

The inlet and outlet dampers are manually operated through a hand switch located at the hood or on a local control station as in the case of the decontamination area hood exhaust filter system.

Local differential pressure indication is provided across each filter and high differential pressure across the HEPA filter is alarmed at the local control panel.

The fire detection system has four temperature sensors. Two sensors to monitor pre-ignition (set at 190°F) and ignition (set at 450°F) temperatures are embedded in the charcoal filter. Two more identical sensors are located at the air outlet end of the filter train. The pre-ignition and ignition temperatures alarm directly in the control room. At ignition temperature, the inlet and outlet dampers are automatically closed to isolate the whole filter train. A manual deluge system is available for operations use should a fire occur.

Temperature indicators are provided at the local control panel to monitor the temperature of the inlet and outlet air of the filter train. In addition, high temperature differential between the inlet and outlet air of the filter train is alarmed at the local control panel.

9.4.1.3 Safety Evaluation

All safety related control structure and control room systems are designed to maintain functional integrity during a design basis accident. Each system is provided with redundant equipment and controls to maintain uninterrupted room air circulation, cooling and heating for personnel comfort and instrument functioning. All equipment is located within the control structure, a protected Seismic Category I structure. During loss of offsite power, standby power is available from the standby diesel generators for the continued operation of all safety related equipment.

The single failure criteria for active safety related equipment are met by using redundant equipment and controls and automatically switching from one redundant system to the other. Manual control of the 'A' train, isolated from the control room is also provided at the CSHVAC Alternate Control panel. Active equipment such as fans, controls, dampers, pumps, and chillers are redundant. Passive system components such as supply and return ductworks systems are common.

For failure mode and effect analysis see Tables 9.4-16 through 9.4-21 for safety related modes of operation.

All ductwork and supports for the safety related systems meet the Seismic Category I requirements.

The control room HVAC system is designed to maintain environmental conditions within the space as specified for habitability and equipment operation under the normal and abnormal operating conditions. All equipment in the system is designed to Seismic Category I requirements, except the humidification equipment.

A radiation monitoring system is provided in the outside air intake to detect high radiation and initiate measures to ensure that personnel safety and equipment functions are not impaired. In the event of a high radiation condition, the normal outside air supply to the system is diverted through the emergency outside air filter train before being delivered to the control room. Isolation dampers on control room kitchen exhaust and control room toilet exhaust fan systems will be closed. These operations will be annunciated in the control room.

The emergency outside air filter train and the control room shielding envelope are designed to limit the occupational dose level as required by 10CFR50.67.

The introduction of a predetermined quantity of outside air maintains the control structure envelope at a positive pressure with respect to surrounding areas. This positive pressure is maintained during all the plant operating conditions except when the system is in the recirculation mode.

The control room HVAC system can be manually switched to the recirculation mode to cycle room air through the emergency outside air filter train (charcoal adsorber) system.

A smoke removal system is provided with a capability of purging any one of the floor areas under supervisory control.

9.4.1.4 Tests and Inspections

The control room HVAC system and its components were thoroughly tested in a program consisting of the following:

a) Factory and component qualification tests. (see Table 9.4-1)

b) Onsite preoperational testing. (see Chapter 14)

c) Onsite subsequent periodic testing. (see the Technical Specifications)

Written test procedures establish minimum acceptable values for all tests. Test results are recorded as a matter of performance record, thus enabling early detection of faulty performance.

All equipment was factory inspected and tested in accordance with the applicable equipment specifications, codes, and quality assurance requirements. Refer to Table 9.4-1 for details of inspection and testing.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.4.1.5 Instrumentation Requirements

The control switches and the associated status indicating lights of all safety related equipment of the control room and control structure HVAC systems are located in the control room. Control switches and indicating lights of all isolation dampers are located on local control panels. Status indicating lights of all isolation dampers are duplicated in the control room.

Although the control switches of isolation dampers are remote from the control room, the redundant isolation dampers are always in series and are designed to fail safe in the closed position. In addition, the redundant isolation signals of the isolation dampers are wired so that they override their corresponding control switch.

The control switches and status indicating lights of all non-safety related equipment, except the smoke removal system, are located on the equipment, on local panels, or on local control stations. Control switches and indicating lights of the smoke removal system fans and dampers are located on the fire protection panel in the control room.

Control switches and the associated indicating lights for fans 0V103A, 0V115A, 0V116A, and 0V118A are also located on the CSHVAC Alternate Control panel. Operation from this panel provides input to the Bypass Indication System (BIS).

All safety related equipment failures, such as fans failing to establish airflow when required, are alarmed in the control room on one of two separate annunciators (one annunciator for Division I equipment and one for Division II). In addition, the following are alarmed in the control room:

a) High radiation in the outside air.

b) High-high radiation in the outside air (upscale).

c) Outside air radiation detection systems failure.

d) High temperature (pre-ignition) in a charcoal adsorber of the Control Structure Emergency Outside Air Supply Systems (CSEOASS) or (CREOASS).

e) High-high temperature (ignition) in a charcoal adsorber of the CSEOASS or (CREOASS).

f) High pressure differential across an upstream HEPA filter of the CSEOASS or (CREOASS).

g) High temperature differential across a filter train of the CSEOASS or (CREOASS).

h) Normal outside air supply isolation damper failed closed in the absence of control structure isolation signals.

i) Loss of control power to the electronic instruments.

The outside air radiation level is continuously recorded in the control room.

Failure of non-safety related equipment is alarmed on local control panels and is retransmitted to the control room as a trouble alarm.

All safety related equipment with maintained contacts type control switches have automatic input to the bypass indication systems (see Section 7.5) when the switch is in the "OFF" position.

Instruments of the safety related systems are seismically qualified and redundant to meet the single failure criteria. In particular, the emergency outside air supply systems (atmosphere cleanup) are instrumented to comply with the requirements of Regulatory Guide 1.52. Airflow in these systems is indicated, recorded, and alarmed (loss of flow) in the control room. Upstream HEPA filter pressure differentials are recorded and alarmed (high pressure differential) in the control room.

9.4.2 REACTOR BUILDING VENTILATION SYSTEM

The following systems are covered under this subsection:

a) Reactor building HVAC systems for normal operation.

b) Other safety related air cooling systems: 1) Emergency Core Cooling Systems (ECCS) and RCIC pump rooms unit coolers and 2) emergency SWGR room and load center room cooling units (for normal and emergency operation).

The ESF reactor building recirculation system is covered in Subsection 6.5.3, and the standby gas treatment system (SGTS) is described in Subsection 6.5.1.

9.4.2.1 Reactor Building HVAC Systems for Normal Operation

The secondary containment is divided into three isolated ventilation zones. Zones I and II surround respective Units 1 and 2 containments below the floor at elevation 779 ft-1 in. and also include stairwells and elevator machine rooms and shafts above elevation 779 ft-1 in. Zone III includes Units 1 and 2 secondary containments above the floor at elevation 779 ft-1 in. including the refueling floor. (See Dwgs. M-176, Sh. 1 and M-2176, Sh. 1, and M-175, Sh. 1, M-175, Sh. 2. and M-2175, Sh. 1.) Zone III also includes the railroad access shaft and railroad bay (Unit 1 only). The Railroad Access Shaft can be aligned to Secondary Containment Ventilation Zones 1, 3 or a No-Zone, depending on the position of dampers, doors, walls, and hatches. The normal ventilation alignment for the Railroad Access Shaft is a No-Zone.

The H&V equipment rooms in Units 1 and 2 are not part of Secondary Containment Zones I, II, or III. See Dwg. M-175, Sh. 1 for the air flow diagram for the Unit 1 Electrical Equipment Room.

This section discusses Unit 1 secondary containment HVAC systems (Zones I and III of Unit 1). The Unit 2 secondary containment HVAC systems (Zones II and III of Unit 2) are identical to those described for Unit 1 except minor air quantity and distribution elevation 779 ft-1 in. including the refueling floor. (See Dwgs. M-176, Sh. 1 and M-2176, Sh. 1, and M-175, Sh. 1, M-175, Sh. 2. and M-2175, Sh. 1.)

Each of the ventilation zones is provided with independent HVAC systems designed to operate during plant normal operation and during shutdown. Zone III systems will function during normal fuel handling and storage operation. The recirculation system and SGTS will be used after a fuel handling accident.

9.4.2.1.1 Design Basis

The reactor building HVAC system is designed to accomplish the following objectives during stable and transient operating conditions, from start-up to full load to shutdown:

a) Provide filtered outside air.

b) Maintain air flow from areas of lesser to areas of greater potential contamination.

c) The building will not exceed the maximum temperature values shown for the various rooms under “Normal operating condition Environment” on Dwgs. C-1815, Sh. 4, C-1815, Sh. 5, C-1815, Sh. 6, C-1815, Sh. 7, C-1815, Sh. 8, C-1815, Sh. 9, C-1815, Sh. 10, C-1815, Sh. 11, C-1815, Sh. 12.

d) The minimum temperature of the reactor building rooms will be the values shown under “Normal operating condition Environment” on Dwgs. C-1815, Sh. 4, C-1815, Sh. 5, C-1815, Sh. 6, C-1815, Sh. 7, C-1815, Sh. 8, C-1815, Sh. 9, C-1815, Sh. 10, C-1815, Sh. 11, C-1815, Sh. 12.

e) Maintain the secondary containment at a minimum negative pressure of 0.25 in. wg.

f) Supply ventilation or purge air to the primary containment.

g) Provide ventilation, cooling, and heating to the ECCS pump rooms during normal plant operation. For safety related cooling see Subsection 9.4.2.2.

h) Filter air exhausted from areas of greater potential contamination (equipment rooms-all zones).

i) Monitor radiation in the unfiltered air from the Zone III exhaust system (V 213), and isolate the Zone III portion of the secondary containment on a high radiation signal.

j) Provide for radiation sampling in the reactor building exhaust vent.

k) Provide for a transit time of exhaust air from the radiation monitors to the isolation dampers of Zone III unfiltered exhaust system, greater than the damper closing time plus the radiation monitor response time.

l) Isolate appropriate ventilation zone or zones and start the recirculation system upon receipt of the secondary containment isolation signal.

m) Isolate supply and exhaust ducts of rooms containing high energy pipelines after a pipe break. (Note: The closure function is not credited in the FSAR Appendix 3.6A high energy line break analysis.)

The portion of the reactor building ventilation system that is associated with the recirculation system is safety related and an engineered safety feature. The remaining portion of the ductwork within the secondary containment boundary is not safety related; however, it is seismically designed and analyzed to ensure that it will not damage the safety related equipment and systems. Safety classifications are shown on the airflow diagrams, Dwgs. M-176, Sh. 1, M-2176, Sh. 1, M-175, Sh. 1, M-175, Sh. 2, and M-2175, Sh. 1.

Monitoring of radiation levels in the spent fuel pool is discussed in Subsection 12.3.4.

9.4.2.1.2 System Description

The air flow diagrams for the reactor building are shown on Dwgs. M-176, Sh. 1, M-2176, Sh. 1, M-175, Sh. 1, M-175, Sh. 2, and M-2175, Sh. 1. System design parameters are listed in Table 9.4-3. Cooling water is supplied to the air cooling coils in the HVAC systems by the reactor building chilled water system described in Subsection 9.2.12. The controls and instrumentation associated with each system are an integral part of that system. The instruments and controls are shown on Dwgs. VC-176, Sh. 1, VC-2176, Sh. 1, VC-175, Sh. 1, VC-175, Sh. 2, and VC-175, Sh. 3.

All the equipment of the Unit 1 air handling systems is located in two H&V equipment rooms (El. 779 ft-1 in. and 799 ft-1 in. east of the spent fuel pool). The two rooms are outside the secondary containment boundary. Unit 1 and Unit 2 air handling systems are identical, with Zone I systems handling Unit 1 and Zone II systems handling Unit 2. Access to any zone (except railroad access shaft) from outdoors, to H&V equipment rooms, or access between the zones (except railroad access shaft) is through air locks with airtight doors on both sides.

Zone I Supply Unit System (V-202) and Zone III Supply Unit System (V-212)

Each system supplies the respective zone with conditioned 100 percent outdoor air.

Each supply system consists of two 100% capacity redundant fans (one normally operating and one in standby), outside air intake louvers, six radiant heaters, a filter bank, an electric heating coil bank, and a chilled water cooling bank. The system layout includes two disc type isolation dampers in series, distribution ductwork with associated dampers, and supply air outlets.

Zone I Equipment Compartment Exhaust System(V-206) and
Zone III Filtered Exhaust System (V-217)

Each system exhausts air from the respective zone equipment compartments and from rooms with the higher potential for radioactive contamination.

Each exhaust system consists of two 100% capacity redundant fans and two 55% capacity filter trains connected to a common exhaust and discharge duct. Each filter train contains prefilters, upstream HEPA filters, charcoal absorber (6 in. deep vertical bed), and downstream HEPA filters. The system layout also includes two disc type isolation dampers in series.

Zone I Exhaust System (V-205) and Zone III Exhaust System (V-213)

Each system exhausts air from the respective zone areas of lesser radioactive contamination potential. Each system includes, in the direction of air flow: distribution ductwork with exhaust registers and dampers; two disc type, isolation dampers in-series; two 100 percent capacity fans; discharge ductwork connecting to the reactor building exhaust vent, and associated controls.

Recirculation System (V-201) (See Subsection 6.5.3.2.)

During normal plant operation the reactor building ventilation systems maintain the design temperature and pressure in the respective zones of the secondary containments of Units 1 and 2. The supply air systems (V-202 and V-212) supply the respective zone with constant air volume. Fan discharge dampers of the exhaust systems V-205 and V-213 are modulated by appropriate pressure differential controllers to maintain a negative pressure of approximately 0.25 in. wg in the secondary containment. The air flow of exhaust systems V-206 and V-217 are controlled by their pressure differential controllers to maintain the air flow from areas of lesser to areas of greater potential contamination.

The Zone I and Zone II supply systems are provided with two air temperature controllers that control the temperature of the air leaving the supply fans. A step type controller is used to regulate the electric heating coils, and the cooling controller regulates a three-way mixing valve in the chilled water system supply to the cooling coils. The Zone III temperature is controlled by monitoring of the air leaving the exhaust fans. Note that a room thermostat controls the two-way modulating chilled water control valve for the CRD repair room cooling coil.

All panel mounted instruments and controls, including fan manual switches, are installed on local control panels. A group alarm from each panel is annunciated in the control room. In addition a "no ventilation" alarm for each zone is annunciated in the control room.

The chilled water cooling coils are drained and isolated during the winter months to prevent the coils from freezing. During the fall and spring seasons when the cooling coils are still functional, the coils are protected from freezing by low temperature switches mounted on the face of each coil. (See Subsection 9.2.12.)

Radiant heaters are provided in the intake plenum to automatically melt drifted-in snow to prevent the filter from blockage. Manual operation of the heaters is also possible by means of a hand switch on the local panel.

Two back draft isolation dampers (BDID) in-series, are provided on supply and exhaust ducts of selected rooms (see Dwg. M-176, Sh. 1) housing ECCS pumps or containing high energy piping. Each BDID is provided with a pressure differential switch that trips the release mechanism to close the damper on sensing high pressure inside the room. (Note: The closure function is not credited in the FSAR Appendix 3.6A high energy line break analysis.)

The trip circuits are connected to uninterruptible DC power supply.

Only one fan of each system is running during plant normal operation. On loss of air flow from the running fan, its associated discharge damper closes and the standby fan starts automatically. Failure of both fans on any one system to establish air flow will result in an automatic shutdown of the remaining ventilation systems in that zone. The loss of the zone ventilation is alarmed in the control room.

Redundant radiation monitors are provided on three branch ducts of V-213 (Zone III exhaust system). A high radiation signal from any monitor will automatically isolate Zone III as described in Subsection 9.4.2.1.3. Exhaust air transit time between the monitors and the V-213 system isolation dampers is greater than the combined time of damper closure and the monitor response.

The systems' intake louvers and exhaust vents are not safety related and are outside the secondary containment; therefore, no provisions for missile protection are made for these components.

During purge mode, the primary containment is purged at a rate of 10,500 cfm. This amount of air is diverted to the primary containment from the Zone I supply system. From there the air is filtered through the SGTS and exhausted to the environment.

The reactor building exhaust vent is provided with a radiation sampler. High radiation level in the exhaust air is alarmed in the control room.

9.4.2.1.3 Safety Evaluation

The Reactor Building Ventilation system is housed within the Seismic Category I reactor building. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

The secondary containment isolation is the only active safety related function of the normal operation of the reactor building HVAC system. The system passive safety related function is the use of related ductwork in the reactor building recirculation mode which is discussed in Subsection 6.5.3.

The isolation dampers which are used for secondary containment isolation are redundant (two in series), fail closed, disc type dampers, operated by spring loaded air cylinders. If an active failure disables one of the two dampers, the other one is able to perform the isolation function. For the duct to Airlock I/II-707, two isolation dampers were not installed for secondary containment isolation. Therefore, damper HD1(2)7534C has been closed and deactivated and a blank has been installed in the airlock to replace the exhaust register.

All hand control switches and indicating lights for safety related isolation dampers are located in the control room. The reactor building ventilation system is started manually from the local control panel. The primary containment purge supply air damper is manually operated from the control room.

The appropriate ventilation zones of the secondary containment are automatically isolated and the recirculation system is actuated upon receipt of one of the following signals:

SIGNAL	ISOLATES ZONE(S)
High radiation in the refueling floor exhaust ducts	III
High radiation in the railroad access shaft exhaust duct (Unit 1 only)	III
High pressure in the drywell	I* & III
Low reactor water level	I* & III
A manual signal from the control room	III or I* & III
* **Or Zone II if the signal is from the Unit 2 drywell or reactor.**	

Any of the above isolation signals will result in the following automatic sequence for the affected zone or zones:

a) Trip all running ventilation fans and prevent standby units from operating

b) Close normally open isolation dampers (two in-series separating safety-related from non-safety-related portions of each system)

c) Open normally closed recirculation dampers (two, in parallel), on each duct connecting the recirculation system fans into the ventilation system ductwork to be used in the recirculation mode of operation

d) Start the recirculation system (Subsection 6.5.3)

e) Start the SGTS (Subsection 6.5.1)

During the plant normal or emergency operation the following events will result in the secondary containment not being maintained at a pressure below atmospheric:

a) Loss of offsite power (emergency operation). This will also result in false LOCA signal on Unit 1 and II.

b) A normally opened isolation damper on any of the supply or exhaust systems failing in a closed position results in a system trip.

c) Loss of the reactor building ventilation due to failure, malfunction of system components.

Loss of reactor building ventilation will be alarmed in the control room, and the isolation of the affected ventilation zone(s) of the secondary containment may be initiated manually. As a result, the preferred air flow from areas of lesser to areas of higher potential contamination may not be maintained; however, the affected secondary containment will be maintained at a negative pressure of approximately 0.25 in. wg.

Each ventilation system is provided with two 100 percent capacity fans. When failure of a running fan or its discharge damper is detected by a flow switch, the respective standby fan will automatically start. On failure of a fan or its discharge damper, the preferred air flow pattern will not be affected.

The failure of a BDID in a closed position will result in a loss of ventilation for the equipment room affected and trouble alarm on a local HVAC panel. Each trouble alarm will be sounded in the control room as the panel group alarm. Indicating lights on the local panel will identify the failed damper, which can be manually reset to the open position.

Refer to Subsection 9.4.2.1.5 for a list of abnormal conditions which are alarmed on the local HVAC control panels.

The operational degradation of ventilation system components can be detected by direct equipment status indication (indicating lights for damper position, fan running status) or can be concluded based on abnormal temperature, differential pressure, alarms, and indication.

Corrective action can then be taken.

9.4.2.1.4 Tests and Inspections

All tests and inspections described in Table 9.4-1 apply to the reactor building HVAC systems, which are used during normal operation.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.4.2.1.5 Instrumentation Requirements

Hand switches and status indicating lights are provided in the control room for each isolation damper (except for the air locks isolation dampers). Hand switches and status indicating lights for the balance of the air handling systems, and for the air locks isolation dampers (except HD1(2)7534C, which has no hand switch or indicating lights) are located on local HVAC control panels.

The following alarms are annunciated in the control room:

a) Fan trouble, each safety-related fan

b) High radiation in Zone III exhaust ducts, and the downscale signal from radiation monitors

c) Reactor Building vent effluent radiation monitoring system alarms listed in Section 11.5.2.1.1

d) High flow in ducts interconnecting Zone I and zone II ventilation systems with the recirculation system fans. This is to detect recirculation dampers which fail open in the ventilation zone which is not being recirculated

e) Loss of ventilation in any of the three ventilation zones (Zone I, II or III)

f) Group alarm on closure of any of the backdraft isolation dampers

g) Group alarm from each HVAC local control panel

h) Manually induced inoperability of the safety-related systems is alarmed and continuously indicated in the control room on bypass indication system as required by Reg. Guide 1.47 and identified in FSAR Section 7.5.1b.7. Note that the ECCS and RCIC Pump Room Unit Coolers are not included in BIS.

i) Pre-ignition and ignition temperatures of charcoal absorbers.

In addition, the following conditions are alarmed on the local HVAC control panels and transmitted to the control room as a group alarm:

a) Fan failure, each non safety-related fan

b) High pressure drop across filters

c) High or low pressure in the zone or one of the potentially contaminated areas

d) Low air temperature entering cooling coils handling outside air (freeze protection)

e) High pressure differential across the upstream HEPA filter bank of each filter train

f) Pre-ignition and ignition charcoal absorber temperatures

g) High temperature differential across charcoal absorber bed

All instruments and controls performing safety related functions are qualified to the Seismic Category I requirements. Requirements concerning redundancy and separation of instrumentation and controls for this equipment is detailed in Section 7.0.

9.4.2.2 Other Safety-Related Air Cooling Systems

The following equipment and systems are covered under this heading:

1) Unit 1 and Unit 2 RHR, HPCI, RCIC, and core spray pump rooms unit coolers.

2) Unit 1 and Unit 2 Emergency SWGR cooling units with associated ductwork.

3) Unit 2 Emergency SWGR refrigeration system.

9.4.2.2.1 Design Basis

The above cooling systems are designed to:

a) After a DBA, maintain temperature in the ECCS and RCIC pump rooms below the maximum values shown on Dwgs. C-1815, Sh. 5 and C-1815, Sh. 6.

b) Maintain emergency SWGR and motor control center room temperature below the maximum values shown on Dwgs. C-1815, Sh. 8 and C-1815, Sh. 9.

The coolers, refrigeration units, associated ductwork, refrigeration piping and supporting structures are safety-related and are Seismic Category I.

9.4.2.2.2 System Description

General

The safety related air cooling systems are shown on the reactor building air flow diagrams for Zone I and Zone II (Dwgs. M-176, Sh. 1 and M-2176, Sh. 1, respectively). These rooms primarily use the RBHVAC system for cooling during normal operation. However, in an emergency, the individual room coolers are used to dissipate any generated heat load. The system design parameters are displayed in Table 9.4-4a. The emergency switchgear and load center room cooling units contain two different cooling coils. One of the coils is supplied with reactor building chilled water during normal operation, and the other is supplied with control structure chilled water on Unit 1 and a direct expansion type refrigerant cooling coil on Unit 2 during DBA conditions. The RHR, HPCI, RCIC, and Core Spray room coolers are supplied by the emergency service water system. The instrumentation and controls for each system are shown on Dwgs. VC-176, Sh. 1 and VC-2176, Sh. 1.

Safety-Related Pump Room Unit Coolers

Each safety-related pump room unit cooler recirculates and cools the respective room air, and is capable of carrying the following cooling loads:

a) RHR and core spray pump rooms are provided with a unit cooler for each pump installed, thus two coolers in each room. Each cooler is sized for 100% cooling of the heat load generated when the respective pump is running.

b) RCIC and HPCI pump room coolers - the total room cooling load.

Each unit cooler consists of a cabinet with a cleanable emergency service water cooling coil, a direct drive vane-axial fan mounted outside of the cabinet, and except for RHR pump room coolers, a sheet metal transition section with a supply air register. The unit coolers are mounted adjacent to the pumps they serve, and they start automatically when the pump starts. Each cooler is also provided with a hand switch in the control room for manual operation. During plant normal operation, the reactor building ventilation system is used to maintain the design conditions in the ECCS and RCIC pump rooms (see Subsection 9.4.2.1).

Each pair of RCIC and HPCI room coolers is provided with additional hand selector switches in the control room for selection of the lead and standby units. In addition each cooler is provided with a temperature switch to transfer to the standby unit on detection of high air temperature at the discharge of the running unit and to annunciate this condition in the control room.

An additional temperature switch is provided in both the RCIC pump room and the RHR pump room to detect high room temperature resulting from fan control failure due to a fire in the control room. Detection of high temperature results in the automatic start of the "B" fan in the RCIC pump room and the "B" fan in the RHR pump room ("A" fan for the Unit 2 RHR pump room) while simultaneously isolating the control room controls from the fan starter circuits. This occurrence also results in "fan trouble" annunciation in the control room. A low temperature setpoint is also provided to stop the fans after adequate cooling has occurred.

Emergency SWGR and Load Center Room Cooling Units

Two 100 percent capacity cooling units are provided for the emergency SWGR and load center rooms. Each unit consists of a cabinet with the following components, in the direction of the air flow: prefilters, emergency cooling coil (Control Structure Chilled Water (Unit 1), Direct Expansion (Unit 2)), a Reactor Building chilled water cooling coil, and a belt driven centrifugal fan. The air discharge of each unit is connected to a common supply air duct.

Air enters the unit inlet directly from the surrounding area in one division and from a different elevation in the other division to avoid common mode failure concerns. Duct penetrations for the supply air, and the transfer grilles for the return air to and from each room, are redundant and parallel, and are furnished with fire protection dampers. During normal operation Reactor Building chilled water flow through the coil is modulated by a three-way mixing valve controlled by the discharge air temperature controller. In addition, to eliminate a single failure mode the Control Structure Chilled Water Supply and return valves to the coil are in the open position and the bypass valve is closed allowing chilled water to be available for normal and emergency operation. The thermal overloads for these valves have been removed.

After a DBA Reactor Building chilled water is not available, and the Control Structure chilled water cooling coils are used for the Unit 1 cooling units. Control Structure chilled water flow through the coils is unrestricted with no supply air temperature or water flow control. After a DBA the Reactor Building chilled water is not available for the Unit 2 cooling units, and the direct expansion cooling coils are used. The refrigerant flow passing through the direct expansion coils depends upon the temperature of the air and is modulated by the thermoexpansion valves.

Heat from both the Control Structure chilled water and direct expansion cooling coils is ultimately transferred to the ESW system.

Only one cooling unit is running during plant normal or emergency operation. When loss of air flow or high discharge air temperature from the running unit is detected that unit's discharge damper closes and the fan is tripped. The standby unit starts automatically. Both the high temperature and the running unit trip are alarmed in the control room.

Each unit is provided with a three position (auto, start, stop) hand switch in the control room, a flow switch and a temperature switch both mounted on a common supply air duct.

Unit 1

In order to provide for an automatic response to high room temperatures in the Emergency Switchgear and Load Center Rooms, a separate room temperature switch has been installed. Once a high room temperature is sensed, providing that the respective Division control structure chilled water circulation pump is running, the switch will isolate control circuits from the Control Room and initiate an autostart of the “A” (Div. I) or “B” (Div. II) Emergency switchgear and Load Center room coolers using the aforementioned control structure chilled water coil. Once the temperature is reduced below the existing cutout setpoint, the switch will then turn the coolers off. This design provides for room cooling in the event of a Control Room fire in which the existing control room circuits are disabled. Any actuation of this feature is annunciated in the Control Room.

Unit 2

Similar to Unit 1 but taking into account the differences in the supply to the emergency cooling coil, a separate temperature switch was installed to isolate the control circuits of the Emergency Switchgear Room Cooling equipment from the Control Room. This temperature switch performs the same function of starting and stopping the room cooler based on existing room temperature. Interlocks are provided in the fan control circuit to prevent it from starting until the compressor is running. This occurrence also results in the “Fan Trouble” and “Emergency Switchgear Room Cooling System Trouble” alarm in the Control Room.

9.4.2.2.3 Safety Evaluation

For failure mode and effect analysis see Table 9.4-5, for safety-related modes of operation.

All units, ductwork and supports, and other systems components, except for discharge air temperature pneumatic control loop, meet Seismic Category I requirements and single failure criteria.

9.4.2.2.4 Tests and Inspections

With the exception of items (4) and (7) through (9) all tests and inspections described in Table 9.4-1 apply to the coolers and associated ductwork system.

The system was preoperationally tested in accordance with the requirements of Chapter 14.

9.4.2.2.5 Instrumentation Requirements

The following systems and/or equipment are provided with hand switches and status indicating lights in the control room:

Each ECCS pump room unit cooler
Each switchgear cooling unit
The Unit 2 switchgear refrigeration units

The following alarms are annunciated in the control room:

Fan trouble, each safety related fan
High supply air temperature for the emergency switchgear rooms
Group alarm from each HVAC local control panel
Trouble of Unit 2 switchgear refrigeration systems (Local Alarm as well)

All instruments and controls performing safety related functions are qualified to Seismic Category I requirements. Requirements concerning redundancy and separation of instrumentation and controls for this equipment is detailed in Section 7.0.

9.4.3 RADWASTE BUILDING VENTILATION SYSTEM

9.4.3.1 Design Bases

The Radwaste Building HVAC systems have no safety-related functions.

The Radwaste Building Heating, Ventilating, and Air Conditioning (HVAC) systems are designed to operate during normal operations and accomplish the following objectives:

a) Provide a supply of filtered and tempered outside air to all areas of the building

b) Maintain airflow from areas of lesser to areas of greater potential contamination

c) Maintain the building spaces below the following maximum temperatures:

General Areas	100°F
Equipment Rooms	104°F
Tank Rooms	120°F

d) Maintain the building minimum temperature of 40°F

e) Maintain the building at a slightly negative pressure to minimize exfiltration to the outside atmosphere

f) Filter through charcoal and particulate filters all air exhausted from:

- Liquid Radwaste Processing

    1. Liquid radwaste sample tanks
    2. Liquid radwaste filter
    3. Spent resin tank
    4. Liquid radwaste collection tanks
    5. Radwaste building sump and pumps
    6. Radwaste mist eliminator
    7. Radwaste bldg. chemical radwaste sump & pumps

- Solid Radwaste Collection

    1. Waste mixing tank
    2. Waste sludge phase separator
    3. Reactor water clean-up phase separator

- Liquid Radwaste Chemical Processing

    1. Chemical waste tank
    2. Radwaste evaporator and condenser
    3. Evaporator distillate sample tank
    4. Radwaste evaporator concentrate storage tank

- Liquid Radwaste Laundry Processing

    1. Laundry drain tanks
    2. Laundry drain sample tanks

g) Discharge all air exhausted from the Radwaste Building areas through pre-filters and particulate filters to the turbine building exhaust vent.

h) Discharge gas from the Primary Coolant Degasifier to the turbine building exhaust vent.

9.4.3.2 System Description

The airflow diagrams for the radwaste building are shown on Dwgs. M-179, Sh. 1 and M-179, Sh. 2. Systems design parameters are listed in Table 9.4-6. Cooling water is supplied to the air cooling coils of the HVAC supply unit by the radwaste building chilled water system described in Subsection 9.2.12. The instrumentation and controls, shown on Dwg. VC-179, Sh. 1, are considered an integral part of their systems.

The Radwaste Building HVAC supply and exhaust units are located in the equipment rooms on elevation 691 ft. 6 in. The tank vent filter system fan and filters are located in the filter room on elevation 646 ft. 0 in.

The supply system contains two 100 percent capacity fans, a housing containing one bank of particulate filters, a bank of electric heating coils, and a chilled water cooling coil. Filtered and tempered air is distributed throughout the building in quantities designed to maintain required temperatures and airflow toward areas of higher potential contamination. The building exhaust system contains two 100 percent capacity fans and two 50 percent capacity filter housings, each with a bank of high efficiency particulate filters (HEPA) and a bank of prefilters upstream. This exhaust system is balanced to maintain the flow of air within the building as described.

In addition to the Building Supply System, a Recirculation System supplies cooling air to the off-gas area. The Recirculation System includes a unit cooler which is interlocked with the Building Exhaust System.

The tank vent filter system provides a means of filtering and venting air from tanks and equipment housed in the radwaste building. A single fan and filter train are employed for this purpose. An electric duct heater upstream of the filter is used to lower the humidity of the air, as necessary, to ensure proper filter operation. The filters, in the direction of air flow are prefilter, HEPA, and charcoal. Since the flow of air from tanks and equipment varies, space air is admitted as required to maintain system volume.

The exhaust systems use the same duct to transport the filtered air to the turbine building exhaust vent. Also, the controlled shop exhaust in the Services and Administration Building is routed through the radwaste building to the turbine building exhaust vent where it is discharged.

The building exhaust system and the supply system are interlocked so that complete failure of either system will shut down the entire building ventilation system. This condition is a "total loss of radwaste building ventilation" and is alarmed directly in the control room.

Radiant heaters are provided in the outside air intake duct plenum of the supply system to melt drift-in snow to protect the filter. Manual operation of the heaters is provided by a hand switch on the local panel.

The control switch of each of the fans in the building exhaust system is on a local control panel. The two exhaust fans are interlocked so that failure of the operating fan will automatically start the standby unit, isolate the failed unit, and alarm in the local control panel. This system is manually started.

The variable inlet vanes of each exhaust fan enable the system to vary exhaust airflow to maintain the building at a slightly negative pressure. Each of the two filter trains is manually set up for operation by opening the train's inlet and outlet dampers through the control switch on the local control panel.

The Radwaste Building Supply (and Exhaust) System air handling unit consists of two fans. During normal operation one fan runs and the other is on automatic standby. In the event the operating fan fails, local alarm is energized and the standby fan starts automatically.

When the supply system is operating, the system discharge air temperature controller directly controls the amount of chilled water entering the systems cooling coils. This temperature controller also controls the output of the banks of electric heaters.

When the handswitch for the tank vent filter system is in manual start, then it operates in conjunction with the Radwaste Building exhaust and supply systems. The control switch of this system's fan is on the local control panel and fan failure is alarmed on the same panel. High temperature and high-high temperature in the charcoal adsorber are alarmed directly in the control room. The tank vent filter system filter train high differential temperature is alarmed on the local panel.

When the charcoal adsorber approaches ignition temperature, the high-high temperature switch trips the fan.

The electric heater in the duct upstream of the filter train operates only if the filter train exhaust fan is running. The electric heater is used to limit the humidity of the air entering the charcoal filter.

9.4.3.3 Safety Evaluation

The failure of the radwaste building HVAC systems or their components will not compromise any safety-related system or prevent a safe shutdown of the plant.

The charcoal filters contain fire detection instruments which annunciate high and high-high charcoal temperature on the HVAC panel in the control room. The exhaust air is checked for radiation by the radiation monitors in the turbine building exhaust vent.

9.4.3.4 Tests and Inspection

The system was preoperationally tested in accordance with the requirements of Chapter 14. Maintaining normal conditions verifies that the system is performing properly during operation. The filter and ductwork in-service tests and inspections are described in Table 9.4-1 items 12 and 13.

9.4.3.5 Instrumentation Requirements

All hand control switches of the radwaste building HVAC systems are on the local control panels in the radwaste building. Local alarms exist at these panels, which also have annunciators that transmit a trouble alarm to the control room if any abnormal condition exists in the radwaste building HVAC systems.

The following abnormal conditions are alarmed at local panels:

a) All fan failures

b) High or low indoor/outdoor pressure differential

c) High pressure differential across the filter of the supply system

d) High temperature differential across the tank exhaust system filter train

e) High pressure differential across the HEPA filter of the tank exhaust system

f) Phase B overcurrent on the exhaust fan motors feeder breakers

g) Supply system electric heater trouble

h) High pressure differential across the HEPA filters of the exhaust system

i) High temperature in the Off-gas Area Cooling System.

The following are alarmed directly in the control room:

a) Loss of ventilation in the radwaste building that is low flow of exhaust air

b) High and high-high temperatures in the tank exhaust system charcoal adsorber

A pressure differential controller, with pressure sensors inside and outside the building, modulates the variable inlet vanes of the exhaust fans to maintain the building at a slightly negative pressure. A pressure differential indicator is also provided on the local control panel.

Pressure differential indicators are also provided locally at all the filters including the tank vent filter system charcoal adsorber.

A temperature sensor is provided at the supply system outside air intake plenum which automatically operates the radwaste building chilled water systems (see Subsection 9.2.12).

9.4.4 TURBINE BUILDING VENTILATION SYSTEM

9.4.4.1 Design Basis

The turbine building heating, ventilating, and air conditioning (HVAC) systems have no safety-related functions.

The turbine building HVAC systems are designed to operate during normal operation and accomplish the following objectives:

a) Provide a supply of filtered and tempered air to most areas of the building

b) Maintain airflow from areas of lesser to areas of greater potential contamination

c) Maintain building spaces below the following maximum temperatures:

General Areas	104°F
Electrical Rooms	104°F
Mechanical Areas	120°F

d) Maintain the building minimum temperature of 40°F

e) Maintain the Turbine Building except the generator bay area, at a slightly negative pressure to minimize exfiltration to the outside atmosphere

f) Recirculate and cool space air to reduce exhaust volume

g) Exhaust air from potentially contaminated spaces through particulate and charcoal filters

h) Discharge all exhaust air through the turbine building exhaust vent

i) Provide cooling air to the motor generator sets

9.4.4.2 System Descriptions

The airflow diagram for the turbine building HVAC systems is shown on Dwgs. M-174, Sh. 1 and M-174, Sh. 2. System design parameters are listed in Table 9.4-7. Cooling water is supplied to the HVAC cooling coils by the turbine building chilled water system described in Subsection 9.2.12. The instruments and controls shown on Dwg. VC-174, Sh. 1, should be considered an integral part of the system. The turbine building supply unit and associated return fans are located in the H&V equipment room at elevation 762 ft. 0 in. This room also contains the recirculation unit, the filtered exhaust unit, and the MG set cooling unit. The condenser area unit coolers are installed in the condenser area at elevation 676 ft. 0 in. The condensate pump room unit coolers are located in the condensate pump room at elevation 656 ft. 0 in. The Tool Room Facility exhaust fans are located in the tool room mezzanine adjacent to the southeast corner of the U2 turbine building.

The systems described are for the Unit 1 turbine building. Unit 2 systems are similar except for the Battery Room Exhaust Fan manual operation.

Supply System (V101)

The supply system unit housing contains two 100 percent capacity fans, a bank of chilled water cooling coils, a bank of electrical heating coils, and a bank of particulate filters. The unit is connected to a ductwork system with outlets, dampers, and controls to distribute tempered air throughout the building to maintain temperatures and airflows so that they meet the stated requirements. The air entering the supply unit contains at all times sufficient outside air for ventilation. This minimum quantity of outside air will be increased up to 100 percent of system airflow when outside air temperature makes this practicable.

The supply system must operate when the return air system is on. The reason is that the return air system fan, when started, pressurizes the supply system air plenum and therefore, the supply system must be on to offset this effect. Supply system fan operation and control is accomplished manually from a local control panel. The supply system consists of two fans. During normal operation one fan runs and the other is on automatic standby. In the event the operating fan fails, local alarm is energized and the standby fan starts automatically.

Return Air System (V104)

The return air system housing contains two 100 percent capacity fans that, through the associated ductwork system, exhaust air from clean areas. Depending on requirements of the supply system (V101), this air may be either exhausted directly to the turbine building vent or returned to the intake of the supply unit.

The return system fan operation and control is accomplished manually from a local control panel. The return system consists of two fans. During normal operation one fan runs and the other is on automatic standby. In the event the operating fan fails, local alarm is energized and the standby fan starts automatically.

Recirculation System (V105)

The recirculation unit housing contains two 100 percent capacity fans, a chilled water cooling coil and a bank of particulate filters. The housing connects to both a supply and a return ductwork system complete with outlets and dampers.

The recirculation system supplies and returns air to and from areas as required for cooling but does not affect access and clean areas.

The hand control switches of the recirculation system fans are located on the local control panel. The system is put into operation by manually starting one fan and setting up the second fan in standby mode. The standby fan starts automatically on failure of the operating fan.

Filter Exhaust System (V106)

The filtered exhaust system contains two 100 percent capacity fans and two filter housings, of 50 percent capacity each. Each filter housing contains prefilters, charcoal filters, and upstream HEPA filters. Air from potentially contaminated areas in the turbine building is routed through the filtered exhaust system before it is discharged to the atmosphere via the turbine building exhaust vent.

The backwash receiving tank for the CFS is an atmospheric tank, which connects directly into the existing filtered exhaust duct through a full flow HEPA filter. During the backwash process, air expelled from the tank is vented through the HEPA filter into the building filtered exhaust system.

The filtered exhaust system operates only if the supply system (V101) is operating. The exhaust system fan operation and control is accomplished manually from a local control panel. The exhaust system consists of two fans. During normal operation one fan runs with both filter trains and the other is on automatic standby. In the event the operating fan fails, local alarm is energized and the standby fan starts automatically.

MG Set Cooling System (V103)

The MG set cooling system unit housing contains two 100 percent capacity fans and a bank of particulate filters. Forced ventilation cooling of the MG set drive motor and generator is supplied by one of the two fans. During normal operation one fan runs and the other is on automatic standby. In the event the operating fan fails, local alarm is energized and the standby fan starts automatically. To prevent the MG set from overheating in the event of a pneumatic actuator damper motor diaphragm failure, the exhaust air damper and one half of the outside air intake damper are locked open. This allows the MG set to operate in a safe/reliable manner without the possibility of fresh air, exhaust air or recirculation air dampers failing due to diaphragm wear. Return air from the drive motors and generators can either be directed to the atmosphere through the turbine building exhaust vent or back to the suction side of the fans.

The control switches of the MG set cooling system fans are located in the control room on the same board as the controls and instrumentation of the MG sets. This system is put into operation by manually starting one fan and setting up the second fan in standby mode. The standby fan starts automatically on failure of the operating fan.

Condenser Area Cooling (V113)

The condenser area unit cooler system consists of two pairs of unit coolers. Each unit cooler is sized for 50 percent of the load and its housing contains a fan and a bank of chilled water cooling coils. Each pair of unit coolers discharges cooled air through a common duct to the condenser area.

The control switch for each fan is located on a local control panel. One fan on each pair of unit coolers is manually started and the remaining unit may be either, manually started or placed in standby mode. If one unit of a pair is placed in standby mode, then a room thermostat automatically starts the standby unit when temperature rises to 120°F. The standby unit also starts automatically on failure of the operating unit.

Condensate Pump Room Cooling (V112)

The condensate pump room unit cooling system consists of four unit coolers. Each unit cooler is sized for 33.3 percent of the load and its housing contains a fan and a bank of chilled water cooling coils. Each pair of unit coolers discharges cooled air through a common duct to the condensate pump room.

The control switch of each fan is on a local control panel. Under normal operating conditions three fans are manually started. The fourth unit is set in standby mode. The standby unit starts automatically on failure of any of the three operating units or when the pump room temperature rises to the setting of the high temperature switch. The high temperature switch is set to ensure that a temperature of 104°F is not exceeded.

Battery Room Exhaust (V114)

The Battery Exhaust System consists of one 100% centrifugal fan. The fan discharges air from the Battery Room into the Turbine Building Exhaust Vent stack.

The hand control switch of the fan is located on a local control box. Fan failure is alarmed locally.

Tool Room Facility Exhaust System (OV122A/B)

A common tool room facility serves both Unit 1 and Unit 2. It is located at the southeast corner of the Unit 2 Turbine Building at elevation 676. The existing turbine building east wall (with railway and personnel doors) serves as a common boundary of the turbine Building/Tool Room facility interface. The tool room is an extension of the turbine building HVAC system and will be maintained at a slightly negative pressure. Air is exhausted from the facility directly into the Unit 2 Turbine Building railroad bay.

Exhaust air is provided by two (2) 100 percent capacity variable speed fans when the doors to the turbine building are closed. When required, one fan is in continuous operation and one fan is in standby. The standby fan auto starts on loss of air flow. Both fans auto stop on signal from fire/smoke alarms. System control and indication is local.

Audio and visual local indication of auto start of standby fan is provided.

9.4.4.3 Safety Evaluation

The turbine building HVAC systems have no safety-related functions.

The turbine building HVAC systems are designed to maintain airflows from clean areas to potentially contaminated areas and from areas of potentially lower level contamination to areas of potentially higher level contaminations, then through a filter exhaust system. All systems are provided with redundant fans; except for the Unit 2 Battery Room Exhaust Fan, upon any failure of any operating fan, the standby fan will be automatically started.

The main exhaust charcoal filters contain a fire detection system that annunciates on the control room panel when high temperature occurs. When the charcoal adsorber approaches ignition temperature, the high-high temperature switch trips the fan. A manual deluge system is available for Operations use should a fire occur. The exhaust air is monitored for radiation by the radiation detection system in the exhaust vent outlet.

9.4.4.4 Tests and Inspections

All components are tested and inspected as separate components and as integrated systems. After the ductwork system is installed and airflows are measured and adjusted to meet design requirements, all instruments are calibrated to the design conditions. The system was preoperationally tested in accordance with the requirements of Chapter 14.

Periodic flow measurements will be taken to verify the design condition in order to ensure operability and integrity of the system. The filter and ductwork in-service tests and inspections are described in Table 9.4-1, items 12 and 13.

9.4.4.5 Instrumentation Requirements

All the hand control switches of the turbine building HVAC equipment (including the Battery Room Exhaust Fan for Unit 2), are on the local control panel in the turbine building, except for the control switches of the fans in the MG set cooling system which are located in the control room and except for the Tool Room Facility Exhaust System controller which is located in the Tool Room Facility. The local control panel has an annunciator that transmits a trouble alarm to the control room if any abnormal condition occurs in the turbine building HVAC systems' fans, filters or dampers, (except for Tool Room HVAC) Tool Room HVAC trouble will only alarm at the local panel in the tool room.

The following abnormal conditions are alarmed at the local control panel:

a) All fan failures

b) High temperatures at the condenser area

c) High temperatures at the condensate pump rooms

d) High pressure differential across the upstream HEPA filter of the filtered exhaust system

e) High differential temperature across the filter train of the filtered exhaust system

f) High and low pressure differential between the generator area (clean) and condenser area (contaminated)

g) High pressure differential across the filter of the supply system

h) High differential pressure across the filter of the recirculation system

i) High differential pressure across the filter of the MG set cooling system

j) Supply fans (V101), return fans (V104), exhaust fans (V106), and MG set cooling fans (V103) motor feeder breakers phase B overcurrent

k) Supply system electric heater trouble

Supply fan outside air low temperature alarm

The following abnormal conditions are alarmed directly in the control room:

a) Loss of ventilation in the turbine building

b) Pre-ignition and ignition temperatures of the filtered exhaust system charcoal filters

c) Turbine building vent effluent radiation monitoring system alarms listed in Section 11.5.2.1.2

Local pressure differential indicators are provided across all the filters. Pressure differential indicators are also provided on the local control panels to monitor the building pressure as well as differential pressures between clean and contaminated areas.

The condenser area and the condensate pump rooms are provided with room thermostats. These thermostats automatically start their associated unit coolers when the temperature rises above set point.

Inlet and outlet air temperatures of the recirculation and supply systems and the filter trains of the filtered exhaust system are displayed on temperature indicators at the local control panel.

9.4.5 PRIMARY CONTAINMENT ATMOSPHERE RECIRCULATION AND COOLING SYSTEM

9.4.5.1 Design Basis

The primary containment atmosphere recirculation and cooling systems are designed to accomplish the following objectives during stable and transient operating conditions from start-up to full load to shutdown:

a) Maintain temperatures in the various spaces within specified limits. The general drywell area will be maintained at an average temperature of 135°F, maximum not to exceed 150°F. The control rod drive area design temperature is 135°F, while maximum allowable temperature is 185°F. The area around the recirculation pump will be maintained at 128°F average and 135°F maximum. The drywell head area design temperatures are 135°F average and 150°F maximum (see Dwg. C-1815, Sh. 1).

b) Provide for the primary containment air purge (see Subsection 9.4.2.).

c) Prevent concrete structures within the containment from exceeding the maximum design temperature of 150°F locally.

d) During post LOCA conditions selected drywell air cooler and reactor under vessel CRD area recirculation fan systems are designed to mix the drywell atmosphere to prevent hydrogen concentration build-up. This is the only safety-related function performed by the dry well unit coolers and the reactor under vessel CRD area recirculation fans.

The fan and the ductwork of the cooling systems serving the head area (1V414A&B), one of the recirculation systems serving the drywell general area (1V416A&B) and the recirculation fans serving the reactor under vessel CRD area (1V418A&B) are safety-related and engineered safety features. All other Unit 1 and 2 cooling systems are seismically analyzed to ensure that they present no hazard to the safety-related equipment and systems. Safety classification and seismic categories are shown on Dwg. M-177, Sh. 1. Pipe whip has not been considered as the pressure differential between the Drywell atmosphere and the inside of the duct is less than 6" W.G. and the fluid density is low.

9.4.5.2 System Description

The air flow diagram for the drywell is shown in Dwg. M-177, Sh. 1. The duct layout is shown in Dwgs. V-26-2, Sh. 1, V-26-3, Sh. 1, V-26-4, Sh. 1, V-26-5, Sh. 1, V-26-6, Sh. 1, V-26-10, Sh. 1, V-26-11, Sh. 1, V-26-12, Sh. 1, V-26-13, Sh. 1, V-26-14, Sh. 1, and V-26-15, Sh. 1.

Design parameters are shown in Table 9.4-8. Cooling water to the cooling coils is provided by the reactor building chilled water system or, on loss of offsite power, by the reactor building closed cooling water system.

The controls and instruments associated with each system are shown on Dwgs. VC-177 Sh. 1, and VC-177, Sh. 2, and should be considered as an integral part of that system.

The drywell air flow system in both units contain 14 unit coolers (7 pairs), 1 fan (approximately 8650 CFM) per cooler, and 1 cooling coil per cooler. Each cooler has an individually ducted supply system. The unit coolers are arranged in pairs. The two units of each pair are physically separated. However, they can be operated simultaneously if necessary to maintain the required space temperatures. During the high speed mode of operation units on standby, will start automatically on loss of air flow in the running cooler.

In addition, the drywell air flow system contains two (2) recirculation fans serving the reactor under vessel CRD area. During normal plant operation, one fan operates at high speed to provide ventilation to the under vessel CRD area; and the second fan which is on standby will start automatically upon loss of air flow to the running fan or if there is a high temperature condition in the under vessel CRD area.

The unit coolers and the recirculation fans are assigned (in pairs) to specific areas of the drywell as follows:

Unit Coolers V411A&B	RPV support skirt flange area and reactor shield annulus. Cooling air is supplied through two ring headers, each with 12 evenly spaced penetrations through the reactor shield feeding outlets in the skirt flange area. From there the air is forced through the annulus between the RPV insulation and the shield and is exhausted to the drywell general area. Each supply air opening is furnished with a dispersing plate to prevent direct impingement of cold air against the RPV skirt.
Unit Coolers V414A&B	Safety-related systems - serving the RPV head space and the main steam relief valve area. Cooling air is supplied to the head area through two outlets at an angle of 180° apart for maximum air mixing. The air is exfiltrated through four openings in the seal plate into the top of the drywell.
Unit Coolers V415A&B	Non-safety-related systems. Each system supplies its total air flow to the general drywell area around elevation 719'-1".
Unit Coolers V412A&B V413A&B V416A&B V417A&B	Systems V416A&B are safety-related - Each system, except V417A&B, supplies a major portion of its air flow at the top of the drywell directly below the seal plate. Systems V417A&B supply a portion of the cooling air in the vicinity of the main steam relief valves. The supply duct outlets, at the top of the drywell, are arranged tangentially around the RPV, so that an even air distribution is maintained for cooling and air mixing.
Recirculation fans V418A&B	Safety-related systems serving the CRD area. Ventilation air is supplied by these fans which are located close to the openings at an angle of 180° apart in the lower elevations of CRD pipe space. CRD pipe openings, at the top of the space, are used to allow the air to exfiltrate into the drywell general area.

The cooling units and the recirculation fans are connected to ductwork on the discharge side only. Return air enters each unit cooler and the recirculation fans directly from the space. Physically the unit coolers and the recirculation fans are dispersed around the RPV in the lower section of the drywell between elevations 704 ft-0 in. and 714 ft-0 in.

The unit coolers and the recirculation fan are provided with two speed motors. The low speed operation is for the drywell post LOCA conditions and the integrated leak rate test, and the high speed operation is for normal conditions. The fan impellers are subject to a 125% overspeed test to provide assurance that they will not generate missiles.

Each drywell unit cooler is provided with the following controls (see Dwgs. VC-177, Sh. 1 and VC-177, Sh. 2 for control diagrams):

a) A four position switch - start high; start low; auto high; stop - (located in the control room)

b) A pressure differential switch across each fan (flow detection function) - (local)

c) Temperature sensors on inlet and outlet - (local)

d) Temperature sensor on cooling coil leaving water line - local (see Subsection 9.2.12.3.)

e) Local high outlet air temperature alarm, and an individual alarm in the control room

f) Local high chilled water outlet temperature alarm, and an individual alarm in the control room

g) Fan failure alarm in the control room

h) Fan starter switch bypass indication in the control room, for the safety-related unit coolers only

In addition, a common local temperature indication and alarm panel, for both air and chilled water, is in the reactor building outside the primary containment.

Each reactor under vessel CRD area recirculation fan (V418A&B) is provided with the following controls:

a) Four position switch-start high, start low, auto high and stop (located in the control room).

b) Fan starter switch bypass indication in the control room.

Ambient temperature of various areas of the primary containment is monitored (See Subsection 6.2.1.1). The high temperature signal or the failure of the running fan for the reactor under vessel CRD areas will automatically start the CRD area standby recirculation fan, if it is placed in “auto-start”. The high temperature detected in the general drywell area or the failure of the running drywell unit cooler fan will automatically start the standby unit cooler of the pair, if it is place in “auto-start”. In the event that the average air temperature in the drywell cannot be maintained with (14) drywell coolers the reactor will be shutdown in accordance with the technical specifications.

All drywell unit coolers and the under vessel CRD area ventilation fans, including standbys, can be operated manually from the control room, if necessary to control the drywell temperature.

All operating modes of the drywell coolers are shown in Table 9.4-9.

9.4.5.3 Safety Evaluation

The Primary Containment atmosphere and recirculation cooling system is located within the Seismic Category I reactor building. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

The low speed operation of the drywell unit coolers V414A&B, V416A&B and the under vessel CRD area recirculation fans V418A&B is the only safety-related function of the system. For failure mode and effect analysis see Table 9.4-10. For high speed operation, during normal plant operation, none of the drywell unit coolers and under vessel CRD area recirculation fans have any safety-related function. Fans are started manually. If a fan fails to start or fails during operation, the standby fan starts automatically when on "Auto-High" mode. The failure is annunciated in the control room. This is accomplished by use of pressure differential switches across each fan.

To ensure continuous operation during loss of offsite power, all drywell unit cooler fans including under vessel CRD area recirculation fans and controls are on the emergency power supply. Units A are on Division I Power Supply and Units B are on Division II Power Supply.

9.4.5.4 Tests and Inspection

Tests and inspections described under items (1) through (3), (13) and (14) in table 9.4-1 apply to reactor under vessel CRD area recirculation fans. With the exceptions of items (4) and (6) through (12), (15) and (16), all the tests and inspections described in Table 9.4-1 apply to the drywell unit coolers.

The system was preoperationally tested in accordance with the requirements of Chapter 14. The recirculation fans V418A&B were pre-operationally tested in accordance with the requirements identified in the design modifications under which they were installed.

9.4.5.5 Instrumentation Requirements

Each drywell unit cooler for both Units 1 and 2 is controlled from the control room by a four position starter switch. Each under vessel CRD area recirculation fan is controlled from the control room by a four position starter switch.

Failure of any fan is alarmed in the control room. For each cooler, high air and water discharge temperatures are alarmed individually on the local control panel, and in the control room, as a group alarm. Safety-related unit cooler fan and recirculation fan starter switch bypass is indicated in the control room.

Fan starter switch circuits for the safety-related coolers and recirculation fans are safety-related. All other controls and instrumentation, including alarms, are not safety-related. The safety-related switches are qualified to Seismic Category I requirements. Isolating relays are provided to separate safety-related from non safety-related control circuits.

9.4.6 REFUELING AND SPENT FUEL AREA VENTILATION SYSTEM

The refueling and spent fuel area ventilation system is part of Zone III ventilation system described in Subsection 9.4.2.

The following features are provided to control air distribution in the spent fuel area in order to reduce concentration and spread of airborne radioactive contaminants within the refueling floor:

a) Exhaust air registers high over the spent fuel pool, in addition to general exhaust registers on the west wall of the refueling floor. (See Figure 9.4-17.)

b) The high exhaust air duct damper over the refuel pool is locked into position to provide design minimum flow and the wall exhaust air duct damper on the refuel floor wall is locked into position to provide design maximum flow. This ensures adequate ventilation during both normal and emergency plant operations.

9.4.7 DIESEL GENERATOR BUILDINGS VENTILATION SYSTEMS

9.4.7.1 Design Basis

The H&V systems for the diesel generator buildings have a safety-related function. They are designed to maintain a suitable environment for the diesel generators and their accessories during all modes of operation. To ensure proper diesel generator operation, Diesel Generator Rooms A, B, C and D are individually ventilated and heated not to exceed a maximum design room temperature of 120°F and a minimum design room temperature of 72°F. The Diesel Generator 'E' building is ventilated and heated to maintain the space temperature in accordance with the design temperature parameters listed in Table 9.4-11b.

9.4.7.2 System Description

Diesel Generator Rooms A, B, C and D are provided with a separate ventilation system as shown in Dwgs. VC-182, Sh. 1, and M-182, Sh. 1. The Diesel Generator 'E' building ventilation system is shown on Dwgs. V-182, Sh. 8, and M-182, Sh. 2. Each system is designed to modulate outside/return air flow ratio from 0 to 100 percent depending on the respective room cooling demand. Design parameters are listed in Tables 9.4-11 and 9.4-11A.

In addition to the design features which minimize the impact of dust on the operation of all five diesel generators, the preventative maintenance program for the control cabinets include requirements for cleaning out dust accumulation when the equipment is checked.

9.4.7.2.1 Diesel Generator Rooms A, B, C and D

Each supply fan starts 2 minutes after its associated diesel receives its start signal or when the room temperature, sensed by a start temperature switch, exceeds approximately 95°F and continues to run after the diesel stops until the temperature in the room is below the stop thermostat cutout setting of approximately 85°F. Each supply fan also automatically starts if its associated room temperature reaches a high-high value, resulting from fan control failure due to a fire in the control room, and stops after adequate room cooling has occurred. The fan discharge air temperature is controlled by modulating outside air intake, exhaust, and recirculation dampers. Ventilation is provided by infiltration when the diesels and fans are off. Circulating fans, located in the basement of each diesel generator room, circulate air between the basement and main floor. These fans are manually started by a local hand switch. These fans are not safety-related. Heating for each room is provided by thermostatically controlled electric unit heaters that operate when the room temperature falls below approximately 72°F. The basement is heated with electric wall heaters, which are controlled by individual thermostats. The heating systems are not safety-related.

The ventilation and combustion air is protected from dust by locating the air intake/combustion air filter in a separate compartment inside the building about 25 ft. above the grade (676'-0) elevation, see Figure 9.5-27. In addition, further dust protection is provided by the physical layout of the building to its immediate surroundings. The Diesel Generator Building is surrounded by grass, gravel, and asphalt. Considering the location of the air intake, the combustion air dust exposure is minimum.

9.4.7.2.2 Diesel Generator 'E' Building

Two (2) 50 percent capacity supply fans, two (2) 50 percent capacity exhaust fans and one (1) 100 percent capacity battery room and basement exhaust fan were selected to ventilate the building. The ventilation system is designed as safety-related and Seismic Category I.

The first set of interlocked supply and exhaust fans maintain space temperature below 100°F by means of damper modulation and starting of fans from the space thermostat. The second set of interlocked supply and exhaust fans start when the indoor temperature rises above 110°F. This arrangement of one (1) 50 percent capacity supply and one (1) 50 percent capacity exhaust fan running during normal ventilation mode is furnished to conserve energy. No filtration or cooling is provided in the ventilation system. The modulating damper system will control temperature and is designed to ensure full ventilation on a loss of power to the respective inlet and outlet modulating dampers; as they will fail in the open position. Normal ventilation is provided by leakage through the dampers when the ventilation supply fan is not operating.

The exhaust fan for the battery room and basement is manually operated, will run continuously, and the fan motor was selected for explosion-proof construction.

The heating system for all areas consists of electric unit heaters and electric baseboard heaters. The heaters are not safety-related and are designed to commercial industry standards. They are, however, supported to Seismic Category I requirements to avoid potential safety impact concerns. The heaters have built-in thermostats to automatically maintain space temperature in accordance with the design parameters listed in Table 9.4-11B.

The building HVAC system will automatically shut down in the event of a fire unless the diesel generator is operating in the emergency mode.

The ventilation and combustion air is protected from dust by locating the air intake/combustion air filter in a separate compartment inside the building about 35 ft. above grade elevation.

9.4.7.3 Safety Evaluation

The Diesel Generator A, B, C and D fan systems are located in a separate room within the Seismic Category I Diesel Generator Building. The Diesel Generator 'E' fan system is located within the Seismic Category I Diesel Generator 'E' building. The ventilation system required for heat removal from each room is safety-related and designed to Seismic Category I requirements. For failure mode and effect analysis see Table 9.4-12. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

9.4.7.4 Test and Inspection

With the exception of items 4 through 12, 15, and 16, all tests and inspections described in Table 9.4-1 apply to safety-related components of the diesel generator ventilation system, with the addition of the manufacturer's motor test reports. These reports provide the following data for each Diesel A through D ventilation supply fan motor (0V512A, B, C, and D), and for the E Diesel building ventilation fan motors (0V511E and 0V512E1, 2, 3, and 4):

a) Running light current (no load)
b) Power input
c) High potential
d) Bearing inspection (rotor gap and end play, for the “A” through “D” fans), or bearing design life (“E” fans)
e) Calculated locked rotor current

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.4.7.5 Instrumentation Requirements

9.4.7.5.1 Diesel Generator A, B, C and D Building

Each ventilation system for an aligned diesel generator can be individually controlled from the control room. The system can be started manually or automatically when in the auto mode, the diesel start signal or the tripping of the high temperature switch causes the ventilation system to operate. An additional temperature switch is provided in each diesel generator room to detect high-high room temperature resulting from fan control failure due to a fire in the control room. Detection of high-high temperature will actuate the switch causing transfer of controls from the control room circuit to this temperature actuated control circuit and automatically start the associated fan. This occurrence will also result in "fan trouble" annunciation in the control room. A low temperature setpoint is also provided to stop the fan after adequate cooling has occurred. In addition to the fan start and stop temperature switches a low temperature and two high temperature switches in each diesel room actuate alarms in the control room in case of abnormal temperature conditions. Failure of any ventilation component resulting in loss of air flow also alarms in the control room.

9.4.7.5.2 Diesel Generator E Building

When Diesel Generator 'E' is aligned for either Diesel Generators A, B, C or D, the Diesel Generator 'E' ventilation system can be manually controlled from the control room. If Diesel Generator 'E' is not aligned to an ESS bus, the Diesel Generator 'E' ventilation system can be manually controlled only from local Panel 0C577E. Whether Diesel Generator 'E' is aligned or not the ventilation system can be started automatically when in the auto mode by the tripping of either of the two high temperature switches. In addition to the fan start and stop temperature switches, there are three low temperature and two high temperature switches in the Diesel Generator 'E' building which actuate alarms on Panel 0C577E. These alarms are then combined and reflashed in the control room as a general trouble alarm for Panel 0C577E. Failure of any ventilation component resulting in loss of air flow also alarms in the control room.

9.4.8 ENGINEERED SAFEGUARD SERVICE WATER PUMPHOUSE VENTILATION SYSTEM

9.4.8.1 Design Basis

The H&V system for the ESSW pumphouse has a safety-related function. It is designed to maintain a suitable environment for the ESW and RHRSW pumps and their associated accessories. To insure proper pump operation each of the two separate areas is individually ventilated not to exceed a maximum design temperature of 104°F. The heating system is not safety-related but is designed to maintain the temperature above 60°F.

9.4.8.2 System Description

Each of the ESW and RHRSW pumps is provided with a separate ventilation system as shown on Dwgs. VC-182, Sh. 1, and M-182, Sh. 1. Each system is designed to modulate outside/return airflow ratio from 0 to 100 percent depending on the cooling demand. Design parameters are listed in Table 9.4-13. Each supply fan starts with its associated pump, or when temperature sensed by a start temperature switch exceeds approximately 95°F, and continues to run when the pump is shut off until the temperature in the room is below the stop thermostat cutout setting (75°F). The fan discharge air temperature is controlled by modulating the outside air intake, exhaust and recirculation dampers. The exhaust and intake dampers are designed to fail close in order to prevent freeze up in the event of damper control malfunction. Ventilation of the pump house when the pumps are not in operation will be provided by infiltration. Heating for each room is provided by thermostatically controlled electric unit heaters, which operate to maintain the room temperature above 60°F.

In the event of loss of control from the control room due to a control room fire, an additional temperature switch initiates autostart of the ventilation fan should pump room temperature rise above high temperature setting, and shuts off when the room temperature falls below the cutout setting.

9.4.8.3 Safety Evaluation

The eight fans and components serving the ESSW pumphouse are located in the Seismic Category I ESSW pumphouse structure, which is divided into two areas with a missile proof separation wall.

The ventilation systems required for heat removal are safety-related and designed to Seismic Category I requirements. The heating system is not safety-related. For failure mode and effect analysis see Table 9.4-14. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

9.4.8.4 Test and Inspections

With the exception of items 4 through 12, 15, and 16, all test and inspections described in Table 9.4-1 apply to safety-related components of the ESSW pumphouse ventilation system, with the addition of manufacturer's motor test reports. These reports provide the following data for each ventilation supply fan motor:

a) Running light current (no load)
b) Power input
c) High potential
d) Bearing inspection (rotor gap and end play)
e) Calculated locked rotor current

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.4.8.5 Instrumentation Requirements

Each ESSW pumphouse ventilation system can be individually controlled from the control room. The system can be started manually or automatically. When in the auto mode, the corresponding pump start signal or the tripping of the high temperature switch will cause the ventilation system to operate. In addition to the fan start and stop temperature switches a high temperature switch is located in the vicinity of each pump along with a low temperature detector for each of the two pumping bays. The tripping of any of the switches causes alarms in the control room in case of abnormal temperature conditions. Failure of any ventilation component, resulting in loss of air flow, also alarms in the control room. An additional temperature switch initiates autostart of the ventilation fan upon high ambient pump room temperature. This provides cooling in the event control is lost due to a control room fire. This occurrence also results in "fan trouble" annunciation in the control room.

9.4.9 CIRCULATING WATER PUMPHOUSE AND WATER TREATMENT BUILDING HVAC

9.4.9.1 Design Basis

The HVAC systems for the circulating water pumphouse and water treatment building have no safety-related functions and are only used to maintain a suitable environment for the circulating and service water pumps, the water treatment equipment and all associated accessories.

To ensure proper pump operation, the circulating water pump room is heated and ventilated not to exceed a maximum design temperature of 104°F, during plant operation, and a minimum design temperature of 40°F during plant shutdown. The diesel driven fire pump room (located in the circulating water pumphouse) heating and ventilation is designed to maintain a minimum of 70°F when the pump is not in operation, and a maximum temperature of 104°F during pump operation. The water treatment building minimum design temperature is 60°F, with the exception of the lab where the design temperature is 72°F. Ventilation is provided for the water treatment building.

9.4.9.2 System Description

The circulating and service water pump area is ventilated by 20 roof mounted exhaust fans, controlled by their individual thermostats. Outside air is drawn through the louvers/dampers, which are located at ground level on the east side of the building, and exhausted through the roof. Each fan and its associated damper is controlled by a thermostat, which is located adjacent to a pump motor.

The fire pump room is normally ventilated by a roof mounted ventilation fan which also exhausts air from the sump area of the pumphouse. During operation of the diesel fire pump, the inlet dampers open to provide outside air for combustion and cooling. Prior to the room temperature reaching 90°F with the diesel running, a thermostat will start the exhaust fan, or, prior to the room temperature reaching 90°F and the diesel is not running, the thermostat will open the intake damper and start the exhaust fan.

The water treatment building is ventilated by a number of different fan systems. The main system contains two in-line axial fans, one operating continuously, the other being on standby. Air is exhausted from the acid storage room and the water treatment rooms (Elevations 676'-0" and 693'-0"), by the main system. Tempered air is drawn through transfer grills into the acid storage room from the circulating pump room. Outside air is also drawn into the water treatment room (el. 693'6-0"). Prior to the water treatment room (el. 693'-0") temperature exceeding 90°F, a roof mounted exhaust fan starts and draws in additional outside air through a three position damper cooling area.

The toilet and janitor's closet are ventilated by a common roof exhaust fan. The laboratory is also ventilated with a roof mounted exhaust fan and cooled by a through-wall air conditioning unit.

See Dwgs. M-173, Sh. 1 and VC-173, Sh. 1. Design parameters are listed in Table 9.4-15.

Heating for the circulating water pumphouse and the water treatment building is provided by electric unit heaters, base board heaters and cabinet connectors. Each of these heating devices is controlled by its individual thermostat.

9.4.9.3 Safety Evaluation

The HVAC systems for the circulating water pumphouse and water treatment building are not safety-related, however, there is a redundant fan for the main ventilation system in the water treatment building. Two redundant unit heaters have been designed as back up heaters to assure 60°F temperature for the acid storage room.

9.4.9.4 Test and Inspections

All equipment will be tested after installation, to verify its design conditions. The system will be pre-operationally tested in accordance with the requirements of Chapter 14.

9.4.9.5 Instrumentation Requirements

The HVAC systems in the circulating water pumphouse, and water treatment building are controlled by local thermostats or by locally mounted switches, which can override the thermostat. There are no HVAC systems in this building that can be controlled from the control room. High temperature in the vicinity of each circulating water pump is detected and alarmed individually on a local control panel and in the control room as a group alarm.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

1) GENERAL

a) All safety related components identified in Table 3.2-1 are designed, fabricated, installed, and tested under quality assurance requirements in accordance with Appendix B to 10CFR50.

b) For systems that must perform a safety related function, periodic in-service testing of all fans, valves, controls, and instrumentation in the systems will be performed. All motor-operated valves and dampers will be tested by opening and closing the valve or damper.

c) Equipment in Seismic Category I systems is required by specification to meet the seismic requirements for this project. Before each equipment item is shipped, the supplier of that item is required to submit an adequate analysis or applicable test data as evidence of compliance, which is approved by PPL.

d) Systems designed to meet Seismic Category I requirements are subjected to a program of plant and field testing.

e) All standby units will be tested at periodic intervals to verify the operation of essential features. Periodic tests of the activation circuitry and the system components will be conducted during normal plant operation.

2) FANS

All centrifugal and propeller fans are tested in accordance with the AMCA Standard Test Code for Air Moving Devices, Bulletin 210. Vane axial fans are tested in the field for flow and pressure requirements. Blade setting adjustments are made to correct flow rates when necessary.

3) MOTORS

All motors are built, designed, rated, and tested in accordance with NEMA-MG-1. Category I motors will have certification for the NEMA tests required in Publication No. MG-1. Motors used within the containment comply with IEEE 334.

4) HEATING COILS

The heating coils are furnished in accordance with the requirements of UL 1096 and the National Electrical Code, Article 424. The heating coils are installed according to the National Fire Protection Association Pamphlets 90A and 90B.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

5) COOLING COILS

The cooling coils are furnished in accordance with ASHRAE 33 and ARI Standard 410. All chilled water, service water, refrigerant coils and emergency service water coils are hydrostatically and pneumatically tested. Category I coils are seismically qualified by analysis or testing on a shaker table. The refrigerant coils and Emergency Service Water Cooling coils have been tested in accordance with ASME subsection 3 ND-6200 and ND-6300.

6) MIST ELIMINATORS

All eliminators are built in accordance with MSAR 71-45, "Entrained Moisture Separators for Fine (1 to 10 microns) Water-Airstream Service". The eliminators are Seismic Category I and have been seismically analyzed.

7) PARTICULATE FILTERS (Supply Air)

The particulate filters are UL Class 1 approved under UL 900. The filter efficiency and performance is in accordance with ASHRAE Standard 52-68. The airflow resistance of the particulate filters is less than 0.35 in. wg (clean) and a maximum of 1.4 in. wg (dirty) at rated flow (2000 cfm). The filters have an efficiency rating of 85 to 90% by dust spot test on atmospheric dust.

8) PREFILTERS (Used in Series with HEPA Filters)

The prefilters are certified to meet the standards for UL Class 1 filters. The airflow resistance of the prefilters at rated flow is less than 0.3 in. wg (clean) and 0.9 in. wg (dirty). The prefilters have an efficiency rating of 80 to 95% by the dust spot test on atmospheric dust.

9) HEPA FILTERS

a) Qualification Tests Prior to Installation

The HEPA filters are constructed in accordance with MIL-F-51079A, Filter Medium, Fire Resistant, High Efficiency, and MIL-F-51068C, (Filter, Particulate High-Efficiency, Fire Resistant). The filters are Type IIC (SGTS) and IIB (all others). The minimum tensile strength of the filter media is at least 2.5 lb/in. of width in accordance with the requirements of MIL-F-51079A. Note that the above-referenced military standards (MIL-F-51079A and MIL-F-51068C) have been deleted, but represent acceptable standards for installed (or previously purchased)

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

HEPA filters. New HEPA filters will meet the standards presented in ASME AG-1-1997.

The filter medium is securely fastened to the sides and ends of the filter frame with adhesive to seal the edges of the medium to the filter frame. Patching of holes or tears in the medium is not permitted.

The assembled filters are type tested in accordance with the requirements of UL 586 (High Efficiency Air Filter Units) to minimize fire hazards. The filters are approved UL Class 1.

Each filter has been tested for flow resistance at rated flow. The filter resistance does not exceed the rated pressure drop of 1 in. wg under this condition.

The filters have been rough handled with the Q110 Vibrating Machine, DLA 26-18-67, examined for damage and the DOP penetration determined in accordance with Section 4.3.4.1.

All filters have been subjected to acceptance tests made by an NRC quality assurance station. The filter efficiency exceeds 99.97% when tested with monodispersed, thermally generated DOP aerosol having a mean particle size of 0.3 micron.

Filters selected at random from the manufacturer's production line have been subjected to moisture, overpressure resistance, and filter dust loading tests in order to initially qualify the filters. The moisture and overpressure resistance tests were performed in accordance with MIL-F-51068 or ASME AG-1-1997 (see above discussion).

Each filter has been individually tested by the appropriate NRC quality assurance station at 100% and 20% of the rated capacity.

b) Preoperational Tests for Acceptance (performed in filter train housing).

Visual and dimensional checks of the housing and mounting frames were made in the field for conformance with design specifications. Nonconforming items are rejected and replaced with acceptable equipment.

After installation, in-place testing of the HEPA filter efficiency was conducted in accordance with Section 10 of ANSI N510-1975 (formerly ANSI N101.1-1972). The tests are conducted at the rated airflow, using the DOP aerosol test equipment, test procedures, and test reports specified in ANSI N510-1975. The overall filtration efficiency is not less than 99.97%. When leaks that would result in inability to meet the specified system parameters exist, they are located and repaired by welding. The system is then tested again to ensure conformance with acceptance criteria.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

10) <u>CHARCOAL ADSORBERS</u>

Charcoal adsorbers were tested as follows:

a) Qualification Tests Prior to Installation

1) Representative samples, taken from each batch of charcoal used for filling the adsorbers, were tested for adsorption efficiencies of radioactive elemental iodine, radioactive particulate iodine, and radioactive methyl iodine. The test methods were comparable to those shown in the Oak Ridge Laboratory Publication NSIC-65. The iodine loading in the test gas stream was about 0.01 mg/m^3. The removal efficiencies and residence times were at least as follows for relative humidities up to 70%:

2 3/16 in. (0.25 sec. res. time)	95% elemental 95% organic
6 in. (0.75 sec. res. time)	99% elemental 99% organic
8 in. (1.0 sec. res. time)	99% elemental 99% organic

Calculations have been done to demonstrate that the residence times shown above are met.

2) Each charcoal adsorber cell was tested for leakage using the test method presented in ANSI 510 (formerly AEC Report DP1082). The tracer gas used in the test was either R-112 or R-11, (tetrachlorodifluorothane or trichlorofluoromethane). The tracer gas was mixed into the rated airflow in accordance with the above procedure. Leakage paths were identified and blocked by welding, as necessary to meet the limiting requirements on leakage. The pressure drop across the cell was measured during the tracer gas test.

3) The percentage of impregnation on the charcoal as well as type was verified by random lot sampling.

4) In addition, tests were conducted in accordance with Paragraph 4.3 and Table #4 of RDT M16-1T to determine the following:

a) Particle size

b) Ignition temperature

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

c) Apparent density

d) Moisture content

e) Carbon tetrachloride activity

b) In-place Testing of Adsorber

1) Refrigerant (R-11 or R-112) was introduced into the upstream side of the adsorber at a concentration of approximately 20 ppm at rated airflow. The downstream concentration was less than 0.25 percent of the upstream 20 ppm. No more than four tests were conducted on any given charcoal adsorber cell. No radioactive isotopes were used in the efficiency tests performed on the charcoal adsorbers.

2) The installed carbon adsorber filter bank was visually and dimensionally checked for conformance to the design specifications.

11) <u>FILTER HOUSINGS</u>

In addition to the housing manufacturer's shop tests, a field performance test was given to each housing. The leakage rate for each housing was less than 0.1 percent of the rated airflow in cubic feet per minute at 125 percent of the negative design pressure (-0.25 in. wg).

12) <u>FILTER IN-SERVICE TESTS AND INSPECTIONS</u>

a) The air filtering systems are subject to in-place bypass leakage testing before initial startup and after maintenance or modification that could affect filter bypass leakage. In addition, testing frequencies for in-place bypass leakage testing performed on non-safety related HEPA filters and Charcoal Adsorbers are based on the operating experience of the individual filter. Testing frequencies for SGTS and CREOASS are as defined in Tech Specs.

The testing frequency for removal of a non-safety related charcoal test canister is based on the operating experience of the individual filter. Testing frequencies for removal of charcoal test canisters from SGTS and CREOASS are as defined in Tech Specs.

b) The periodic testing of the filter banks ensures that the filter bank performance is not degraded, through normal use or during standby service, to a level of below that assumed in the accident analyses. The test methods and sensitivities are the same as or equal to those for initial acceptance of the system components.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

Should the test results indicate that the performance of a component has fallen to the level assumed by the accident analyses, the component is replaced.

c) The results of all tests are made available upon completion of performance and acceptance by PPL.

d) The following filter in-service tests and inspections are performed at regular intervals during plant life to determine that the filtration systems are functioning correctly:

1) With the fan running, readings of the differential pressure gauges, mounted on the filter plenum are observed and recorded.

2) Prefilters are replaced when the pressure drop across them reaches 1.0 in. water column.

3) HEPA filters are replaced when the pressure drop across them reaches 3.0 in. water column.

4) Field leak tests are conducted after each change of HEPA filters in a system.

5) Field leak tests of HEPA filter banks are made with dioctylphtholate. An efficiency of less than 99.95% requires corrective action.

6) Corrective action after a leak test may consist of increasing the contact pressure on a seal, or replacement of a cell or cells. After corrective action is taken, an additional leak test is made.

13) DUCTWORK

a) Leakage tests on all Category I ductwork were conducted during construction.

b) All air distribution systems were tested and balanced to provide design air quantities at each outlet within a tolerance of $\pm$ 10 percent.

c) Category I ductwork is supported by seismically designed duct hangers.

d) All Category I ductwork is seismically designed and based on the analysis and test results which were conducted by Bechtel Power Corporation in April, 1976.

The test reports were based on:

1. Structural Design of Class I Seismic HVAC Ducts.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

2. Report on testing of HVAC Duct Specimens.

14) CONTROLS

a) All controls and instrumentation were tested prior to plant operation.

b) In-service tests and inspection procedures were incorporated in the plant operations manual and are performed at regular intervals during the life of the plant to show that the instruments are functioning properly. Recalibration, when necessary, is made at that time.

15) BRANCH TECHNICAL POSITION-ETSB NO. 11-2

All secondary filter systems used for normal ventilation exhaust, comply to Branch Technical Position-ETSB No. 11-2 Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light Water-Cooled Nuclear Power Reactor Plants, with the exception of the following paragraphs (References are to BTP-ETSB 11-2).

a) Reference: Para B.2.a. Moisture separators are used only where moisture impingement may be a problem. Heaters are used to lower the relative humidity (R.H.) when the ambient exceeds 70% R.H. None of the secondary non-safety related filter systems require either a moisture separator or heater to reduce the moisture content or lower the R.H.

b) Reference: Para B.2.c. The pertinent pressure drop which is instrumented to signal, alarm, and record in the control room is the pressure drop across the first HEPA filter.

c) Reference: Para B.2.e. Overall design considerations include reduction of radiation exposures during routine maintenance and testing insofar as effectually possible. It is envisioned, however, that workers will not handle filter units after a design basis accident and will thereby avoid exposures associated with immediate post-accident filter handling. Accordingly, no efforts were made toward a unitized atmosphere cleanup train design in the interest of accident exposure reduction.

d) Reference: Para B.3.b. Since none of the HEPA filters separators are exposed to potential iodine removal spray, the units are not designed for contact with the spray. The military standards referenced by draft standard ANSI N509 have been deleted, but represent acceptable standards for installed HEPA filters. New HEPA filters will meet the standards presented in ASME AG-1-1997.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

e) Reference: Para B.3.d. In this section and all others where reference is made to ORNL-NSIC-65, the reference is understood to be ERDA 76-21 or ANSI N509 where appropriate.

f) Reference: Para B.4.b and B.4.c. The spacing requirement is applicable to systems requiring operator access to remove filters and adsorber trays. Where unnecessary, the space is not provided, e.g., gasketless carbon adsorbers which are filled and emptied externally.

g) Reference: Para B.4.d. The length of pipe associated with manifolding would promote plate-out of the constituents of the sampled gas stream, thereby resulting in erroneous test results. The test probes are located in readily accessible locations; a minimum run of piping is used and manifolding is not employed.

h) Reference: Para B.5.a and B.5.c. The atmosphere clean up systems will be subject to in-place bypass leakage testing before initial startup and after maintenance or modification that could affect filter bypass leakage. In addition, testing frequencies for in-place bypass leakage testing performed on non-safety related HEPA filters and Charcoal Adsorbers will be based on the operating experience of the individual filter.

i) Reference: Para. B.5.d. The bypass leakage through the adsorber will be less than or equal to 0.05%. This exception is consistent with the guidance given in Section 6.3 of Regulatory Guide 1.140, Revision 2.

j) Reference: Para B.6.a and B.6.b. The testing frequency for removal of a non-safety related charcoal test canister will be based on the operating experience of the individual filter. Laboratory tests will be performed per ASTM D3803-89, Standard Test Method for Nuclear-Grade Activated Carbon, at a relative humidity of 70% for a methyl-iodide penetration of less than 10% for 2 inch filters and less than 1% for 6 inch filters. These requirements are consistent with the guidance given in Regulatory Guide 1.140, Rev. 1 and in SECY-97-299.

k) Reference: Table 2 Note b. The testing frequency for removal of a non-safety related charcoal test canister will be based on the operating experience of the individual filter.

16) UNIT 2 EMERGENCY SWGR REFIGERATION UNITS

The Refrigeration System Water Cooled Condensers are furnished in accordance with the requirements of ASME III, Section 3 Subsection ND and NF and ARI 450.

The Refrigeration System Compressors are furnished in accordance with requirements of ARI 520.

TABLE 9.4-1
VENTILATION SYSTEMS TESTS AND INSPECTIONS

The Compressor-Condenser Assembly is seismic Category I and will be seismically tested.

TABLE 9.4-2

CONTROL STRUCTURE HVAC SYSTEMS DESIGN PARAMETERS

	SAFETY RELATED SYSTEMS					
ITEM	H&V SYSTEM OV-103	COMPUTER RM OV-115	BATTERY RM OV-116	CONTROL RM OV-117	SGTS EXH SYS OV-118	SGTS HTNG SYS OV-144
Type	Air handling	Air handling	Indiv. fans	Air handling	Indiv. fans	Air handling
Number of Units	2	2	2 fans	2	2 fans	2
Flow rate each, CFM	31,950	30,600	3,500	20,545	3,500	3,000
Fan Type Drive No. of fans per unit No. of running fans Static pressure, each, in. wg Motor hp, each	 Centrif. Belt 1 1 4.0 50	 Centrif. Belt 1 1 4.0 40	 Centrif. Belt 2 1 3.8 5	 Centrif. Belt 1 1 4.0 40	 Centrif. Belt 2 1 3.7 5	 Centrif. Belt 1 1 2.0 5
Cooling Coil No. of coils per unit Cooling capacity each, Btu/hr	 2 1,132,000	 2 773,600	N/A - -	 2 539,300	N/A - -	N/A - -
Heating Coils No. of coils per unit Heating capacity each, Btu/hr	 1 443,690 (130 kw)	N/A - -	N/A - -	N/A - -	N/A - -	 1 102,000 (30 kw)
Filters Quantity and size, in.	 4-24x12x12 24-24x24x12	 4-24x12x12 24-24x24x12	N/A - -	 4-24x12x12 24-24x24x12	N/A - -	 3-24x24x12
Pressure drop, in. wg Clean Dirty	 0.5 1	 0.5 1	 - -	 0.5 1	 - -	 0.5 1
Efficiency [1] %	90%	90%	-	90%	-	90%

[1] Dust spot test on atmospheric dust.

TABLE 9.4-2 (continued)

	NON-SAFETY RELATED SYSTEMS						
ITEM	**SMOKE REMOVAL 0V-104**	**ACCESS & LAB EXH 0V-105**	**LAB FUME HOOD 0V-106**	**TOILET EXHAUST 0V-107**	**KITCHEN EXH 0V-108**	**ACCESS TOILET EXH 0V-112**	**ACCESS GEN EXH 0V-113**
Type	Indiv. fans	Air handling	Air handling	Indiv. fans	Indiv. fans	Indiv. fans	Indiv. fans
Number of Units	2 fans	1	1	1	1	1	1
Flow rate each, cfm	6,000	10,600	1,950	125	200	1,300	5.115
Fan							
Type	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.
Drive	Belt	Belt	Belt	Belt	Belt	Belt	Belt
No. of fans per unit	2 per sys.	1	1	1	1	1	1
No. of running fans	1	1	1	1	1	1	1
Static pressure each, in. wg	3.67	3.25	2.0	2.0	2.0	2.25	2.5
Motor hp, each	7.5	20	3	1	1	1.5	7.5
Cooling Coil	N/A		N/A	N/A	N/A	N/A	N/A
No. of coils per unit	-	2	-	-	-	-	-
Cooling capacity each, Btu/hr	-	1,066,000	-	-	-	-	-
Heating Coils	N/A			N/A	N/A	N/A	N/A
No. of coils per unit	-	1	1	-	-	-	-
Heating capacity each, Btu/hr	-	680,400 (252 kw rated)	122,900 (36 kw rated)	-	-	-	-
Prefilters	N/A			N/A	N/A	N/A	N/A
Quantity and size, in.	-	3-24x12x12 15-24x24x12	4[1]-16x25x2	-	-	-	-
Pressure drop, in. wg				4			
Clean	-	.5	0.18	-	-	-	-
Dirty	-	1	0.5	-	-	-	-
Efficiency [2], %	-	90%	[3]70-80%	-	-	-	-

1. High velocity filters
2. Dust spot test on atmospheric dust
3. ASHRAE Standard 52-68 test method

TABLE 9.4-2 (continued)

ITEM	SAFETY RELATED EMERG. O/A SUPP 0V-101 (See Table 6.5-1)	NON-SAFETY RELATED CONTAMINATED FILTER UNITS EXHAUST SYS[5] 0V-114			
Type	-- --	Built-up unit			
Number of units	-- --	2			
Flow rate each, cfm	-- --	7,180[4]			
Fan					
Type	-- --	Centrif.			
Drive	-- --	Belt			
No. of fans per unit	-- --	1			
No. of running fans	-- --	1			
Static pressure each, in. wg	-- --	10			
Motor hp, each	-- --	30			
Cooling Coil					
No. of coils per unit	-- --	N/A	N/A	N/A	N/A
Cooling capacity each, Btu/hr	-- --	N/A	N/A	N/A	N/A
Heating Coils					
No. of coils per unit	-- --	N/A	N/A	N/A	N/A
Heating capacity each, Btu/hr	-- --	N/A	N/A	N/A	N/A
	-- --				
Prefilters					
Quantity and size, in.	-- --	2-24x24x12	2-24x24x12	2-24x24x12	2-24x24x12
Pressure drop, in. wg					
Clean	-- --	0.2	0.2	0.2	0.2
Dirty	-- --	0.9	0.9	0.9	0.9
Efficiency[1], %	-- --	95	95	95	95

TABLE 9.4-2 (continued)

ITEM	SAFETY RELATED EMERG. O/A SUPP 0V-101 (See Table 6.5-1)	NON-SAFETY RELATED CONTAMINATED FILTER UNITS EXHAUST SYS(5) 0V-114			
HEPA filter, upstream					
Quantity and size, in.	-- --	2-24x24x12	2-24x24x12	2-24x24x12	2-24x24x12
Pressure drop, in. wg					
Clean	-- --	0.8	0.8	0.8	0.8
Dirty	-- --	3.0	3.0	3.0	3.0
Efficiency(2), %	-- --	99.97	99.97	99.97	99.97
Charcoal Adsorber					
Type	-- --	Horizontal tray	Horizontal tray	Horizontal tray	Horizontal tray
Depth, in.	-- --	2 3/16	2 3/16	2 3/16	2 3/16
Filter media	-- --	Impregnated activated carbon	Impregnated activated carbon	Impregnated activated carbon	Impregnated activated carbon
Pressure drop, in. wg	-- --	1.2	1.2	1.2	1.2
Efficiency					
Removing inorganic iodine, %	-- --	70	70	70	70
Removing organic iodine, %	-- --	70	70	70	70
HEPA filter, downstream	-- --	N/A	N/A	N/A	N/A

(1) Dust spot test or atmospheric dust.
(2) By MIL Standard 282 DCP test method 0.3.
(3) Retained for numbering purposes
(4) 0F133 – 1,250 cfm
0F136 – 1,250 cfm
0F139 – 1,250 cfm
0F142 – 1,080 cfm
Unfiltered Exh – 2,350 cfm
(5) System includes four banks of filters.
(6) 70% Relative Humidity

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TABLE 9.4-3

REACTOR BUILDING HVAC SYSTEMS DESIGN PARAMETERS

ITEM	SUPPLY UNIT SYS. NO. V-202	EXHAUST FANS SYS. NO. V-205	EQUIP. COMP. EXH. SYSTEM SYS. NO. V-206	SUPPLY UNIT SYS. NO. V-212	EXHAUST FANS SYS. NO. V-213	FILTERED EXH. SYSTEM SYS. NO. V-217	MAIN STEAM PIPE TUNNEL COOLING UNITS SYS. NO. V-201
Type	Built-up Unit	Fans in Built-up Exh. Plenum	Built-up Unit	Built-up Unit	Fans in Built-up Exh. Plenum	Built-up Unit	Built-up Unit
Number of units	1	1	2	1	1	2	2
Flow rate each							
cfm for Unit 1	67,750	39,930	27,890	92,050	86,350	6,600	42,000
cfm for Unit 2	67,650	42,880	28,420	86,950	82,200	5,550	42,000
Fan							
Type	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Vane-axial
Drive	Belt	Belt	Belt	Belt	Belt	Belt	Direct
No. of fans per unit	2	2	1	2	2	1	1
No. of running fans	1	1	1	1	1	1	1
Total static pressure, each, in. WG	5	4	14	4.5	4.5	15	15
Motor hp, each	100	50	100	100	125	30	25
Cooling Coils							
No. of coils per unit	4	N/A	N/A	4	N/A	N/A	2
Cooling cap. each, Btu/hr.	420,000	N/A	N/A	650,000	N/A	N/A	304,000
Heating Coils							
No. of coils per unit	4	N/A	N/A	4	N/A	N/A	N/A
Heating cap, each, Btu/hr. (Unit 1)	1,810,000 (530 kW)	N/A	N/A	1E227A-1,766,000 (517.5 kW) 1E227B-1,766,000 (517.5 kW) 1E227C-2,237,000 (655.5 kW) 1E227D-2,237,000 (655.5 kW)	N/A	N/A	N/A

TABLE 9.4-3 (Cont'd)

REACTOR BUILDING HVAC SYSTEMS DESIGN PARAMETERS

ITEM	SUPPLY UNIT SYS. NO. V-202	EXHAUST FANS SYS. NO. V-205	EQUIP. COMP. EXH. SYSTEM SYS. NO. V-206	SUPPLY UNIT SYS. NO. V-212	EXHAUST FANS SYS. NO. V-213	FILTERED EXH. SYSTEM SYS. NO. V-217	MAIN STEAM PIPE TUNNEL COOLING UNITS SYS. NO. V-201
Heating cap. each, Btu/hr. (Unit 2)	1,810,000 (530 kW)	N/A	N/A	2E227A-1,531,000 (448.5 kW) 2E227B-1,531,000 (448.5 kW) 2E227C-2,237,000 (655.5 kW) 2E227D-2,237,000 (655.5 kW)	N/A	N/A	N/A
Prefilters or Filters							
Quantity and size, in.	36-24x24x12	N/A	16-24x24x12	44-24x24x12	N/A	2-24x24x12	N/A
Pressure drop, in. WG							
Clean	0.5	N/A	0.3	0.5	N/A	0.3	N/A
Dirty	1.0	N/A	0.9	1.0	N/A	0.9	N/A
Efficiency(3), %	50 min.	N//A	85 min.	50 min.	N/A	85 min.	N/A
HEPA filter, upstream							
Quantity and size, in.	N/A	N/A	16-24x24x12	N/A	N/A	2-24x24x12	N/A
Pressure drop, in. WG							
Clean	N/A	N/A	1.0	N/A	N/A	1.0	N/A
Dirty	N/A	N/A	3.0	N/A	N/A	3.0	N/A
Efficiency(4), %	N/A	N/A	99.97%	N/A	N/A	99.97%	N/A
Charcoal adsorber							
Type	N/A	N/A	Vertical bed	N/A	N/A	Vertical bed	N/A
Depth, in.	N/A	N/A	6.in.	N/A	N/A	6 in.	N/A
Filter media	N/A	N/A	Impregnated activated carbon	N/A	N/A	Impregnated activated carbon	N/A

TABLE 9.4-3 (Cont'd)

REACTOR BUILDING HVAC SYSTEMS DESIGN PARAMETERS

ITEM	SUPPLY UNIT SYS. NO. V-202	EXHAUST FANS SYS. NO. V-205	EQUIP. COMP. EXH. SYSTEM SYS. NO. V-206	SUPPLY UNIT SYS. NO. V-212	EXHAUST FANS SYS. NO. V-213	FILTERED EXH. SYSTEM SYS. NO. V-217	MAIN STEAM PIPE TUNNEL COOLING UNITS SYS. NO. V-201
Pressure drop, in. WG	N/A	N/A	3.1	N/A	N/A	3.1	N/A
Efficiency	N/A	N/A		N/A	N/A		N/A
Rem. Inorganic iodine, %	N/A	N/A	99	N/A	N/A	99	N/A
Rem. Organic iodine, %	N/A	N/A	99	N/A	N/A	99	N/A
HEPA filter, downstream(5)	N/A	N/A	(5)	N/A	N/A	(5)	N/A

(1) Normally two filter trains operate in conjunction with one fan rated at 29,150 cfm.
(2) Normally two filter trains operate in conjunction with one fan rated at 7,000 cfm.
(3) Dust spot test on atmospheric dust.
(4) By MIL Standards 282DOP test method on 0.3 micron particles.
(5) All design parameters same as HEPA, upstream.
(6) 70% Relative Humidity.

TABLE 9.4-4

REACTOR BUILDING - SAFETY RELATED AND RCIC AIR COOLING SYSTEM DESIGN PARAMETERS

Item	Emergency SWGR Rooms Cooling Units Sys. No. V-222	RCIC Pump Room Unit Coolers V-208 A&B	HPCI Pump Room Unit Coolers V-209 A&B	RHR Pump Rooms Unit Coolers		Core Spray Pump Rooms Unit Coolers	
				RHR North V-210 B&D	RHR South V-210 A&C	North V-211 B&D	South V-211 A&C
Type	Built-up unit	Built-up unit	Built-up unit	Built-up unit	Built-up unit	Built-up unit	Built-up unit
Number of Units	2	2	2	2	2	2	2
Flow rate, each cfm	14,000	5,000	7,000	25,600	25,600	10,000	10,000
Fan							
Type	Centrifugal	Vane-axial	Vane-axial	Vane-axial	Vane-axial	Vane-axial	Vane-axial
Drive	Belt	Direct	Direct	Direct	Direct	Direct	Direct
No. of fans per unit	1	1	1	1	1	1	1
No. of running fans	1	1	1	1	1	1	1
Total pressure, in. WG	3.4[1]	0.93[5]	0.85[5]	0.89[5]	0.89[5]	0.85[5]	0.85[5]
Motor, hp, each	15	1.5	1.5	10	10	2.0	2.0
Cooling Coil							
No. of coils per unit	2[2]	1	1	1	1	1	1
Cooling capacity, each[2], Btu/hr	191,172 (CHW) 476,400 (Emerg.)	100,000	140,000	520,000	520,000	200,000	200,000
Filters							
Quantity and size, in.	8-24x24x12	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
Pressure drop, in. WG							
Clean	0.35	N/A	N/A	N/A	N/A	N/A	N/A
Dirty	1.00	N/A	N/A	N/A	N/A	N/A	N/A
Efficiency[3]	90%	N/A	N/A	N/A	N/A	N/A	N/A

(1) External unit static pressure is 2 in. WG.
(2) Two in series coils, one - chilled water coil (CHW) supplied from RBCW, the other-emergency use control structure chilled water coil for unit 2 will use direct expansion cooling coils with a capacity of approximently 360,000 BTU/HR.
(3) Dust spot test on atmospheric dust.
(4) 2 in. thick "throw away" roughing filters construction filters only, no filters used during normal plant operation.
(5) Fan total pressure (static plus velocity pressure).

TABLE 9.4-5

REACTOR BLDG HVAC SYSTEMS FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power supply	Total loss of offsite power (LOOP)	None. All safety-related equipment and controls are redundant and are powered from separate standby diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Cooling fans RHR room-south (V-210)	Loss of a fan	Eventual loss of the fans' associated pump.	Alarm in the control room	No loss of safety function. The RHR pumps in separate rooms are redundant (See Section 6.3)
Emergency (LOCA or LOCA + LOOP)	Cooling fans RHR room-south (V-210)	Loss of both fans	Eventual loss of the two RHR pumps in the room.	Alarm in the control room	No loss of safety function. The RHR pumps in separate rooms are redundant (See Section 6.3)
Emergency (LOCA or LOCA + LOOP)	Cooling fans RHR room-north (V-210)	Loss of a fan	Eventual loss of the fans' associated pump.	Alarm in the control room	No loss of safety function. The RHR pumps in separate rooms are redundant (See Section 6.3)
Emergency (LOCA or LOCA + LOOP)	Cooling fans RHR room-north (V-210)	Loss of both fans	Eventual loss of the two RHR pumps in the room.	Alarm in the control room	No loss of safety function. The RHR pumps in separate rooms are redundant (See Section 6.3)
Emergency (LOCA or LOCA + LOOP)	Cooling fans RCIC room (V-208)	Loss of one fan	None. The standby fan will automatically start.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Cooling fans RCIC room (V-208)	Loss of both fans	Eventual loss of the RCIC system	Alarm in the control room	No loss of safety function. The RCIC system is backed up by the HPCI system (See Subsection 5.4.6)
Emergency (LOCA or LOCA + LOOP)	Cooling fans HPCI room (V-209)	Loss of one fan	None. The standby fan will automatically start.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Cooling fans HPCI room (V-209)	Loss of both fans	Eventual loss of the HPCI system	Alarm in the control room	No loss of safety function. The HPCI system is backed up by the ADS or LPCI or Core Spray (See Section 6.3)

TABLE 9.4-5 (Continued)

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (LOCA or LOCA + LOOP)	Cooling fans core spray pumps room (V-211)	Loss of a fan	Eventual loss of the fans' associated pump	Alarm in the control room	No loss of safety function. The core spray pumps in separate rooms are redundant (See Section 6.3)
Emergency (LOCA or LOCA + LOOP)	Cooling fans core spray pumps room (V-211)	Loss of both fans	Eventual loss of the two core spray pumps in the room	Alarm in the control room	No loss of safety function. The core spray pumps in separate rooms are redundant (See Section 6.3)
Emergency (LOCA or LOCA + LOOP)	Emergency SWGR cool fans (V-222)	Loss of one fan	None. The standby fan will automatically start.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fan discharge dampers	Damper failure	None. The dampers are designed to fail closed. When the damper fails closed it trips and locks out its associated fan. Then standby fan automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Emergency service water cooling coils	Loss of ESWS or loss of water due to pipe break	None. The standby fan will automatically start.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Recirc system to vent system ductwork dampers 2 in parallel (HD-17601, HD-17602 HD-17657)	Failure of one damper	None. The dampers are redundant and are in parallel; therefore, failure of one branch does not affect the system air flow.	Damper position indication in the control room	No loss of safety function
Emergency (Zone III isolation with or without LOOP)	Recirc system to vent system ductwork dampers 2 in parallel (HD-17601, HD-17602 HD-17657)	Failure of one damper	None. The dampers are designed to fail in the safe closed position. In addition, redundant air flow switches are provided to alarm in the control room in the event of an air flow leak.	Damper position indication in the control room	No loss of safety function
Emergency (pipe break in rooms containing high energy piping)	Backdraft isolation dampers (BDID)	Failure of one damper	The closure function is not credited in the high energy line break analysis; therefore, there is no impact if a damper fails to close.		

TABLE 9.4-5 (Continued)

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (LOCA or Zone III isolation with or without LOOP)	Recirc system fans (0V-201)	Loss of one fan	None. The standby fan will automatically start.	Alarm in the control room	No loss of safety function
Emergency (LOCA or Zone III isolation with or without LOOP)	Recirc system fan disch dampers (HD-07545)	Damper failure	None. The dampers are fail-closed. When the damper fails closed it trips and isolates its associated fan. The standby fan will automatically start.	Damper position indication in the control room	No loss of safety function
Emergency (LOCA or Zone III isolation with or without LOOP)	Recirc system plenum to SGTS dampers (HD-07543)	Failure of one damper	None. The dampers are redundant and are in parallel. Failure of one damper does not affect the system air flow.	Damper position indication in the control room	No loss of safety function
Emergency (LOCA loss of safety or LOCA + LOOP)	Zone I isolation dampers (HD-17524 HD-17576 HD-17586)	Failure of one damper	None. The dampers are redundant and are in series. Only one damper is needed to close and isolate. In addition, the dampers are designed to fail safe in closed position.	Damper position indication in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Unit 2 Emergency SWGR Refrigeration Units (2K-210 & 2E-297)	Loss of one unit	None. Upon loss of one unit, automatic transfer to the standby unit occurs.	Alarm in control room	No loss of safety function.

TABLE 9.4-6

RADWASTE BUILDING HVAC SYSTEMS DESIGN PARAMETERS

Item	SUPPLY SYS 0V-301A&B	OFF GAS AREA UNIT COOLERS OV-309 A&B	FILTERED EXHAUST OV-302 A&B	FILTERED LRW TANK VENT OV-304
Type	Built-up Unit	Air Handling Unit	Built-up Unit	Built-up Unit
Number of Units	2	2	2	1
Flow Rate Each, cfm	60,540	25,815	68,905[(1)] fan 34,453[(1)] filter	1,000
FAN				
Type	Centrif.	Centrif.	Centrif.	Centrif
Drive	Belt	Belt	Belt	Belt
No. of Fans per Unit	1	1	1	1
No. of Running, Fans	1	1	1	1
Static Pressure, Each, in. wq.	4	3.8	12	6
Motor hp, each	50	30	150	3
Cooling Coil				
No. of Coils per unit	6	2	n/a	n/a
Cooling capacity Each, BTU/hr	292.000	1.085.000	n/a	n/a
Heating Coils				
No. of Coils per unit	6	n/a	n/a	1
Cooling Capacity Each, BTU/hr	1,020,000 (300 KW) 1 Filter Bank Containing		n/a 2 Filter Banks each Containing	25,500 (7.5KW)
Prefilters				
Quantity and Size, in.	24-24x24x12	n/a	30-24x24x12	1-24x24x12
Pressure Drop, In. wg				
Clean	.5		0.3	0.3
Dirty	1.6		0.9	0.9
Efficiency[(2)], %	50 min.		95	95

TABLE 9.4-6

RADWASTE BUILDING HVAC SYSTEMS DESIGN PARAMETERS

Item	SUPPLY SYS 0V-301A&B	OFF GAS AREA UNIT COOLERS OV-309 A&B	FILTERED EXHAUST OV-302 A&B	FILTERED LRW TANK VENT OV-304
HEPA Filter, Upstream	n/a	n/a		
Quantity and size, in.			30-24x24x12	1-24x24x12
Pressure Drop, in. wg				
Clean			1	1
Dirty			3	3
Efficiency (3), %			99.97	99.97
Charcoal	n/a	n/a	n/a	
Type				Horizontal Tray
Depth, in.				2 3116
Filter Media				Impreg. Act. Char.
Pressure Drop, in. wg				1.2
Efficiency				
Removing Inorganic Iodine, %			-	70
Removing Organic Iodine, %			-	70
HEPA Filter, Downstream	n/a	n/a	n/a	n/a

(1) Normally two filter units operate in conjunction with one fan, each fan rated at 50,000 cfm
(2) Dust spot test on atmosphere dust.
(3) By MIL Standard 282 DOP test method on 0.3 micron particles.

TABLE 9.4-7

TURBINE BUILDING HVAC SYSTEMS DESIGN PARAMETERS

Item	Supply Sys V-101	MG Set Clng. Supp V-103	Return Sys V-104	Recirc Sys V-105	Filt Exhaust V-106	Cond PP Rm Clng V-112	Cond Unit Clrs V-113	Batt Rm Exh V-114
Type	Built-Up	Built-Up	Built-Up	Built-Up	Built-Up	Unit Coolers	Unit Coolers	Fan
Number of units	2	2	2	2	2	4	4	1
Flow rate each, cfm	137,470	70,337	109,100	50,000	42,760[1] fan 21,380[1] filter	20,000	24,000	2,600
Fan								
Type	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.	Centrif.
Drive	Belt	Belt	Belt	Belt	Belt	Belt	Belt	Belt
No. of fans per unit	1	1	1	1	1	1	1	1
No. of running, fans	1	1	1	1	1	2	2	1
Static pressure, Each, in. wq.	5.5	4	4	6	18	2	2.5	2.5
Motor hp, each	200	100	125	75	200	20	20	5
Cooling Coil		N/A	N/A		N/A	N/A	--	N/A
No. of coils per unit	8	--	--	6	--	2	2	--
Cooling cap. Each, Btu/hr	600,800	--	--	430,000	--	1,080,000	1,040,000	--
Heating Coils		N/A	N/A	N/A	N/A	N/A	N/A	N/A
No. of coils per unit	8	--	--	--	--	--	--	--
Cooling cap. Each, Btu/hr	765,000 (225 kW)	--	--	--	--	--	--	--
Prefilters (Filters)					2 filter housings, each containing			
Quantity and size, in.	56-24x24x12	36-24x24x12	--	24-24x24x12	21-24x24x12	--	--	
Pressure drop, in. wq			N/A			N/A	N/A	
Clean	0.5	0.5	--	0.5	0.3	--	--	
Dirty	1.4	1.0	--	1.0	0.9	--	--	
Efficiency[2], %	50 min.	50 min.	--	50 min.	95	--	--	
HEPA filter, upstream	N/A	N/A	N/A	N/A		N/A	N/A	
Quantity and size, in.	--	--	--	--	1-24x24x12	--	--	
Pressure drop, in. wq								
Clean	--	--	--	--	1.0	--	--	
Dirty	--	--	--	--	3.0	--	--	
Efficiency[3], %	--	--	--	--	99.95	--	--	

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TABLE 9.4-7

TURBINE BUILDING HVAC SYSTEMS DESIGN PARAMETERS

Item	Supply Sys V-101	MG Set Clng. Supp V-103	Return Sys V-104	Recirc Sys V-105	Filt Exhaust V-106	Cond PP Rm Clng V-112	Cond Unit Clrs V-113	Batt Rm Exh V-114
Charcoal adsorber	N/A	N/A	N/A	N/A		N/A	N/A	
Type	--	--	--	--	Vertical bed	--	--	
Depth, in	--	--	--	--	6	--	--	
Filter media	--	--	--	--	Impregnated activated charcoal	--	--	
Pressure drop, in. wq	-	-	-	-	3.1	-	-	
Efficiency								
Rem. Inorganic Iodine, %	-	-	-	-	99.9 min			
Rem. organic iodine, %	-	-	-	-	99.5 min			

(1) Normally two filter units operate in conjunction with one fan, each fan rated at 40,000 cfm.

(2) Dust spot test on atmospheric dust.

(3) Field tested to current procedure. A efficiency less than, or equal, requires corrective action

TABLE 9.4-8

Unit 1 and 2 Primary Containment Unit Coolers and Recirculation Fans' Design Parameters

------------- SAFETY RELATED ------------			------------------- NON-SAFETY RELATED ------------------				
Item	RPV Head Area V-414 A&B	CRD Area V-418 A&B	Drywell General Area V-416 A&B	RPV Annulus V-411 A&B	Drywell General Area V-412 A&B	Drywell General Area V-413 A&B	Drywell General Area V-417 A&B V-415 A&B
Type	Built-up	Fan	Built-up	Built-up	Built-up	Built-up	Built-up
Number of units	2	2	2	2	2	2	4
Flow rate each, cfm	8,650/4320	8,650/4325	8,650/4320	8,650/4320	8,650/4320	8,650/4320	8,650/4320
Fan							
Type	Vane-axial	Vane-axial	Vane-axial	Vane-axial	Vane-axial	Vane-axial	Vane-axial
Drive	Direct	Direct	Direct	Direct	Direct	Direct	Direct
No. of fans per unit	1	1	1	1	1	1	1
No. of running fans[1]	1	1	1	1	1	1	1
Total External static pressure, each, in. wg.	4.2./2.5	.25/.16	4.2/2.5	4.2/2.5	4.2/2.5	4.2/2.5	4.2/2.5
High speed, rpm	1,770	1,770	1,770	1,770	1,770	1,770	1,770
Low speed, rpm	870	870	870	870	870	870	870
Motor hp, each Hi/Lo speed	10/5	5/2.5	10/5	10/5	10/5	10/5	10/5
Cooling Coil							
No. of coils per unit	1	N/A	1	1	1	1	1
Cooling capacity each, Btu/hr	676,000	N/A	676,000	676,000	676,000	676,000	676,000
Heating Coils	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Filters[2]							

(1) See Table 9.4-9 for operating modes.

(2) "Throw-away" type roughing filters two inch thick were used during plant construction only. No filters are used during normal plant operation.

Table 9.4-9

DRYWELL UNIT COOLERS' AND RECIRCULATION FANS' OPERATING MODES

Number of Power Requirements of Operating Unit Coolers and Recirculation Fans

Condition of Operation	Unit 1	Unit 2
1. Normal Operation	7 to 14 Coolers / 10 HP each and 1 Recirc. Fan / 5 HP [a]	7 to 14 Coolers/ 10 HP each 1 Recirc. Fan/ 5 HP [a]
2. Loss of Chilled Water in Unit 1 [e]	14 Coolers/ 10 HP each and 1 Recirc. Fan/ 5 HP[c]	7 to 14 Coolers/ 10 HP each 1 Recirc. Fan/ 5 HP [a]
3. GE LOCA Signal in Unit 1 [e]	4 Coolers/ 5 HP each and 2 Recirc. Fans/ 2.5 HP ea.[b]	7-14 Coolers/ 10HP each 1-2 Recirc. Fans/ 5 HP each [c]
4. Scram in Unit 1[e]	7 to 14 Coolers/ 10 HP each and 1-2 Recirc. Fans/ 5 HP	7 to 14 Coolers/ 10 HP each 1 Recirc. Fan/ 5 HP [a]
5. Loss of Offsite Power [f]	14 Coolers/ 10 HP each and 1 Recirc. Fan/ 5 HP	14 Coolers/ 10 HP each 1 Recirc. Fan/ 5 HP
6. Design Basis Accident (LOCA in Unit 1 and Loss of Offsite Power) [e][f]	4 Coolers/ 5 HP each and 2 Recirc. Fans/ 2.5 HP [b]	14 Coolers/ 10 HP each 1 Recirc. Fan/ 5 HP
7. Containment Purge[e]	7 to 14 Coolers/ 10 HP each and 1 Recirc. Fan/ 5 HP [a]	7 to 14 Coolers/ 10 HP each 1 Recirc. Fan/ 5 HP [a]
8. Integrated Leak Rate Test	14 Coolers max./ 5 HP each	14 Coolers max./ 5 HP each

Table 9.4-9

DRYWELL UNIT COOLERS' AND RECIRCULATION FANS' OPERATING MODES

Number of Power Requirements of Operating Unit Coolers and Recirculation Fans

(a) 7 Coolers are initially started and continue to run. Additional Coolers are started as required to maintain the drywell temperature within the design limits. One CRD area recirculation fan is operated normally. Second recirculation fan is placed in "auto high".

(b) All coolers stop automatically, 4 coolers and 2 CRD area recirculation fans must be started manually on low speed (only three are required).

(c) 7 coolers are initially started and continue to run. Additional coolers are started, as required, to maintain the drywell temperature within the design limits. One CRD area recirculation is operated normally. Second recirculation fan is placed in "auto-high" and it is started automatically on high temperature in the CRD area.

(d) Not used.

(e) For off-normal conditions occurring in Unit 2, the unit cooler requirements are reversed.

(f) Conditions 5 and 6 affect diesel generator loading.

TABLE 9.4-10

Primary Containment Atmosphere Recirculation and Cooling System Failure Mode and Effect Analysis

Plant Operating Mode	System Component	Component Failure Mode	Effect Of Failure On The System	Failure Mode Detection	Effect Of Failure On Plant Operation
Emergency	Power supply	Total loss of offsite power (LOOP).	None. All units are powered from the standby diesel generators and will restart when emergency power is on.	Alarm in the control room.	No loss of safety function.
Emergency (LOCA or LOCA + LOOP)	Fans - V414A&B V416A&B V418A&B	Loss of one fan of the pair. (loss of one division)	None. All ESF units are manually started (two redundant fans operating).	Indicating lights in the control room.	No loss of safety function on loss of one of the two redundant fans.

NOTE: In addition to 7 sets of unit coolers, primary containment atmosphere recirculation and cooling system includes 2 reactor under vessel CRD area recirculation fans. Analysis shown above applies to both Unit 1 and 2.

TABLE 9.4-11

DIESEL GENERATOR A, B, C AND D BUILDING HVAC SYSTEMS DESIGN PARAMETERS

Item	Vent System 0V-512 (1)	Basement Vent. 0V-511 (1)
Type	Vane Axial	Tubular
Flow rate each, cfm	96,000 (2)	3,000 (2)
Fan		
Type	Propeller	Propeller
Drive	Direct	No. 9 Susp. Horiz.
No. of fans per diesel gen.	1	1
No. of running fans	1	1
Static pressure, each, in wg	1.64	0.25
Motor hp, each	40	1.5
Cooling Coil	N/A	N/A
Heating Coils	N/A	N/A
Filters	N/A	N/A

(1) Typical for each emergency diesel generator

(2) Allowable tolerances are +/- 10%

TABLE 9.4-12

DIESEL GENERATOR BLDGS H&V
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power supply	Total loss of offsite power (LOOP)	None. Units are powered from their associated diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOOP or LOCA + LOOP)	Fan, inlet damper, exhaust damper, and recirc damper	Loss of fan, any damper, or combination of dampers	Possible loss of the ventilation system and eventually loss of one diesel generator	Alarm in the control room. High and low room temperatures are alarmed also in control room.	No loss of safety function. The remaining three diesel generators are capable of meeting all requirements for a safe shutdown of the plant.

NOTE: Failure of the instruments such as temp. element, temp. transmitter, and temp. controller could result in failure of the dampers and eventually loss of the diesel generator.

TABLE 9.4-13

ESSW PUMPHOUSE HVAC SYSTEMS DESIGN PARAMETERS

Division I Pump Room: Division II Pump Room:	Unit ESSW Pump Ventilation Fans 1,2V-506A 1,2V-506B[(1)]	Common ESSW Pump Ventilation Fans 0V-521A,C 0V-521B,D[(2)]
Type	Vane Axial	Vane Axial
Flow rate each, cfm	12,500	10,000
Fan		
Type	Propeller	Propeller
Drive	Direct	Direct
No. of fans per ESSW Unit (1, 2, Common)	2	4
No. of running fans per running pump	1[(3)]	1[(3)]
Static pressure, each, in wg	1	1
Motor hp, each	5	5
Cooling Coil	N/A	N/A
Heating Coils	N/A	N/A
Filters	N/A	N/A

(1) Descriptions are typical for each of the four unit ESSW pump fans. Fans 1, 2V-506A in the Division I pump room serve Residual Heat Removal Service Water (RHRSW) Pumps 1, 2P-506A; and fans 1,2V-506B in the Division II pump room serve RHRSW Pumps 1, 2P-506B.

(2) Descriptions are typical for each of the four common ESSW pump fans. Fans 0V-512A,C in the Division I pump room serve Emergency Service Water (ESW) Pumps 0P-504A,C; and fans 0V-521B,D in the Division II pump room serve ESW Pumps 0P-504B,D.

(3) Additional fan(s) adjacent to the running fan(s) may be started manually from the control room, or will be started automatically by the high temperature switch when additional cooling is required.

TABLE 9.4-14

ENGINEERED SAFEGUARD SERVICE WATER
PUMPHOUSE H&V SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power Supply	Total loss of offsite power (LOOP)	None. All units are powered from their associated diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Ventilation fans	Loss of the fan	Loss of ventilation system and possible loss of all other ESF systems in the area such as the RHR service wtr system & emergency service wtr system (one division only).	Alarm in the control room. High and low temperatures in the building are also alarmed in control room.	No loss of safety functions. The remaining redundant systems are capable of safe shutdown of the plant.
Emergency (LOCA or LOCA + LOOP)	Intake, exhaust, & return dampers	Loss of any one or combination of dampers	Possible loss of the ventilation system and eventually loss of all other ESF systems in the area such as the RHR service wtr system & emergency service water system (one division only).	Fan failure, high and low room temperatures are alarmed in the control room.	No loss of safety function. The remaining redundant systems are capable of safe shutdown of the plant..

NOTE 1: Failure of the instruments such as temp. element, temp. transmitter, and temp. controller could result in failure of the dampers and eventually loss of ventilation systems.

TABLE 9.4-15

CIRC. WATER PUMPHOUSE HVAC SYSTEMS DESIGN PARAMETERS

Item	Diesel Rm. Clng. OV-506	Fire PP. & Sump RR. Rm. OV-503	Toilet Roof Exh. OV-501	Oil Analysis Lab. Roof Exh. OV-507	Circ. PP. Rm. Exh. (1) 1V-503 A&B IV-501 A-H	Wtr. Trmt. Rm. Vent OV-505	Wtr. Trmt. Rm. Vent OV-502
Type	Roof Mounted	Roof Mounted	Roof Mounted	Roof Mounted	Roof Mounted	Roof Mounted	Tubular
Number of units	1	1	1	1	10	1	1
Flow rate each, cfm	7,000	2,300	200	1,280	18,500	6,000	10,000
Fan							
Type	Centrif.	Centrif.	Centrif.	Centrif.	Propeller	Centrif.	Ducted Propeller
Drive	Belt	Belt	Belt	Belt	Belt	Belt	#9 Ceiling Susp
No. of fans per unit	1	1	1	1	1	1	2
No. of running fans	1	1	1	1	As req.	1	As req.
Total pressure, each, in.wg.	0.5	0.5	0.5	0.625	0.5	0.5	1
Motor hp, each	2	.75	.25	.75	5	1.5	5
Cooling Coil	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Heating Coils	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Filters	N/A	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 9.4-16

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
CONTROL ROOM FLOOR COOLING SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power Supply	Total loss of offsite power (LOOP)	None. The systems are redundant and are powered from separate standby diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fans (0V117)	Loss of one fan	None. The standby unit automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fans (0V117) outlet dampers	Damper fails and closes	None. The dampers are designed to fail safe in the close position. When the damper fails closed it trips and isolates its associated fan and the standby unit automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Isolation dampers (HD-07833)	Damper failure	None. The two isolation dampers are in series and are designed to fail safe in the closed position. Only one damper is needed to close and effectively isolate.	Damper position indication in the control room	No loss of safety function

TABLE 9.4-17

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
COMPUTER ROOM FLOOR COOLING SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power Supply	Total loss of offsite power (LOOP)	None. The systems are redundant and are powered from separate diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fans (OV115)	Loss of one fan	None. The standby unit automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fans (OV115) outlet dampers	Damper fails and closes	None. The dampers are designed to fail safe in the closed position. When the damper fails closed it trips its associated fan and the standby unit automatically starts.	Alarm in the control room	No loss of safety function

TABLE 9.4-18

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
CONTROL STRUCTURE H&V SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power Supply	Total loss of offsite power (LOOP)	None. The systems are redundant and are powered from separate standby diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or radiation in outside air, with or without LOOP)	Fans (0V103)	Loss of one fan	None. The standby unit automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or radiation in outside air with or without LOOP)	Fans (0V103) outlet dampers	Damper failure	None. The dampers are redundant and are designed to fail safe in the closed position. When the damper fails close it trips and isolates its associated fan and the standby unit automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or radiation in outside air with or without LOOP)	Isolation dampers (HD-07802) (HD-07824)	Damper failure	None. Redundant isolation dampers are in series and are designed to fail safe in the closed position. Only one damper is needed to close and effectively isolate.	Damper position indication in the control room	No loss of safety function
Emergency (LOCA or radiation in outside air with or without LOOP)	Cooling coils	Loss of cooling coil due to leaks or rupture	None. The redundant full capacity unit train is put into operation.	Eventual loss of chilled water alarm in the control room	No loss of safety function
Emergency (LOCA or radiation in outside air with or without LOOP)	Electric heating coils	Failure of heating coil	None. The electric heating coils are not required to operate during emergency operation.	Temperature indicators at the duct and in local control panels	No loss of safety function
Emergency (radiation in outside air or Zone I, II or III isolation signals with or without LOOP)	Isolation dampers between Units 1 & 2 (HD-07824)	Damper failure	None. The redundant dampers are in series and are designed to fail in the safe closed position.	Damper position indication in the control room	No loss of safety function

TABLE 9.4-19

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
EMERGENCY OUTSIDE AIR SUPPLY SYSTEMS
FAILURE MODE AN EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power Supply	Total loss of offsite power (LOOP)	None. The systems are redundant and are powered from separate standby diesel generators.	Alarm in the control room	No loss of safety function
Emergency (High outside air radiation or Zones I, II or III isolation signals)	Fans (0V-101)	Loss of one fan	None. The standby fan automatically starts.	Alarm in the control room	No loss of safety function
Emergency (High outside air radiation or Zones I, II or III isolation signals)	Fan outlet dampers (HD-07811)	Damper failure	None. The dampers are designed to fail close. When the damper fails closed it trips its associated train and isolates the entire filter train. The standby train will then automatically start.	Alarm in the control room	No loss of safety function
Emergency (High outside air radiation or Zones I, II or III isolation signals)	Emergency outside air dampers (HD-07812, HD-07814)	Damper failure	These are two sets of redundant dampers in parallel. Because they are in parallel failure of one does not affect the system. These dampers are designed to fail in the closed position because they were used for isolation during high chlorine condition	Damper position indication in the control room	No loss of safety function

TABLE 9.4-19

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
EMERGENCY OUTSIDE AIR SUPPLY SYSTEMS
FAILURE MODE AN EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (High radiation in outside air or Zones I, II or III isolation signals)	Recirculation inlet inlet dampers (HD-07813)	Damper failure	None. These dampers are designed to fail closed and are required to be closed during this mode of operation.	Damper position indication in the control room	No loss of safety function
Emergency (High radiation in outside air or Zones, I, II or III isolation signals)	Electric heating coil (0E-143)	Heater failure	None. High temperature (pre-ignition) is alarmed in the control room. At a higher temperature (ignition) the train is tripped and isolated. The standby train automatically starts. When the heater fails (no heat) the train is also tripped and the standby train automatically starts.	Alarms in the control room (pre-ignition and ignition temperatures)	No loss of safety function
Emergency (High radiation in outside air or Zones I, II or III isolation signals)	Prefilter, downstream and upstream HEPA filters	High differential pressure across any of these components	None. If any of these filters is completely clogged, air flow will be lost and the standby unit will automatically start.	Local differential pressure indicators. Pressure differential across the upstream HEPA filter is recorded and alarmed in the control room in compliance with Regulatory Guide 1.52.	No loss of safety function

TABLE 9.4-19

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
EMERGENCY OUTSIDE AIR SUPPLY SYSTEMS
FAILURE MODE AN EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency (High radiation in outside air or Zones I, II or III isolation signals)	Charcoal absorbers (0F-125)	High temperature (ignition temperature)	None. Pre-ignition temperature is alarmed in the control room. At a higher temperature (ignition) the fire protection deluge water valves are opened, the whole train is tripped and isolated and the standby train automatically starts.	Pre-ignition and ignition temperature alarms in the control room	No loss of safety function
Emergency (High radiation in outside air or Zones I, II or III isolation signals)	Q-listed fire protection backup deluge water valve (TV-07813)	Valve failure	None. These values are designed to fail closed and are used to backup the non-seismically qualified deluge valves.	Alarm in the control room	No loss of safety function

TABLE 9.4-20

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
SGTS EQUIPMENT ROOM H&V SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE OF PLANT OPERATION
Emergency	Power Supply	Total loss of Offsite Power (LOOP)	None. The systems are redundant and are powered from separate standby diesel generators.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fans (OV-118)	Loss of one fan	None. The standby fan automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or or LOCA + LOOP)	Fan outlet dampers (HD-07841)	Damper failure	None. The dampers are designed to fail closed. When the damper fails closed it trips and isolates its associated fan. The standby fan automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fans (OV-144)	Loss of one fan	None. The standby fan automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Fan outlet dampers (HD-07842)	Damper failure	None. The dampers are designed to fail closed. When the damper fails closed it trips and isolates its associated fan. The standby fan automatically starts.	Alarm in the control room	No loss of safety function
Emergency (LOCA or LOCA + LOOP)	Electric heaters (OE-144)	Heater failure	None. The standby fan automatically starts on failure of the running unit as well as on low or high room temperature.	Fan status indicating lights in the control room	No loss of safety function

TABLE 9.4-21

CONTROL ROOM & CONTROL STRUCTURE HVAC SYSTEMS
BATTERY ROOM EXHAUST SYSTEMS
FAILURE MODE AND EFFECT ANALYSIS

PLANT OPERATING MODE	SYSTEM COMPONENT	COMPONENT FAILURE MODE	EFFECT OF FAILURE ON THE SYSTEM	FAILURE MODE DETECTION	EFFECT OF FAILURE ON PLANT OPERATION
Emergency	Power supply	Total loss of offsite power (LOOP)	None. The systems are redundant and are powered from separate standby diesel generators.	Alarm in the control room	No loss of safety function
Emergency (High outside air radiation or Zones I, II or III isolation signals)	Fans (0V-116)	Loss of one fan	None. The standby fan automatically starts.	Alarm in the control room	No loss of safety function [gp1]
Emergency (High outside air radiation or Zones I, II or III isolation signals)	Fan outlet dampers (HD-07871A1&B) Isolation dampers (HD-07871A2&B2)	Damper failure	None. The dampers are designed to fail closed. When the damper fails closed it trips and isolates its associated fan. The standby fan automatically starts.	Alarm in the control room	No loss of safety function

Table 9.4-8a

This Table Has Been Deleted

TABLE 9.4-11a

DIESEL GENERATOR 'E' BLDG. HVAC SYSTEMS DESIGN PARAMETERS

Item	Supply Vent System 0V-512E1 & 0V-512E2	Exhaust Vent System 0V-512E3	Exhaust Vent System 0V-512E4	Battery and Basement Exhaust Vent System 0V-511E
Type	Vaneaxial	Vaneaxial	Vaneaxial	Vaneaxial in-line
Flow Rate Each, CFM	56,000 [(1)]	56,000 [(1)]	53,200 [(1)]	2,800 [(1)]
Fan				
Type	Propeller	Propeller	Propeller	Propeller
Drive	Direct	Direct	Direct	Direct
No. of fans	2	1	1	1
No. of running fans	2	1	1	1
Static pressure, each, in w.g.	2.7	2.25	2.5	2.3
Motor hp, each	40	40	40	3.0
Cooling air	N/A	N/A	N/A	N/A
Heating coil	N/A	N/A	N/A	N/A
Filters	N/A	N/A	N/A	N/A

(1) Allowable tolerances are +/- 10%

TABLE 9.4-11b

DIESEL GENERATOR 'E' BUILDING VENTILATION SYSTEM DESIGN TEMPERATURE PARAMETERS

	Summer	Winter
Outdoor Ambient Conditions	92°Fd.B/78° w.b.	-5°F
Indoor Design Conditions		
• Elevation 675'-6" and 708'-0" with D/G 'E' "On"	120°F (Max)	72°F (Min)
• Elevation 675'-6" and 708'-0" with D/G 'E' "Off"	104°F (Max)	72°F (Min)
• Elevation 656'-6" – Battery room with D/G 'E' "On" or "Off"	104°F (Max)	65°F (Min)
• Elevation 656'-6" Remaining Area with D/G 'E' "On"	120°F (Max)	60°F (Min)
• Elevation 656'-6" Remaining Area with D/G 'E' "Off"	104°F (Max)	60°F (Min)

FIGURE RENUMBERED FROM 9.4-1 TO 9.4-1-1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE RENUMBERED FROM 9.4-1 TO 9.4-1-1

FIGURE 9.4-1, Rev. 54

AutoCAD Figure 9_4_1.doc

FIGURE RENUMBERED FROM 9.4-2 TO 9.4-2-1

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FIGURE RENUMBERED FROM 9.4-2 TO 9.4-2-1

FIGURE 9.4-2, Rev. 54

AutoCAD Figure 9_4_2.doc

FIGURE RENUMBERED FROM 9.4-3 TO 9.4-2-2

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FIGURE RENUMBERED FROM 9.4-3 TO 9.4-2-2

FIGURE 9.4-3, Rev. 54

AutoCAD Figure 9_4_3.doc

FIGURE RENUMBERED FROM 9.4-4 TO 9.4-4A

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FIGURE RENUMBERED FROM 9.4-4 TO 9.4-4A

FIGURE 9.4-4, Rev. 54

AutoCAD Figure 9_4_4.doc

FIGURE RENUMBERED FROM 9.4-5 TO 9.4-5A

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE RENUMBERED FROM 9.4-5 TO 9.4-5A

FIGURE 9.4-5, Rev. 54

AutoCAD Figure 9_4_5.doc

FIGURE RENUMBERED FROM 9.4-6 TO 9.4-6A

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE RENUMBERED FROM 9.4-6 TO 9.4-6A

FIGURE 9.4-6, Rev. 54

AutoCAD Figure 9_4_6.doc

FIGURE 9.4-7 REPLACED BY DWG. VC-175, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.4-7 REPLACED BY DWG. VC-175, SH. 1 FIGURE 9.4-7, Rev. 55

AutoCAD Figure 9_4_7.doc

FIGURE 9.4-8 REPLACED BY DWG. VC-175, SH. 2

FSAR REV. 65

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FIGURE 9.4-8 REPLACED BY DWG. VC-175, SH. 2

FIGURE 9.4-8, Rev. 55

AutoCAD Figure 9_4_8.doc

FIGURE 9.4-9 REPLACED BY DWG. VC-175, SH. 3

FSAR REV. 65

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FIGURE 9.4-9 REPLACED BY DWG. VC-175, SH. 3

FIGURE 9.4-9, Rev. 55

AutoCAD Figure 9_4_9.doc

FIGURE 9.4-10 REPLACED BY DWG. M-179, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.4-10 REPLACED BY DWG. M-179, SH. 1 FIGURE 9.4-10, Rev. 55

AutoCAD Figure 9_4_10.doc

FIGURE 9.4-11 REPLACED BY DWG. M-179, SH. 2

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FIGURE 9.4-11 REPLACED BY DWG. M-179, SH. 2

FIGURE 9.4-11, Rev. 48

AutoCAD Figure 9_4_11.doc

FIGURE 9.4-12 REPLACED BY DWG. VC-179, SH. 1

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FIGURE 9.4-12 REPLACED BY DWG. VC-179, SH. 1

FIGURE 9.4-12, Rev. 55

AutoCAD Figure 9_4_12.doc

FIGURE RENUMBERED FROM 9.4-13 TO 9.4-13A

FSAR REV. 65

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FIGURE RENUMBERED FROM 9.4-13 TO 9.4-13A

FIGURE 9.4-13, Rev. 54

AutoCAD Figure 9_4_13.doc

FIGURE 9.4-14 REPLACED BY DWG. VC-174, SH. 1

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FIGURE 9.4-14 REPLACED BY DWG. VC-174, SH. 1

FIGURE 9.4-14, Rev. 55

AutoCAD Figure 9_4_14.doc

FIGURE 9.4-15 REPLACED BY DWG. M-177, SH. 1

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FIGURE 9.4-15 REPLACED BY DWG. M-177, SH. 1

FIGURE 9.4-15, Rev. 56

AutoCAD Figure 9_4_15.doc

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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EXHAUST REGISTERS
REFUELING FLOOR

FIGURE 9.4-17, Rev 54

AutoCAD: Figure Fsar 9_ _17.dwg

FIGURE 9.4-18 REPLACED BY DWG. VC-182, SH. 1

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FIGURE 9.4-18 REPLACED BY DWG. VC-182, SH. 1

FIGURE 9.4-18, Rev. 50

AutoCAD Figure 9_4_18.doc

FIGURE 9.4-19 REPLACED BY DWG. M-182, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.4-19 REPLACED BY DWG. M-182, SH. 1 FIGURE 9.4-19, Rev. 50

AutoCAD Figure 9_4_19.doc

FIGURE 9.4-20 REPLACED BY DWG. M-173, SH. 1

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FIGURE 9.4-20 REPLACED BY DWG. M-173, SH. 1

FIGURE 9.4-20, Rev. 48

AutoCAD Figure 9_4_20.doc

FIGURE 9.4-21 REPLACED BY DWG. VC-173, SH. 1

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FIGURE 9.4-21 REPLACED BY DWG. VC-173, SH. 1

FIGURE 9.4-21, Rev. 48

AutoCAD Figure 9_4_21.doc

FIGURE 9.4-4A REPLACED BY DWG. M-176, SH. 1

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FIGURE 9.4-4A REPLACED BY DWG. M-176, SH. 1

FIGURE 9.4-4A, Rev. 55

AutoCAD Figure 9_4_4A.doc

FIGURE 9.4-4B REPLACED BY DWG. M-2176, SH. 1

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FIGURE 9.4-4B REPLACED BY DWG. M-2176, SH. 1

FIGURE 9.4-4B, Rev. 55

AutoCAD Figure 9_4_4B.doc

FIGURE 9.4-5A REPLACED BY DWG. M-175, SH. 1

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FIGURE 9.4-5A REPLACED BY DWG. M-175, SH. 1

FIGURE 9.4-5A, Rev. 57

AutoCAD Figure 9_4_5A.doc

FIGURE 9.4-5B REPLACED BY DWG. M-175, SH. 2

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FIGURE 9.4-5B REPLACED BY DWG. M-175, SH. 2

FIGURE 9.4-5B, Rev. 55

AutoCAD Figure 9_4_5B.doc

FIGURE 9.4-5C REPLACED BY DWG. M-2175, SH. 1

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FIGURE 9.4-5C REPLACED BY DWG. M-2175, SH. 1

FIGURE 9.4-5C, Rev. 55

AutoCAD Figure 9_4_5C.doc

FIGURE 9.4-6A REPLACED BY DWG. VC-176, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-6A REPLACED BY DWG. VC-176, SH. 1

FIGURE 9.4-6A, Rev. 55

AutoCAD Figure 9_4_6A.doc

FIGURE 9.4-6B REPLACED BY DWG. VC-2176, SH. 1

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FIGURE 9.4-6B REPLACED BY DWG. VC-2176, SH. 1

FIGURE 9.4-6B, Rev. 55

AutoCAD Figure 9_4_6B.doc

FIGURE 9.4-1-1 REPLACED BY DWG. M-178, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-1-1 REPLACED BY DWG. M-178, SH. 1

FIGURE 9.4-1-1, Rev. 55

AutoCAD Figure 9_4_1_1.doc

FIGURE 9.4-1-2 REPLACED BY DWG. M-178, SH. 2

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-1-2 REPLACED BY DWG. M-178, SH. 2

FIGURE 9.4-1-2, Rev. 55

AutoCAD Figure 9_4_1_2.doc

FIGURE 9.4-13A REPLACED BY DWG. M-174, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-13A REPLACED BY DWG. M-174, SH. 1

FIGURE 9.4-13A, Rev. 55

AutoCAD Figure 9_4_13A.doc

FIGURE 9.4-13B REPLACED BY DWG. M-174, SH. 2

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-13B REPLACED BY DWG. M-174, SH. 2

FIGURE 9.4-13B, Rev. 55

AutoCAD Figure 9_4_13B.doc

FIGURE RENUMBERED FROM 9.4-15A TO 9.4-15

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE RENUMBERED FROM 9.4-15A TO 9.4-15

FIGURE 9.4-15A, Rev. 55

AutoCAD Figure 9_4_15A.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE DELETED

FIGURE 9.4-15B, Rev. 55

AutoCAD Figure 9_4_15B.doc

FIGURE DELETED

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE DELETED

FIGURE 9.4-16B, Rev. 55

AutoCAD Figure 9_4_16B.doc

FIGURE 9.4-18A REPLACED BY DWG. V-182, SH. 8

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-18A REPLACED BY DWG. V-182, SH. 8

FIGURE 9.4-18A, Rev. 50

AutoCAD Figure 9_4_18A.doc

FIGURE 9.4-18B REPLACED BY DWG. V-182, SH. 8A

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FIGURE 9.4-18B REPLACED BY DWG. V-182, SH. 8A

FIGURE 9.4-18B, Rev. 50

AutoCAD Figure 9_4_18B.doc

FIGURE 9.4-19A REPLACED BY DWG. M-182, SH. 2

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FIGURE 9.4-19A REPLACED BY DWG. M-182, SH. 2

FIGURE 9.4-19A, Rev. 50

AutoCAD Figure 9_4_19A.doc

FIGURE 9.4-2-1 REPLACED BY DWG. VC-178, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-2-1 REPLACED BY DWG. VC-178,
SH. 1

FIGURE 9.4-2-1, Rev. 56

AutoCAD Figure 9_4_2_1.doc

FIGURE 9.4-2-2 REPLACED BY DWG. VC-178, SH. 2

FSAR REV. 65

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FIGURE 9.4-2-2 REPLACED BY DWG. VC-178, SH. 2

FIGURE 9.4-2-2, Rev. 55

AutoCAD Figure 9_4_2_2.doc

FIGURE 9.4-2-3 REPLACED BY DWG. VC-178, SH. 3

FSAR REV. 65

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FIGURE 9.4-2-3 REPLACED BY DWG. VC-178, SH. 3

FIGURE 9.4-2-3, Rev. 55

AutoCAD Figure 9_4_2_3.doc

FIGURE 9.4-2-4 REPLACED BY DWG. VC-178, SH. 4

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FIGURE 9.4-2-4 REPLACED BY DWG. VC-178, SH. 4

FIGURE 9.4-2-4, Rev. 55

AutoCAD Figure 9_4_2_4.doc

FIGURE 9.4-22-1 REPLACED BY DWG. V-26-2, SH. 1

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FIGURE 9.4-22-1 REPLACED BY DWG. V-26-2, SH. 1

FIGURE 9.4-22-1, Rev. 49

AutoCAD Figure 9_4_22_1.doc

FIGURE 9.4-22-2 REPLACED BY DWG. V-26-3, SH. 1

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FIGURE 9.4-22-2 REPLACED BY DWG. V-26-3, SH. 1

FIGURE 9.4-22-2, Rev. 49

AutoCAD Figure 9_4_22_2.doc

FIGURE 9.4-22-3 REPLACED BY DWG. V-26-4, SH. 1

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FIGURE 9.4-22-3 REPLACED BY DWG. V-26-4, SH. 1

FIGURE 9.4-22-3, Rev. 49

AutoCAD Figure 9_4_22_3.doc

FIGURE 9.4-22-4 REPLACED BY DWG. V-26-5, SH. 1

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FIGURE 9.4-22-4 REPLACED BY DWG. V-26-5, SH. 1

FIGURE 9.4-22-4, Rev. 49

AutoCAD Figure 9_4_22_4.doc

FIGURE 9.4-22-5 REPLACED BY DWG. V-26-6, SH. 1

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FIGURE 9.4-22-5 REPLACED BY DWG. V-26-6, SH. 1

FIGURE 9.4-22-5, Rev. 49

AutoCAD Figure 9_4_22_5.doc

FIGURE 9.4-22-6 REPLACED BY DWG. V-26-10, SH. 1

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FIGURE 9.4-22-6 REPLACED BY DWG. V-26-10, SH. 1

FIGURE 9.4-22-6, Rev. 49

AutoCAD Figure 9_4_22_6.doc

FIGURE 9.4-22-7 REPLACED BY DWG. V-26-11, SH. 1

FSAR REV. 65

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FIGURE 9.4-22-7 REPLACED BY DWG. V-26-11, SH. 1

FIGURE 9.4-22-7, Rev. 49

AutoCAD Figure 9_4_22_7.doc

FIGURE 9.4-22-8 REPLACED BY DWG. V-26-12, SH. 1

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FIGURE 9.4-22-8 REPLACED BY DWG. V-26-12, SH. 1

FIGURE 9.4-22-8, Rev. 49

AutoCAD Figure 9_4_22_8.doc

FIGURE 9.4-22-9 REPLACED BY DWG. V-26-13, SH. 1

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FIGURE 9.4-22-9 REPLACED BY DWG. V-26-13, SH. 1

FIGURE 9.4-22-9, Rev. 49

AutoCAD Figure 9_4_22_9.doc

FIGURE 9.4-16A-1 REPLACED BY DWG. VC-177, SH. 1

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FIGURE 9.4-16A-1 REPLACED BY DWG. VC-177, SH. 1

FIGURE 9.4-16A-1, Rev. 56

AutoCAD Figure 9_4_16A_1.doc

FIGURE 9.4-16A-2 REPLACED BY DWG. VC-177, SH. 2

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-16A-2 REPLACED BY DWG. VC-177, SH. 2

FIGURE 9.4-16A-2, Rev. 56

AutoCAD Figure 9_4_16A_2.doc

FIGURE 9.4-22-10 REPLACED BY DWG. V-26-14, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-22-10 REPLACED BY DWG. V-26-14, SH. 1

FIGURE 9.4-22-10, Rev. 49

AutoCAD Figure 9_4_22_10.doc

FIGURE 9.4-22-11 REPLACED BY DWG. V-26-15, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-22-11 REPLACED BY DWG. V-26-15, SH. 1

FIGURE 9.4-22-11, Rev. 49

AutoCAD Figure 9_4_22_11.doc

FIGURE 9.4-22-12 REPLACED BY DWG. V-34-2, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-22-12 REPLACED BY DWG. V-34-2, SH. 1

FIGURE 9.4-22-12, Rev. 49

AutoCAD Figure 9_4_22_12.doc

FIGURE 9.4-22-13 REPLACED BY DWG. V-34-3, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.4-22-13 REPLACED BY DWG. V-34-3, SH. 1

FIGURE 9.4-22-13, Rev. 49

AutoCAD Figure 9_4_22_13.doc

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 FIRE PROTECTION SYSTEM

Information concerning the Susquehanna Steam Electric Station Fire Protection Program is contained in the Fire Protection Review Report (FPRR) (FSAR Reference 9.5.1).

9.5.2 COMMUNICATION SYSTEMS

9.5.2.1 Design Bases

The communication systems have no safety-related functions.

Various communication systems are provided in the plant to ensure reliable communication. Table 9.5-4 shows communication systems available at the vital areas. The design bases of these systems are:

a) An intra-plant public address providing the following functions:

   1) A 5-channel page-talk handset intercom system for on-site communications between plant locations

   2) Broadcast accountability and fire alarms designed to warn personnel of emergency conditions

b) A private telephone system, with redundant and diversified cables from the plant to two diverse telephone company switching facilities, to permit plant-to-offsite communication on a continuous basis.

c) An intra-plant maintenance/test jack telephone system.

d) Security communication and alarm system.

e) Portable communication system.

f) Voice powered Appendix R communication system to support manual actions required for safe shutdown during Appendix R fire scenario.

g) Satellite telephone system.

9.5.2.2 Systems Description

The plant communication systems are illustrated in riser diagram form (see Dwgs. E-408, Sh. 1, E-408, Sh. 2, E-409, Sh. 1, E-409, Sh. 2, E-409, Sh. 3, E-409, Sh. 4, E-409, Sh. 5, E-409, Sh. 6, E-409, Sh. 7, E-411, Sh. 1, E-411, Sh. 2, and E-418, Sh. 1) and plant location diagrams (see Dwgs. EC-1, Sh. 1, EC-2, Sh. 1, EC-3, Sh. 1, EC-4, Sh. 1, EC-5, Sh. 1, EC-6, Sh. 1, EC-7, Sh. 1, and EC-8, Sh. 1).

9.5.2.2.1 Intra-Plant Public Address (PA)

The intra-plant public address system is a five-channel independent page-party communication system, consisting of telephone handsets, amplifiers and loudspeakers located at various selected areas throughout the plant.

The loudspeakers are powered from individual amplifiers contained in each handset station or from separate power amplifiers. The system provides two-way communication facilities for speech at all handset stations. Each station is capable of originating and receiving information by switching to either a page channel or to one of five non-interfering party-line channels. A desk type "Merge-Isolate," selector switch panel is located in the control room at the plant operating monitor console, and functions as the central control point for the system. Under normal operation six distribution loops of the PA system are "Merged" for complete site coverage. The "Isolate" position of the switch separates the three loops which primarily serve the Unit 1 side of the plant from the three loops which primarily serve the Unit 2 side. This function is seldom used. Buildings and areas outside of the power block are served by various of the six loops. These specifically include the diesel generator buildings, emergency service water pump house, make-up water pump house, circulating water pump house and radwaste building. The preferred power for the PA system is supplied from the Unit 1 vital AC bus, and the alternate power is fed from the Unit 2 vital AC bus. The PA system for the Diesel Generator 'E' facility is powered from a vital AC power supply located in the Diesel Generator 'E' Building. In case the PA system is not available, portable communication will be used.

The Public Address system also broadcasts Emergency Alarms to warn personnel of emergency conditions and provide instructions for site accountability for fire. The Emergency Alarm system consists of a tone generator and tone selector switch.

During emergency conditions the plant operator activates the system by selecting the designated alarm. The alarms and instructions are broadcasted via the PA system page lines to all speakers throughout the plant.

Power for individual P.A. handsets and amplifiers in some specific cases, can be from the plant normal 120V AC system when installed in plant locations other than vital areas as identified in Table 9.5-4.

9.5.2.2.2 Commercial Telephone System (PABX)

The private automatic branch exchange telephone system (PABX) is furnished and maintained by the Commonwealth Telephone Company. This system has switching capability of 4000 lines with more than 1300 in operation. The system includes thirty central office trunks, thirty Electronic Tandem Network Ties and 20 Centrex Ties through Bell Atlantic.

The various types of at least 1500 operating circuits accommodate a great variety of services: dedicated unswitched data transmission; dial-up modem linked data paths; dedicated circuits for video transmission, radio control, rf to audio links; video conferencing on 56k and T-1 long distance carriers.

Telephones and jack stations are located throughout the plant and outlying buildings. These support voice communications and special purpose devices served by the telephone system cable distribution. The power supply for the system consists of two high capacity chargers with a nominal 48 volt battery connected in parallel. This installation can operate the telephone system for a minimum of eight hours after loss of the normal AC supply to the chargers. In addition, an inverter powered by the battery supplies 120 volts AC to the few AC loads critical to the system.

A requirement for specific conventional telephone service (commercial) is mandated by the NRC in 10 CFR 73.55. This requirement is fully met by the installed system.

9.5.2.2.3 Intra-Plant Maintenance/Test Jack System

This system provides independent two-channel station to station communication for use during maintenance and testing activities, and consists of jack stations located at various selected areas throughout the plant. The paging channel is independent of the PA system paging channel. The party lines are connected to the "Jack Station" selector switch panel, which enables the operator to connect any combination of 100 separate stations. All jack stations except PM/test jack stations located on Unit 1 and 2 re-fuel platforms, have a low-level intensity red light to monitor the power supply. Power for this system is supplied from Instrument AC (refer to Subsection 8.3.1.8), except for PM/test jack stations mounted on the re-fuel platform which receive their operating voltage from re-fuel platform 120 VAC power. This system utilizes portable units which are provided with thirty-foot cables and plug type connectors. Each unit contains a power supply, speaker amplifier and speaker, handset amplifier and handset and a preamplifier and jack for use with an optional plug-in headset. The system has the capability, by interconnecting groups of jacks, to provide uninterrupted conversation between the control room and the following areas: control rod drive equipment area, refueling platform, and the turbine generator operating deck. This capability may be used to maintain direct communication between the control room and refueling floor personnel during core alterations as required by plant technical specifications.

9.5.2.2.4 Security Communication System

Refer to the Susquehanna SES Physical Security Plan for a description of the Security Communications System.

9.5.2.2.5 Portable Communication System

Onsite portable radio communication systems are described in the Susquehanna SES Physical Security Plan and in the Susquehanna SES Emergency Plan. Five UHF channels, each consisting of two frequencies for duplex operation through one of five in-plant repeaters, provide onsite portable radio communications. Security is assigned an operating channel and an emergency (backup) channel in accordance with 10 CFR 73. Security officers on continuous and random roving patrols are equipped with handheld two-way radios and/or vehicular mobile radios. The system is tested in accordance with 10 CFR 73.55(9)(3). Provisions of 10 CFR 73.55(f)(3) are accommodated by fixed base stations operating in both channels. Operations is assigned two channels; one channel is assigned to Unit 1 and one to Unit 2. Operators in the plant on rounds and on specific assignments are equipped with handheld two-way radios.

Radio communications for non-routine maintenance or testing by work groups other than Operations are accommodated by use of the fifth channel.

9.5.2.2.6 Voice Powered Appendix R Communication System

The Appendix R communication system is a voice powered communication system, consisting of head sets with either acoustic boom or noise-shielding microphone that plug into jack plates. The jack plates are located in various selected areas throughout the plant. Headsets are provided with a plug in, battery powered portable amplifier for enhanced transmission level to a high noise reception area.

The system provides communication for use during Appendix R fire scenario. No external power is required to operate the system. The system provides communications to perform manual operator actions associated with an Appendix R safe shutdown. Independent loops connect Unit 1 and Unit 2 remote Shutdown Panels with the Control Room and with other appropriate areas. Additionally, a separate loop connects Unit 1 and Unit 2 Remote Shutdown Panels. Annual testing of the system and periodic inventory of installed equipment are performed under the PM Program by Operations.

9.5.2.2.7 Satellite Telephone System

The Satellite Telephone System is a standalone non-Class 1E emergency communications system connected to analog phones located in the control structure, main control room and technical support center. The system provides a means for communication with off-site emergency response organizations under scenarios where normal communication systems are unavailable due to damage to local offsite infrastructure.

The system is powered from a Class 1E emergency standby diesel generator. The system includes a UPS to provide power for up to 8 hours should the diesel backed AC source be unavailable.

9.5.2.2.8 System Evaluation

System design considerations include diversity and operational reliability. The PA, radio, and telephone communication systems are provided with reliable and redundant power supplies for communications between all areas of the Plant.

The PA system and portable radios are the primary means of intra-plant communications for plant operations. The PABX telephone system is used as a backup. The PABX telephone system is also used for special communications requirements and normal offsite communications.

Physical and electrical separation is provided between primary and backup systems to minimize the possibility of a single occurrence affecting more than one system.

Wiring for the public address (PA) system, Intra-Plant Maintenance/Test Jack System, and the telephone (PABX) system is installed in separate and independent conduits. In addition, permanent telephone (PABX) cabling is permitted to be routed in free air.

The Communication Systems have adequate flexibility to keep the plant personnel informed of plant operational status at all times. If one handset station of the PA system would be damaged or inaccessible or if extreme background noise would prevent its use, multiple handset locations at each plant elevation provide easy access to an alternate handset of the PA system.

External communication under extreme environmental conditions is also provided through a satellite telephone system. The satellite telephone provides an additional and diverse method of communication with organizations outside of the plant should normal communication systems, e.g. land based telephone, cellular, be unavailable.

In areas where the ambient sound level could exceed the functional capability of the standard handset, provisions are made for the installation of acoustical enclosures to ensure proper sound levels. However, a maximum dB level for the vital areas identified in the Table 9.5-4 has not been established.

Cabling for the Appendix R voice powered communication system is installed in non-class 1E instrumentation cable tray and conduits. The Appendix R voice powered communication system consists of independent communication loops for safe shutdown from the control room or Remote Shutdown Panels.

9.5.2.3 Inspection and Testing Requirements

Systems described above are conventional and have a history of successful operation at similar existing plants. Most of these systems are in routine use and maintenance, and this ensures their availability. Infrequently used systems are tested on a scheduled basis to ensure operability. The emergency alarm functions are periodically tested. These tests include adequacy of signal level, availability of power sources, and proper function of all circuits.

All employees are familiar with the actual sound of the emergency signal. Notice is given to all plant personnel preceding any alarm test.

Communication equipment used for security is tested in accordance with the requirements of the security plan and 10 CFR 73.55.

Records will be maintained of the scheduled tests of infrequently used systems.

9.5.3 LIGHTING SYSTEM

9.5.3.1 Design Bases

The plant lighting system is designed to furnish illumination levels required for safe performance of plant operation, security, shutdown, and maintenance duties. Emergency DC lighting is provided in essential areas for the safety of personnel during an AC power failure.

a) Area lighting provides the illumination intensities required for the performance of the activities in that area, and is equal to or greater than those recommended by the Illuminating Engineering Society. Lighting fixtures have been selected with consideration for environmental conditions and ease of maintenance.

b) The control room lighting design includes a dimming control system to reduce glare and shadows on the operating control consoles. The structural supports of the lighting fixtures that serve the control room are designed in accordance with Seismic Category I requirements.

c) Incandescent lamps are the only type lamp used within the primary containment and the main steam pipe tunnel. High pressure sodium (HPS) lamps are used at the refueling level of the reactor building. Mercury switches are not used within these areas. High-pressure sodium (HPS) lamps and incandescent lamps are used at the turbine building high bay operating floor. Mercury vapor and fluorescent lamps are used in the remaining plant areas.

d) High-pressure sodium lamps are used for outdoor area lighting and provide illumination required for safe movement of plant personnel, and plant security. Lighting of the protected outdoor area is sufficient to permit effective visual inspection to facilitate surveillance and patrol of the perimeter fence.

e) The 2.5 hour rated emergency lighting systems provide the egress lighting intensities required for use during emergencies or shutdown and meets the requirements stated in the "Building Regulations for Protection from Fire and Panic", Commonwealth of Pennsylvania, Department of Labor and Industry. The eight hour rated emergency lighting system provides the lighting intensities in those areas required to bring the plant to a safe shutdown condition during emergencies and or under conditions for which the control room becomes uninhabitable. The eight-hour emergency lighting system meets the requirements of 10 CFR 50 Appendix R.

The combined 2.5-hour and 8-hour emergency lighting systems have been accepted via response to FSAR Questions 40.33 and 40.34 as a means to aid in bringing the plant to a safe shutdown for defined conditions as Control Room evacuation plus a loop and a single failure. In areas where 2.5 hour emergency lighting fixtures are not provided, 8-hour battery powered lighting is required if shutdown functions or control and maintenance of safety-related equipment are required to be performed.

9.5.3.2 System Description

The plant lighting system is composed of the following subsystems:

a) Normal (AC),
b) Essential (AC),
c) Emergency (DC)

9.5.3.2.1 Normal Lighting System (AC)

The normal AC lighting system receives power from the normal service buses of the plant auxiliary AC power distribution system described in Subsection 8.3.1.1. This system provides lighting for the following areas:

a) All area lighting in the service/administration building, guard house and main steam pipe tunnel

b) All outdoor area lighting (yard)

c) All HPS high bay lighting (turbine building)

d) Approximately 80 to 90 percent of the lighting in all other operating and service areas except the main control room

The high pressure sodium, mercury vapor, metal halide, and fluorescent lighting fixtures in this subsystem are fed from 480/277 V, three-phase, four wire, grounded neutral system distribution panels, which are fed from the normal 480 V motor control centers. The incandescent lighting fixtures on refueling platforms are fed from the 480/277 V, three-phase, four wire, grounded neutral system distribution panels, and the other incandescent lighting fixtures are fed from the dry-type transformers rated at 480-208/120 V, three-phase, four wire, grounded.

The outdoor yard lighting is a high mast lighting system consisting of high-pressure sodium fixtures mounted on 100 ft. lighting poles having a lowering system with a portable drive unit. The transformer yard utilizes a similar system on 40-ft. lighting poles without a lowering system. The location of these poles is shown on Dwg. E-412, Sh. 1.

The power for the Protected Area yard lighting is provided by three non-Safety Related 480/277 Vac, 3 Phase, 4-Wire, lighting distribution panels, each fed from an uninterruptible power supply (UPS). The Protected Area yard lighting is normally automatically energized and de-energized via photo electrically controlled lighting contractors. Each UPS is provided with normal ac input power and bypass ac input power from a security system motor control center via a security system load center that is normally fed by an offsite power supply. In the event of total loss of offsite power (LOOP), the security system diesel generator will provide backup power to the yard lighting via the UPSs. Each UPS provides uninterrupted power to the yard lighting during LOOP and connection of diesel generator backup power.

The yard lighting is designed to provide the minimum lumination requirement of the closed circuit TV cameras.

9.5.3.2.2 Essential Lighting System (AC)

The essential AC lighting subsystem is designed to provide a minimum level of illumination distributed to selected areas of the plant, to aid in safe shutdown, or to aid in restoring the plant to normal operation. This subsystem consists of fluorescent lighting fixtures fed from 480/277 V, 3Ø, 4 wire, grounded neutral system lighting distribution panels, which are normally supplied. The areas served by this subsystem are as follows:

a) Main control room.

b) Approximately 10 to 20 percent of the lighting in all operating and service areas in selected areas at the plant.

The essential lighting distribution panels also serve as the preferred power supply to the 8-hour emergency lighting centers and units described in Subsections 9.5.3.2.3.2.2 and 9.5.3.2.3.2.3 and the preferred power supply to the control structure 120V AC/125V DC emergency lighting system described in Subsection 9.5.3.2.3.1 and the stair lighting units described in Subsection 9.5.3.2.3.2.4.

The essential lighting system is connected to the Class 1E 480V MCCs at all times. No load shedding is provided for this lighting system in the event of total loss of offsite power. The total essential lighting load is shown in Table 8.3-1a assuming all four diesel generators are in operation. The essential lighting load is not divided equally among the four diesel generators due to plant utilization. Therefore, the total lighting loads for each case (assuming one diesel generator not available) as shown by Tables 8.3-2, 8.3-3, and 8.3-5 are different.

9.5.3.2.3 Emergency Lighting System (DC)

Refer to Table 9.5-3 for locations.

9.5.3.2.3.1 125 V DC Emergency Lighting System

Fixtures of the emergency DC lighting subsystem within the plant complex are normally energized from the normal AC subsystem described in Subsection 9.5.3.2.1 except for the control structure fixtures which are normally energized from the essential lighting subsystem described in Subsection 9.5.3.2.2. This DC lighting subsystem is normally supplied from branch circuits of the 120/208 V lighting panels via a transfer switch to the AC/DC lighting panels. Upon loss of the preferred AC source the AC/DC panels will be fed automatically from the 125V DC emergency lighting power system described in Subsection 8.3.2.1.1.8. Continued energization of the lamp with AC during normal operation reduces the load on the battery chargers and maintains the lamp filament at a temperature that limits the initial current surge when the DC voltage is applied to the lamp, and also allows the lights to be monitored continuously.

9.5.3.2.3.2 Self-Contained Emergency Lighting System

9.5.3.2.3.2.1 Exit Lights

Emergency exit lighting in remote buildings and areas where the 125 V DC emergency lighting power system service is not available consists of battery powered self-contained "exit" light units. Each of these units consists of a 2-1/2 hr 6 V battery, a battery charger, and exit sign and are normally energized by the normal 277 volt AC lighting system power supply. The exits lights in the Diesel Generator 'E' Facility have a 1-1/2 hour battery.

9.5.3.2.3.2.2 Emergency Lighting Centers

The emergency lighting centers are designed to provide emergency lighting instantaneously and automatically upon the failure or interruption of the essential lighting power supply (see Subsection 9.5.3.2.2). Each emergency lighting center consists of a battery, a charger, control and monitoring circuits, and devices enclosed as a self-contained unit. Each emergency lighting center is capable of supplying 2 remotely mounted sealed beam lamps for 8 hrs. without the charger.

9.5.3.2.3.2.3 Emergency Lighting Units

Emergency lighting units are similar to the emergency lighting centers as discussed in Subsection 9.5.3.2.3.2.2 except that there are no more than 3 sealed beam lamps locally mounted on the battery pack unit, remotely mounted near the battery pack unit or a combination thereof.

9.5.3.2.3.2.4 Stair Lighting Units

Each of the stair lighting units consists of a 2-1/2 hr. 6 V battery, a charger, and 2-25 watt sealed beam lamps, except where 8-hour battery powered emergency lighting units are required. The units are normally energized by the essential lighting power supply (Subsection 9.5.3.2.2). The stair lighting units in the Diesel Generator 'E' Facility are the same as the emergency lighting units as discussed in Subsection 9.5.3.2.3.2.3.

9.5.3.3 Safety Evaluation

Components of the lighting systems associated with safety-related systems are housed within Seismic Category I structures. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11. Lighting is provided to permit the operators to shut down the plant safely and maintain it in a safe shutdown condition at all times. The lighting system is designed to provide lighting at all times in areas used during reactor shutdown or emergency.

During normal plant operation, all plant lighting systems are energized from the respective on-site buses and off-site feeders.

In the event of AC power loss from both non-Class 1E on-site buses (unit auxiliary), the normal lighting system is inoperable. The essential lighting system remains operable being energized from the Class 1E AC on-site buses. The emergency lighting system remains operable from the non-Class 1E 125V DC emergency lighting power system; the units self-contained battery or the essential lighting power supply to selected emergency lighting fixtures.

In the event of AC power loss from both non-Class 1E off-site feeders, the standby diesel generators will start and energize the respective Class 1E buses within 10 seconds. During the 10 second delay (diesel start-up time) the DC emergency lighting system remains energized from the Emergency Lighting system which is discussed in Subsection 9.5.3.2.3.

9.5.3.4 Tests and Inspections

The AC lighting systems are normally energized and maintained continuously and require no periodic testing. The emergency lighting system is provided with the capability for full functional tests to ensure the operability of the automatic switches and other components of the system.

9.5.4 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

9.5.4.1 Design Basis

a) Provides onsite storage and delivery of fuel oil to the diesel generators for at least seven days of operation. This provides emergency power to meet the load requirements for the engineered safety features following loss of offsite power and a DBA.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE) and to withstand the effects of wind, tornadoes, flooding and missiles.

c) To meet single failure criterion, in that if a failure in the fuel oil system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection and testing during plant operation.

The diesel generator fuel oil system is designed in accordance with the codes and standards listed in Table 3.2-1. The design complies with ANSI Standard N195-1976.

9.5.4.2 System Description

The diesel generator fuel oil system is located in and below grade adjacent to the diesel generator buildings. The system is shown on Dwgs. M-120, Sh. 1, and M-134, Sh. 1, for Diesel Generators A, B, C and D and Dwgs. M-120, Sh. 2, and M-134, Sh. 7, for Diesel Generator 'E'.

The fuel oil system components are as follows:

Diesel Generator Fuel Oil Storage Tanks - Four 50,000 gal nominal capacity storage tanks are provided for Diesel Generators A, B, C and D and one 80,000 gal nominal capacity storage tank is provided for Diesel Generator 'E'. One storage tank is provided for each diesel generator. The No. 2 fuel oil stored in each tank is sufficient for seven days full load continuous generator operation. The tanks for Diesel Generators A, B, C, and D are buried underground adjacent to the diesel generator building as shown on Dwg. C-1006, Sh. 1. The tank for Diesel Generator 'E' is buried underground adjacent to the Diesel Generator 'E' Building as shown on Figure 9.5-26B. For Diesel Generators A, B, C, and D tanks, connections, as shown on Dwg. C-1007, Sh. 1, for level instruments, manhole, day tank overflow pump support flanges, water removal, oil sampling and oil filtration lines are provided on top of the tanks and are all ASME Section III Class 3 material. The vent pipes for these tanks are designed to Seismic Category I. The water removal lines, oil sample and return lines, and oil filtration suction and return lines are Seismic Category I out to the ASME Section III code break valve. For the Diesel Generator 'E' tank, connections as shown on Figure 9.5-26B for pump suction, level instruments, manhole, day-time overflow, water removal, oil sampling, oil filtration, and fill connection are provided on top of the tank. The tank design and material is per ASME Section III, Class 3. The vent pipe for the tank is designed to Seismic Category I. The water removal lines, oil sample and return lines, and oil filtration suction and return lines are Seismic Category I out to the ASME Section III code break valve.

A concrete vault is provided for each tank from grade to the tank connections for access, maintenance, inspection and repair and to provide missile protection of the tank connections. The vault cover at grade level is made of steel plate. The Diesel Generator A, B, C, and D tanks exterior is painted with enamel and wrapped with fiberglass pipe wrapping for corrosion protection. The tank interior bottom is coated for protection against corrosion due to water accumulation. In addition, a rust preventative is applied over the interior surface. The Diesel Generator 'E' tank exterior is coated with polyester resin and wrapped with a fiberglass mat for corrosion protection. The interior surface of the tank sump and the wetted bottom of the tank up to an elevation of seven feet below the horizontal centerline is coated with a two-coat epoxy. Each tank is provided with a sump area for water and solids collection. A tube for water removal is installed within each sump. The tubing runs to the grade level sampling station where water is removed from the sumps by the water removal – oil sampling pump. Fuel oil additives are used to inhibit biogrowth in the diesel fuel storage tanks. Tubes are installed at three different levels within each diesel fuel oil storage tank for drawing oil samples. The tubing runs to the grade level sample station. Oil filtration suction and return pipes are installed in each fuel oil storage tank. The filtration piping for A-D fuel oil storage tanks terminate in below grade missile-protected valve boxes. The E fuel oil storage tank filtration pipes terminate in the above grade sample station. The tanks have a corrosion allowance and are furnished with cathodic protection. The storage tanks are vented through a flame arrestor above grade. This vent does not require missile protection. The only vulnerable section of the vent is a 6 inch (4 inch for Diesel Generator 'E' tank) portion above grade. In the event that this above grade section of the vent is damaged, it would not render the fuel oil tank inoperable. The water removal, oil sampling and oil filtration lines outside of the tank vault are run below grade to the filtration valve boxes and the above grade sample stations. The below grade lines are missile protected and seismically analyzed to provide assurance that they will remain intact after Design Basis Events. The water removal and oil sampling lines in the above grade sample stations, and the above grade Diesel Fuel Oil Storage Tank E filtration lines, do not require missile protection. Any missile damage to the above grade portions of these lines will not render the diesel fuel oil system inoperable. There is no piping under the fuel storage tank concrete mat; therefore the tank's safety function is not endangered by a possible pipe break. The buried tanks and yard pipes for Diesel Generators A, B, C and D are shown in Dwgs. C-1006, Sh. 1, C-1007, Sh. 1, C-1007, Sh. 2, C-1032, Sh. 1, C-46, Sh. 1, C-901, Sh. 1, C-905, Sh. 1, C-1029, Sh. 1 and C-1029, Sh. 2. The buried tanks and yard pipe for Diesel Generator 'E' are shown in Figure 9.5-26B.

Diesel Generator Fuel Oil Transfer Pumps for Diesel Generators A, B, C and D

One fuel oil transfer pump is provided for each storage tank. The pump and motor are both submerged in the fuel oil storage tank and suspended from the pump support flange located on the tank top. Each pump is a horizontal, centrifugal type and is rated at 25 gpm at 30 psi differential head. The fuel oil transfer pump discharge lines run directly to the fuel oil day tanks.

The diesel oil transfer pumps are provided with a suction strainer at the pump inlet located at 5 9/16” above tank bottom. The pump centerline is 10 ¾” above tank bottom. The total volume of the storage tanks is 49328 gallons, which has been corrected for tank internals. The usable volume of fuel oil available in the storage tanks is 47438 gallons. The difference between the total volume and the usable volume in these storage tanks (1890 gallons) is the result of the following considerations:

1. Inaccessible volume of fuel oil at bottom of tank = 1380 gallons

2. Space at top of tank after filling = 210 gallons

3. Tank Manufacturing Tolerances = 300 gallons

The required fuel for seven day operation at full load is 45864 gallons. The spare volume is 1574 gallons, which provides adequate margin for diesel testing.

The required Net Positive Suction Head (NPSH) is 4.5' according to the pump test curves. The available NPSH is approximately 39' at the lowest fuel level at the center line of the pump. This figure is based on the following:

NPSH = abs. barometric pressure (34') + static liquid head (0' at center line) - friction loss in suction line (negligible) - vapor pressure of liquid (negligible) = 34' abs. of water.

The 34' is to be corrected for Diesel fuel No. 2 having a specific gravity of 0.87, 34' 0.87 = 39'.

Diesel Generator Fuel Oil Transfer Pump for Diesel Generator 'E' - A horizontal self-priming fuel oil transfer pump is provided for the Diesel Generator 'E' fuel oil storage tank. The pump and motor are located in the Diesel Generator 'E' Building on floor elevation 656'-6" and the pump centerline is at elevation 658'-4-11/16". The pump is mounted on a common base with the motor and is rated at 20 gpm and 50 feet of water TDH. The pump takes suction from a pipe internal to the tank which projects down the 16 foot diameter tank. The tank bottom is at elevation 651'-0". The total volume of the "E" diesel storage tanks is 76888 gallons, which has been corrected for tank internals. The usable volume of fuel oil available in the "E" diesel storage tank is 73,253 gallons. The difference between the total volume and the usable volume in this storage tank (3635) is the result of the following considerations:

1. Inaccessible volume of fuel oil at bottom of tank = 1814 gallons

2. Space at top of tank after filling = 1301 gallons

3. Tank Manufacturing Tolerances = 520 gallons

The required fuel for seven day operation at full load is 56,683 gallons. The spare volume is 16,670 gallons, which is more than adequate to support diesel testing.

Diesel Generator Fuel Oil Day Tanks – Four 550 gallon fuel oil day tanks are provided for Diesel Generators A, B, C and D, one tank for each diesel generator. A 650 gallon fuel oil day tank is provided for Diesel Generator E. Each fuel oil day tank is located on its respective diesel generator auxiliary skid inside the diesel generator buildings. Connections for filling, overflow return, recirculation, level instrumentation, venting, and emptying are provided. A manhole is provided on each tank for inspection. The day tank contains fuel oil sufficient for approximately one hour continuous diesel generator operation at its continuous rated load. The day tanks are vented outside the diesel generator buildings, through a flame arrestor.

Fuel Oil Booster Pumps - Each diesel generator is provided with two positive displacement fuel oil booster pumps. One pump is diesel engine driven and the second pump is DC motor driven. Relief valves and line filters are furnished on the discharge of each pump. The pumps, valves, and associated piping are all located on the diesel engine skid in the diesel generator buildings. The DC motor driven pump starts when the diesel generator starts. The suction of the motor driven pump is located below the day tank low level elevation; thus, its suction remains flooded at all times. While the diesel is starting, the motor driven pump also primes the engine-driven pump. A check valve is provided in the suction line of the engine-driven pump to assist in maintaining a flooded pump suction.

Associated Piping - The diesel fuel oil system piping is carbon steel and designed for a primary rating of 150 psig and 500°F.

The diesel generator A, B, C and D fuel oil storage tanks are filled and replenished from trucks through the fill connection which branches to each of the four tanks. The fuel oil storage tank for Diesel Generator 'E' has a separate fill station. During refilling, the fuel oil system is designed to minimize contamination from the entrance of deleterious material in the event of either an operator error or natural phenomena. All tank fill connections are protected inside a missile protected concrete vault (Dwgs. C-1032, Sh. 1, and C-5028, Sh. 1, for Diesel Generator 'E'), and the interconnecting fuel transfer piping is routed below grade to the buried tanks (Dwg. C-1006, Sh. 1, and Figure 9.5-26B for Diesel Generator 'E'). The tank vents are goose necked and provided with screens to keep out potential above grade fuel contamination. Periodic sampling shall be taken to determine if the fuel oil is within acceptable limits when checked for viscosity, water, and sediment. If for some reason fuel oil cannot be replenished through the truck fill connection each of the five tanks have the capability to be directly refilled with fuel oil, independent of each other. A duplex type basket strainer is provided in each fill line to prevent solid particles or debris from entering the storage tank.

Each transfer pump takes suction from its fuel oil storage tank and pumps the oil directly to the day tank. Because the capacity of the transfer pump is greater than the fuel oil consumption of the diesel engine, the pump can supply fuel oil to the diesel and simultaneously increase the inventory of the day tank. For Diesel Generators A, B, C and D, the fuel oil transfer pumps are started and stopped automatically by day tank level switches. For Diesel Generator 'E', the fuel oil transfer pump is started and stopped automatically by day tank level switches except when an emergency start signal is received. In this mode of operation, the Diesel Generator 'E' fuel oil transfer pump runs continuously. An overflow line from the day tank to the storage tank is furnished for each diesel generator and its capacity exceeds that of the transfer pump.

The diesel fuel oil booster pumps take suction from the day tank and pump fuel oil to the injector pumps. The DC motor driven pump starts first when the diesels are started and shuts off automatically when the engine maintains a speed above 540 rpm. The engine driven booster pump then furnishes the fuel oil to the diesel engine. The DC motor driven pump can also be started manually and provides a backup to the engine driven pump during normal operation. The DC motor driven pump starts automatically on low fuel oil pressure.

The diesel fuel oil storage tank fill lines and valves, outside the fuel oil storage tank vaults, are seismically analyzed to provide assurance that the installation will remain intact after a Design Basis Earthquake. A missile-protected Filler Valve Vault houses the fill hose connection and the normally closed boundary valves. Valves are shown on Dwgs. M-120, Sh. 1, and M-120, Sh. 2. The tank connections are ASME, Section III, Class 3. The vent pipes are B31.1 and have been seismically analyzed.

FUEL OIL TANK WATER REMOVAL, OIL SAMPLING AND OIL FILTRATION SYSTEM

The system provides the means for water removal from each of the diesel fuel oil storage tanks, the capability to sample fuel oil at three elevations within each of the diesel fuel oil storage tanks, and connections to attach a portable oil filtration system to each of the diesel fuel oil storage tanks. These functions can be conducted without entry into the diesel fuel oil storage tank vaults.

The system for the A, B, C, and D tanks consists of a common water removal – oil sampling panel (OC5101) installed on grade near the tanks as shown on Dwg. C-1006, Sh. 1, and tubing from within the tanks to the sample panel as indicated on Dwgs. M-120, Sh. 1, and M-120, Sh. 3. The system for the E tank consists of a water removal – oil sampling panel (OC5101E) installed on grade near the tank as shown on Figure 9.5-26B and tubing from within the tank to the sample panel as indicated on Dwg. M-120, Sh. 2. A tube for water removal is installed within each diesel fuel oil storage tank sump. The tube runs to the sampling station where water is removed from the sumps by the water removal – oil sampling pump. Tubes are installed at three different elevations within each tank for drawing off oil samples. This tubing runs to the sampling station where grab samples can be withdrawn from the tank from each of the three sampling elevations by the water removal – oil sampling pump.

Each of the two sample stations has a water removal – oil sampling pump, installed in the sample panel that is capable of drawing water or oil from the bottom of the diesel fuel oil storage tank. A manifold system in each sample station is used to select the water removal line or soil sample level to be processed. Removed water is collected locally and disposed of. Oil samples can be returned to the tank via a return line or collected locally for disposal.

Oil filtration suction and return lines are installed within each tank. In the event oil samples indicate the need for oil filtration, a portable oil filtration unit can be connected to the oil filtration lines. Oil will be drawn from the bottom of the tank, filtered and returned to the top of the tank to assure that thorough filtration occurs. The diesel fuel oil tank filtration connections are located in below grade missile – protected valve boxes for Diesel Fuel Oil Storage Tanks A-D and in above grade Sample Station OC5101E for Diesel Fuel Oil Storage Tank E.

The water removal tubing, oil sample tubing and oil filtration piping are ASME Section III, Class 3, Seismic Category I lines from their point of origin inside the tank up to and including an ASME Section III, Class 3 isolation valve located inside the tank vault. The remainder of the installation is B31.1, which as been seismically analyzed to provide assurance that the installation will remain intact after a Design Basis Earthquake. The ASME III valves in the tank vault are normally open with normally closed valves in the filtration valve boxes or sample stations providing the isolation boundary for the storage tanks.

A, B, C, D STORAGE TANK VAULT SUMP WATER REMOVAL SYSTEM

The sump in each of the A, B, C and D Diesel Fuel Oil Storage Tank Vaults has water removal tubing installed that runs from the sump up the sampling panel as indicated on Dwgs. M-120, Sh. 3, and C-1006, Sh. 1. A portable pump can be connected to each tube in the sample panel to draw water from the bottom of the vault sump and thus remove the water that may have accumulated within the vault. The removed water is collected locally and disposed of.

9.5.4.3 Safety Evaluation

The diesel generator fuel oil storage and transfer system is housed within either the Seismic Category I diesel generator building or below grade. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11. Fire Protection is discussed in Subsection 9.5.1. Exposure of the fuel oil system to ignition by flame or hot surfaces is minimized by underground burial of the piping and storage tanks outside the buildings; and by separation of the individual subsystems inside the building in pipe tunnels below the diesel generators except for a short run of piping on the diesel generator elevation to connect to the day tank on the engine auxiliary skid.

The safety evaluations that follow correspond to the design bases stated in Subsection 9.5.4.1.

a) The total capacity of underground diesel generator fuel oil storage tanks and day tanks is sufficient for seven days' operation of the diesel generators at 4000 kW continuous operation which is sufficient capacity for a DBA in one unit and a concurrent safe shutdown of the intact unit. Within this period, additional fuel could be delivered to the plant site by truck or rail. Excessive splashing and sediment turbulence is prevented by a low exit velocity, perforated, vertical sparger discharging fuel through a series of 3/4" diameter holes. Exit velocity at the holes is limited to about 2 ft/sec by design. The max-discharge rate is approximately 310 gpm. The bottom of the fill pipe is capped. The lowest and highest row of holes are 3 ft. and 10 ft. above the tank bottom respectively for Diesel Generators A, B, C and D. For Diesel Generator 'E', the lowest and highest row of holes are 3'-6" and 14'-6" above the tank bottom respectively. If minor sediment turbulence occurs, fuel filters will keep the overall quality of the fuel oil acceptable during refilling. Filters are provided upstream of the day tank in the buried tank fuel transfer pump intake. The filters provided down stream of the day tank are one set of duplex basket strainers and one set of duplex in line strainers. Both sets have high differential pressure alarms across them to monitor filter effectiveness (see Dwgs. M-134, Sh. 1, and M-134, Sh. 7).

b) There is physical redundancy of active components in the diesel generator fuel oil system. An independent fuel oil supply subsystem is provided for each diesel generator. Each transfer pump is powered from the bus to which the diesel generator it serves is connected. Failure of one pump or diesel generator will not affect the operability of any component in another train. Three diesel generators are required during loss of offsite power and DBA to meet the engineered safety feature load requirements. The transfer pump discharge headers have a common connection line to permit fuel oil from one storage tank to be pumped to any diesel generator if required. These cross connections are valved and require manual initiation for operation. The rupture of any portion of the transfer piping would affect the supply of oil of only one diesel generator.

c) The diesel generator fuel oil system is designed in accordance with Seismic Category I requirements as specified in Section 3.2.

9.5.4.4 Tests and Inspections

The components of the diesel generator fuel oil system received an NDT examination in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Class 3 prior to routine construction tests and inspections. System operability can be demonstrated during regularly scheduled tests of the diesel generators. At this time the fuel oil volume and quality will be monitored.

The fuel oil storage tanks are provided with manholes that permit access to the tank connections for periodic inspection of the tanks, pumps, and instrumentation. The day tanks, booster pumps, and associated piping and valves are in the diesel generator buildings and are accessible for inspection during testing and operation.

The fuel oil inventory in the storage tanks and day tanks is continuously monitored and the level is indicated at the local control panels in the applicable diesel generator buildings.

To insure the quality and reliability of fuel oil supply to the diesel generators, diesel fuel oil will be purchased which conforms to the limits specified for No. 2D fuel in ASTM – D975. Procurement and receipt inspection of the diesel generator fuel oil will be conducted under the Susquehanna Diesel Fuel Oil Test Program. Fuel shipments will not be offloaded until samples have been analyzed and the results accepted by PPL Susquehanna, LLC. Fuel shipments will be inspected and sampled upon delivery to assure that the fuel has not degraded in transit. Samples from the station's underground storage tanks will be tested to verify conformance to the water and sediment limits of the above standards on a frequency as described in the Technical Specifications.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.4.5 Instrumentation Applications

The fuel oil transfer pumps are operated automatically by level switches at the day tank with the exception of the Diesel Generator 'E' transfer pump which operates continuously when an emergency start signal is received and is controlled by level switches during all other modes of operation. The pumps can also be operated manually by control switches on the diesel generator control panels. Indications of tank levels and high and low level alarms are displayed at the local control panels. A secondary means of storage tank level determination is provided by a dipstick. The fuel oil transfer pump discharge head is also displayed at the local control panels. As the fuel oil tanks and piping are within the Diesel Generator Buildings or buried in the ground, the diesel fuel oil (No. 2) temperature will be between 50°F and 120°F, with the exception of fuel oil in lines mounted on or near the engine, which is acceptable for operation of the diesel generators. Consequently, monitoring of fuel oil temperature is not required.

All valves in the fuel oil system are manually operated. The valves in the fuel oil transfer lines are locked open except for ‘E’ D/G valve 0-20-302 which is locked throttled.

9.5.5 DIESEL GENERATOR COOLING WATER SYSTEM

9.5.5.1 Design Bases

The Diesel Generator Cooling Water System has a safety-related function. The design bases of the Diesel Generator Cooling Water (DGCW) system are as follows:

a) To cool the engine cylinder jackets, lube oil, combustion air, fuel oil (Diesel Generator E only) and jacket water sufficiently to permit continuous diesel generator operation at its continuous rated load.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE).

c) To meet single failure criterion, in that if a failure in the cooling water system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection and testing during plant operation in accordance with 10CFR50, General Design Criterion 45 and 46.

Codes and standards applicable to the diesel generator cooling water system are listed in Table 3.2-1. The system is designed and constructed in accordance with Quality Group classifications specified in Table 3.2-1 and is designed to meet seismic Category I requirements.

9.5.5.2 System Description

Two separate systems are used to cool the various engine components and systems. These are the Jacket Water System and the Emergency Service Water System.

Jacket Water System

The jacket water system is a closed system using demineralized water as the coolant. Its prime function is to provide water to the jackets of the engine cylinders and also to the jacket of the combustion air turbocharger for cooling purposes. In addition, the jacket water system circulates water through the governor oil cooler and hot water through the small core of each intercooler to heat the air discharging from the turbocharger should the temperature in the combustion air header fall below 105°F. This occurs mostly at startup to help ensure rapid starting and loading.

The jacket water system consists of the following:

1) A standpipe that serves as a reservoir, deaerator, and an expansion tank

2) An engine driven main water pump

3) A motor driven standby water pump

4) A circulation pump and heater to keep the engine warm during shutdown periods

5) An automatic thermostatic control valve

6) A cooler to dissipate the heat in the jacket water

7) For Diesel Generators A, B, C and D, control valves to direct warm jacket water through the combustion air watercoolers when the temperature in the combustion air header falls below 105°F. Warm jacket water flows continuously to the combustion air intercooler/heaters for Diesel Generator E.

8) Alarms, trips, indicators, valves & piping

When the engine is running, the engine driven water pump takes water from the standpipe and pumps it through the thermostatic control valve and jacket water cooler. From here the jacket water flows into the main jacket water headers. From the left bank header a small header directs water to the jacket of the turbocharger and both left and right bank headers have small branch headers that direct water to the intercoolers. The latter is only used when the temperature of the combustion air is less than 105°F. Individual connections from both the left and right bank headers carry water to their respective cylinder jackets. If the jacket water temperature reaches 190°F or its pressure falls to 12 psi the motor driven standby pump will start automatically (10 psi for Diesel Generator 'E').

Diesel engines A, B, C and D jacket water cooling systems have a capacity of approximately 710 gallons. The Diesel Engine 'E' jacket water cooling system has a capacity of approximately 1,480 gallons. The standpipe, located on the auxiliary skid immediately adjacent to the engine's forward end, is vented to the atmosphere and serves as the system's reservoir, deaerator and expansion tank. For Diesel Engines A, B, C and D, the standpipe is 13 feet 9 inches tall and extends two feet above the top of the engine. The top section is one foot in diameter and 5 feet 9 inches in length. The capacity of the standpipe when filled to its proper operating level is 217 gallons. Similarly for Diesel Engine 'E', the standpipe is 15'-7-3/4" tall and is 3 feet 1-1/2 inches in diameter. The capacity of this standpipe when filled to its proper operating level is approximately 700 gallons. The vent, located at the top of the standpipe is the cooling system high point. The low level alarm set point on the standpipe is located at a point above the engine thus assuring that the system is always flooded. The motor driven standby jacket water pump and the jacket water circulating water pump are located on the skid at the same level as the bottom of the standpipe. The engine driven jacket water pump for Diesel Engines A, B, C and D located 7'-0 1/4" above the base of the standpipe require 10 to 11 feet of NPSH. Available NPSH is 25 ft-9 ins. The design is similar for Diesel Generator 'E'. The jacket water cooling pumps have mechanical seals to minimize leakage to less than 0.1 gal per month. Water loss from the system over a seven day period will be much less than the available supply in the standpipe.

When the diesel engine is shutdown the circulation pump operates and takes water from the standpipe and pumps it through the heater to both the left and right bank jacket water headers. The water is then directed to the individual cylinder jackets to keep them warm for easier starting.

Makeup to the jacket water system is provided by the Makeup Demineralizer.

The jacket water system for Diesel Generators A, B, C and D is shown in Dwgs. M-134, Sh. 1, and M30-69, Sh. 1, and M-134, Sh. 5 for Diesel Generator 'E'.

Emergency Service Water System

The emergency service water system is used to supply cooling water to the following components of the diesel generator:

1) Lube oil coolers
2) Fuel Oil Cooler (Diesel Generator E Only)
3) Jacket Water Cooler
4) Combustion air intercoolers except when air temperature is below 105°F as described under Jacket Water System

The diesel generator cooling water schematic is shown on Dwg. M30-71, Sh. 1 for Diesel Generators A, B, C and D and Dwg. FF61604, Sh. 7 for Diesel Generator 'E'. The emergency service water system is described in Subsection 9.2.5.

9.5.5.3 Safety Evaluation

The cooling water systems are housed with their respective diesel generator unit in the Seismic Category I diesel generator buildings. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4.

Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

Diesel Generators A, B, C and D are completely isolated from each other in their own concrete, missile protected cells. Diesel Generator 'E' is enclosed in its own missile protected seismic category I building.

9.5.5.4 Tests and Inspections

Visual inspections, pressure and leakage tests, and operational checks of the cooling system components were performed following installation. The operability of the diesel generator cooling water system is demonstrated during scheduled testing and inspection of the diesel generator.

The operation of the jacket water warning system is checked during diesel generator shutdown periods.

Testing of the diesel generator systems is discussed in Subsection 8.3.1.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.5.5 Instrument Applications

High temperature and low pressure alarm switches are provided that will automatically start the motor driven jacket water pump if either the jacket water temperature rises to 190°F or its pressure drops to 12 psi (10 psi for diesel generator 'E'). A low jacket water temperature alarm switch is also provided. A high-high temperature switch will shutdown the diesel engine if the jacket water temperature reaches 205°F. However this high-high temperature switch will only trip the engine when it is being tested. During emergency conditions, the trip signal from the high-high temperature switch is bypassed. During the emergency mode of operation the diesel generator can only be tripped by engine overspeed, low lube oil pressure, or generator differential current.

Jacket water temperature from the engine is controlled by a three-way thermostatic valve downstream of both the engine driven jacket water pump and the motor driven standby pump. The valve maintains jacket water temperature out of the engine at approximately 170°F by directing jacket water flow through or around the cooler as necessary.

The standpipe is provided with a level indicator, a low level alarm and a high level alarm. The vent located at the top of the standpipe is the engine cooling water system high point. The low level alarm set point on the standpipe is also located at a point above the top of the engine. This ensures that all components and piping are filled with water.

9.5.6 DIESEL GENERATOR STARTING AIR SYSTEM

9.5.6.1 Design Bases

The Diesel Generator Starting Air System has safety-related functions. The design bases of the diesel generator starting air system are as follows:

a) To initiate an engine start so that within 10 seconds after receipt of the start signal the diesel generator has attained rated speed and is ready to receive electrical loads

b) To remain functional during and after a SSE

c) To meet single failure criterion, in that if a failure in the starting air system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection testing during plant operation.

Codes and standards applicable to the diesel generator starting air system are listed in Table 3.2-1. Portions of the Diesel Generator Starting Air Systems that are safety related are designed to seismic Category I requirements.

The starting system air receiver tanks, valves, and piping from the receiver inlet check valve to the engine skid are designed and constructed in accordance with quality group C specifications. The remaining components are designed and constructed in accordance with the manufacturer's standard.

9.5.6.2 System Description

Each diesel engine is furnished with a starting air system that includes the following:

a) Two air compressors each driven by an AC motor

b) Two air receiver tanks for Diesel Generators A, B, C and D and four air receiver tanks for Diesel Generator 'E'

c) Two entrainment separators

d) Piping, valves, strainers, air dryers, pressure switches, safety valves and controls, and all accessories as required.

For Diesel Generators A, B, C and D, the system is designed to crank the engine using air from both receiver tanks. The starting air system contains sufficient air to provide five (5) consecutive cold engine starts without recharging the receiver(s). For Diesel Generator E, the system is designed to crank the engine using air from all four (4) air receivers. Each bank of two (2) receivers contains sufficient air to provide five (5) consecutive cold engine starts without recharging the air receiver(s). Each bank of receivers is normally replenished by one (1) of the two (2) air compressors. A pressure switch provided on each bank of receivers for Diesel Generator 'E' and for each air receiver tank for Diesel Generator A through D will start the appropriate air compressor to replenish the tanks. If only one (1) of the two (2) required air compressors start, it is possible to replenish all tanks associated with a diesel generator by opening normally closed valves on the interconnecting piping between banks of receivers (Diesel Generator 'E') or between receivers (Diesel Generators A through D).

For Diesel Generators A, B, C and D, a drain trap is provided below each air receiver tank for expelling moisture. As the liquid level rises in the trap, a float will lift and uncover an orified outlet blowing the trap until the float level drops. For Diesel Generator 'E' this drain trap assembly is not required since the air compressor skids associated with Diesel Generator 'E' are designed to provide clean dry air to the air receivers through the use of filters, moisture separators and air dryers. The diesel generator 'E' air receivers do have manual drain valves located off the bottom of the receivers. These drain valves are opened periodically as a check to ensure that no moisture exists and to verify proper operation of the air compressor skid equipment.

On leaving the tanks, the starting air passes to the starting air valves and air distributor. For Diesel Generators A, B, C and D, a strainer is provided between the tanks and starting air valves. Filters are provided upstream of the air distributor on all engines. The air distributors provide pilot air to the air start valves at the correct sequence.

Further protection from fouling is provided by filters/separators in the control lines which supply air to the starting air solenoids and the starting air control valve pilot.

On each side of the engine, a line with a check valve is connected from the turbocharger warm air discharge to the starting air header. The purpose of this is to continuously purge the piping, preventing an explosion and preventing condensation in the piping on the engine.

The starting air system is shown schematically on Dwg. M-738, Sh. 1 for Diesel Generators A, B, C and D and Dwgs. M-134, Sh. 5, and M-134, Sh. 6 for Diesel Generator 'E'.

9.5.6.3 Safety Evaluation

The starting air systems are housed with their respective diesel generator units in reinforced concrete Seismic Category I structures.

Each of the Diesel Generator A-D units is enclosed in its own concrete, missile protected cell that is isolated from the other units. Diesel Generator 'E' is enclosed in its own Seismic Category I building.

Tornado, flood, and missile protection are discussed in Sections 3.3, 3.4, and 3.5, respectively. Protection against the dynamic effects associated with a postulated rupture of piping is discussed in Section 3.6. Environmental design is discussed in Section 3.11.

Each air receiver tank for Diesel Generators A-D is provided with a relief valve set at 265 psi. For Diesel Generator 'E', each air receiver is provided with a relief valve set at 275 psig.

9.5.6.4 Tests and Inspections

Visual inspections, pressure and leakage tests, and operational checks of the starting air system components were performed after installation. The operability of the diesel generator starting air system is tested and inspected during scheduled testing of the diesel generator.

Testing of the diesel generator systems is discussed generally in Subsection 8.3.1.1.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.6.5 Instrument Applications

Each air receiver tank is provided with a pressure switch, a pressure indicator, and a low pressure alarm. For Diesel Generator 'E', a pressure switch, pressure indicator and low pressure alarm is provided for each bank of air receivers (2). The pressure switch starts the air compressors when the air pressure in the tanks is 240 psi and falling and stops them when the pressure reaches 250 psi rising.

9.5.7 DIESEL GENERATOR LUBRICATION SYSTEM

9.5.7.1 Design Bases

The Diesel Generator Lubrication System has safety-related functions and is designed to the following design bases:

a) The DGLS is designed to supply lube oil to the engine bearings surfaces and other internal moving parts at controlled pressure, temperature and cleanliness conditions to permit continuous diesel generator operation at its continuous rated load.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE).

c) To meet single failure criterion, in that if a failure in the lubrication system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection and testing during plant operation.

The DGLS cooler is designed in accordance with ASME Section III, Class 3. Piping and valves are in accordance with manufacturers standards for Diesel Generators A, B, C and D as shown in Table 3.2-1. Piping and valves for Diesel Generator E are designed in accordance with ASME Section III, Class 3 requirements for auxiliary skid components and in accordance with manufacturers standards for the diesel engine skid components.

9.5.7.2 System Description

The DGLS consists of an oil sump in the engine frame, an engine driven positive displacement pump, and an oil cooler and filter. The lube oil pump takes oil from the sump through a strainer and delivers it to a three-way thermostatically controlled valve that directs the oil through or around the oil cooler, through a full flow multiple element cartridge type filter, through a basket strainer, to the engine bearings and other internal moving engine parts and back to the sump. The E Diesel Generator full flow filter has an internal automatic bypass that will open if the element becomes clogged. Indication of high differential pressure across the filter shows up as a trouble alarm. The DGLS provides sufficient, reliable, sump storage of lube oil for operating the standby diesel generators for at least seven days at their maximum rated loads without makeup.

Instrumentation is provided to monitor the lube oil temperature, pressure and sump level. All system alarms are annunciated on the diesel generator control panels and retransmitted to the control room via a trouble alarm. The DGLS operates automatically, excluding the lube oil makeup and storage portions. Adequate alarms are provided to detect and annunciate the need for lube oil makeup. Lube oil can be added manually to the engine during operation if necessary.

The system also includes a standby prelubrication system and preheating system to keep the engine ready for quick start standby operation. It consists of a motor-driven positive displacement pump that takes oil from the sump and directs it through an electric heater, through the main oil filter, through the oil strainer, through the engine bearings and pistons and back to the sump. In order to prevent flooding of the turbocharger bearings and associated housing for Diesel Generators A, B, C and D, the prelubrication intervals and timing are controlled. For all engines, warm lube oil is circulated through the engines by the AC powered, motor-driven circulating and prelube pump whenever engine speed is below 280 RPM. Automatic signals start the pump on decreasing speed, maintaining flow during diesel generator shutdown, and stop the pump on increasing speed. For Diesel Generators A, B, C and D, the lube oil supply to the turbocharger bearings is cutoff until the engine is either starting or running. Therefore, continuous prelubrication of the engine bearing circuit does not affect nor will if flood the turbocharger bearings. The turbocharger bearings for Diesel Generator E are designed to allow for continuous lubrication. Therefore, it is not necessary to cutoff flow to turbocharger bearings after a diesel generator shutdown.

The DGLS is schematically illustrated in Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and in Dwg. FF61604, Sh. 3 for Diesel Generator E. Dust protection is discussed in Section 9.4.7.2.

9.5.7.3 Safety Evaluation

The DGLS is an integral part of the diesel generator. The system meets the single failure criterion in that, if a failure in this system prevents the satisfactory operation of the associated diesel generator, the other three aligned diesel generators will provide adequate power to safely shut down the plant or to mitigate the consequences of any of the postulated accidents.

Each diesel generator lube oil sump contains an adequate reservoir of lube oil to maintain a sufficient quantity of lube oil for the diesel generator operating for seven days at its maximum-rated load.

Bearing temperature detectors are provided to indicate hot spots. Ten (twelve for Diesel Generator E) explosion relief valve-doors have been provided on each engine to relieve excessive pressures resulting from a crankcase explosion. The relief valve-doors are spring loaded to close following pressure decay, preventing air from entering the crankcase and causing a secondary explosion.

The DGLS is designed to satisfy Seismic Category I requirements and is located within structures designed to withstand effects from design weather conditions.

To prevent possible damage or shutdown of a diesel engine from low lube oil, sump low level instrumentation is provided. Setpoints for alarms are sufficient to allow plant personnel adequate time for corrective action.

All system alarms are annunciated on the diesel generator control panels and retransmitted to the control room via a trouble alarm.

Tornado, flood, and missile protection are discussed in Sections 3.3, 3.4, and 3.5 respectively. Protection against the dynamic effects associated with a postulated rupture of piping is discussed in Section 3.6. Environmental design is discussed in Section 3.11.

9.5.7.4 Tests and Inspection

The operability of the diesel lubrication system is tested and inspected along with the overall engine during scheduled testing of the engine.

During standby periods, the keep-warm feature of the system is checked at scheduled intervals to ensure that the oil is warm enough to assist quick starting of the engine.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.7.5 Instrument Application

The pressure, temperature and level instrumentation and control devices for the DGLS are shown schematically in Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and

Dwg. FF61604, Sh. 3 for Diesel Generator 'E'. Their location is also shown on these figures. Low lube oil pressure trips the diesel generator during any mode of operation.

9.5.8 DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

This subsection discusses the mechanical features of the diesel generator combustion air intake and exhaust system. The diesel generator buildings ventilation systems are discussed in Subsection 9.4.7.

9.5.8.1 Design Bases

The diesel generator combustion air intake and exhaust system has safety-related functions and is designed to the following design bases:

a) The diesel generator combustion air intake and exhaust systems are capable of supplying adequate combustion air and disposing of resultant exhaust products to permit continuous diesel generator operation at its continuous rated load.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE).

c) To meet single failure criterion, in that if a failure in the combustion air intake and exhaust system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) The diesel generator combustion air intake and exhaust systems are capable of being tested during plant operation.

Codes and standards applicable to the diesel generator combustion air intake and exhaust system are listed in Table 3.2-1.

9.5.8.2 System Description

The diesel generator combustion air intake and exhaust system is shown schematically on Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and Dwg. M-134, Sh. 7 for Diesel Generator 'E'. Each diesel generator has a separate exhaust and intake system.

9.5.8.2.1 Component Description and System Operation

Each air intake system includes an air intake filter and an intake silencer with the necessary interconnecting piping and flexible joint for connection to the engine turbocharger. A butterfly valve is located in the turbocharger air inlet to shut off combustion air flow when engine overspeeding occurs.

An exhaust gas driven turbocharger draws in a volume of air that is equally divided between the two banks of combustion cylinders by the intake manifolds.

Compressing the air with the turbocharger generally raises the temperature to a point where cooling water must be continually circulated to cool it. Occasionally the air being compressed enters the turbocharger at a temperature too low for adequate combustion. In this case heated water from the jacket water inlet header is circulated through the intercoolers. The heater/intercoolers are fin-tube type and are mounted directly in the engine air inlet headers downstream of the turbocharger.

Following combustion the hot exhaust gases leave the cylinders through the exhaust manifold and are then used to drive the turbocharger. The gas leaves the turbocharger through a flexible joint and enters the exhaust piping, which includes a silencer. The exhaust piping terminates at the diesel generator building roof and is completely missile protected for Diesel Generators A, B, C and D. For Diesel Generator 'E', the exhaust piping terminates into an insulated exhaust chamber located in the southeast corner of the Diesel Generator 'E' Building at plant elevation 726 feet. This exhaust piping is also missile protected.

9.5.8.3 Safety Evaluation

The diesel generator combustion air intake and exhaust system is an integral part of the diesel generator. The system meets the single failure criterion in that, if a failure in this system prevents satisfactory operation of the associated diesel generator, the other three divisions of the emergency power system will provide adequate power to safely shut down the plant or mitigate the consequences of any of the postulated accidents. The diesel generator combustion air intake and exhaust system is located within the confines of the diesel generator building. The intake and exhaust ducts are located outside the buildings and are missile protected. All equipment and supports for this system are designed to Seismic Category I requirements.

Diesel engines A, B, C and D are Cooper-Bessemer Model KSV-16-T, and are located in four separate rooms at plant elevation 677 feet. Each engine is supplied with combustion air from intakes also at plant elevation 677 feet. Each engine, at full load, exhausts approximately 48,000 cubic feet per minute at a temperature of approximately 950 degrees Fahrenheit. Exhaust gases from the engines are carried by piping through silencers to roof level at plant elevation 723 feet. Each of the four exhaust pipes runs horizontally across the roof to a common discharge point. The exhaust pipes are fully enclosed in a concrete structure for missile protection, except for the very end of the pipe, which is exposed to the outside. The end of the pipe is protected from missiles by vertical concrete walls which are open above and at the lower front for exhaust gas discharge. Each of the four exhaust pipes discharge against the vertical concrete missile shield located some four feet beyond the end of the pipe. These discharge pipes are installed in pairs in two bays, separated by additional missile shielding. These arrangements are shown on Figures 9.5-26 and 9.5-27.

Diesel engine 'E' is a Cooper-Bessemer Model KSV-20-T, and is located in its own Seismic Category I building at plant elevation 676 feet. This engine is supplied with combustion air from the air intake chamber located on the north side of the building at plant elevation 708 feet. This engine, at full load, exhausts approximately 51,000 cubic feet per minute at a temperature of approximately 950°F. The exhaust gases from this engine are carried by piping through expansion joints and a silencer to an insulated exhaust chamber located in the southeast corner of the building at plant elevation 726 feet. The exhaust chamber and piping is protected against the effects of tornadoes and missiles. This arrangement is shown in Figure 9.5-26A.

None of the components of the diesel generator air intake and exhausts systems are exposed to inclement weather conditions except about 4 feet of the exit end of the exhaust pipe on Diesel Generators A, B, C and D. This section of the pipe is open to the atmosphere from above. The bottom of the pipe is 5 ft.-6 in. above the roof of the building. Since the pipe is closely shielded on all sides, except directly above, exposure is minimized. In addition, the exhaust pipe end is cut at an angle which would prohibit accumulation of sleet and snow in the pipe. See Figure 9.5-27.

The effects on combustion air quality of recirculation of engine exhaust gases has been analyzed for Diesel Generators A, B, C and D. For the analysis, it was assumed that all four diesel generators are operating at full load, and that all exhaust gases were discharged to the two open bays of the missile shield enclosure. It was also assumed that the exhaust gases travel upward out the bay and spread in the open atmosphere at an angle of ninety degrees to form approximately a conical plume. Two engines exhaust into each bay, so that the volume of gases from each of the two bays is approximately 96,000 cubic feet per minute. The assumption of plume spread at a ninety degree angle is reasonable, considering the exhaust gas horizontal velocity against the missile shield, and further considering the elevated temperatures of the gases, both factors contributing to rapid turbulent mixing.

The diesels on the Susquehanna project utilize approximately 200% required combustion air. The engines will continue to operate at full load capacity down to approximately 85 percent of normal oxygen in the combustion air (17 percent vs. 20 percent oxygen in normal ambient air). The conservative value of 130 percent combustion air is assumed for this analysis. The actual exhaust gases contain approximately 10% oxygen. The analysis assumed that the exhaust gases from the engines contain approximately 6 percent oxygen as an additional conservatism.

As the exhaust gases expand in the atmosphere in a cone-shaped vertical plume, each increment of gas contains the original volume, containing 6 percent oxygen, plus some additional volume of entrained ambient air containing 20 percent oxygen. Maintaining the cone-shaped plume expansion at 90 degrees for a number of one-foot increments, it was then calculated that entrainment of ambient air caused the oxygen-depleted exhaust gases to become enriched to 17.5 percent oxygen at eight feet above the bay, and to 18.1 percent oxygen at ten feet above the bay. Thus, even if exhaust gases are entrained by dynamic mixing in the turbulent wake of the building into the engine air intakes some 53 feet below, sufficient oxygen will be present to sustain normal engine operation.

The effects on combustion air quality of recirculation of engine exhaust gases has not been analyzed for Diesel Generator 'E'. To minimize recirculation of engine exhaust into the combustion air intake, the combustion exhaust is located at the opposite end of the building. The potential for exhaust gases mixing with intake air is extremely remote, however, should this occur, the concentration of exhaust gases in the intake air would be minimal and would not affect engine operation.

The engines are equipped with temperature indicators in the air inlet manifolds and cylinder exhaust thermocouples to monitor the intake and exhaust temperatures. There is also a gauge on the engine control panel to monitor intake and crankcase pressures. The engine is not equipped with alarm or shutdown sensors for abnormal conditions in the intake and exhaust systems, as the engines are designed to operate under all specified operating conditions.

Flood protection is discussed in Section 3.4. Protection against dynamic effects associated with postulated rupture of piping is discussed in Section 3.6. Environmental design is discussed in Section 3.11.

9.5.8.4 Tests and Inspections

Testing of the diesel generator system is discussed generally in Section 8.3. The diesel generator combustion air intake and exhaust system is operationally checked during the periodic testing of the diesel generator system.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.8.5 Instrument Application

Instrument locations are shown on Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and Dwg. M-134, Sh. 7 for Diesel Generator 'E'.

9.5.9 HYDROGEN WATER CHEMISTRY (HWC) SYSTEM

The function of the Hydrogen Water Chemistry (HWC) System is to supply and inject hydrogen gas into the feedwater system at a flow rate necessary to mitigate the chemical conditions in the Boiling Water Reactor (BWR) that allow Intergranular Stress Corrosion Cracking (IGSCC) in the lower reactor vessel internals.

9.5.9.1 Design Basis

The HWC System has no safety-related functions.

The HWC System is designed to inject hydrogen into the reactor feedwater at the suction of the three feedwater pumps to mitigate IGSCC in the recirculation piping and reactor vessel internals. The hydrogen causes a reduction in a dissolved oxygen concentration by decreasing the radiolytic production rate of hydrogen and oxygen in the vessel core region and recirculation water. The addition of hydrogen to the feedwater results in an excess ratio of hydrogen to oxygen at the entrance to the offgas system. An oxygen flow rate of approximately equal to one half the hydrogen flow rate is injected to the offgas system upstream of the catalytic recombiner. Because oxygen concentration is reduced in the steam, condensate oxygen concentration is also reduced. To counter this effect, a small amount of oxygen may be injected into the condensate pump suction to keep oxygen concentration in the feedwater within acceptable limits.

9.5.9.2 System Description

The HWC System consists of a Tank Farm Gas Supply facility, hydrogen injection equipment, oxygen injection equipment, process piping and monitoring and control instrumentation.

The Gas Supply facility is operated and maintained by a commercial gas supply vendor. The facility is common for both units. The function of this facility is to store and supply hydrogen and oxygen at the required pressure and flow rates. The Gas Supply facility is automatic in operation and includes its own controls, alarms, and shutdowns. Excess flow check valves are provided to shut off hydrogen and oxygen gas flow in the event of a pipe break.

The HWC System is designed to inject hydrogen into the plant feedwater, inject a stoichiometric amount of oxygen into the offgas system, and monitor the results. The system also manually injects oxygen into the condensate system. The system includes gas flow control valves, automatic controls, alarms, and automatic shutdowns.

The system includes an HWC Control Panel, a Hydrogen Flow Control Panel, an Oxygen Flow Control Panel, a HWC Hydrogen Isolation Valve and oxygen analyzers (which are part of the offgas system analyzers described in Section 11.3.2.2.8). These panels are connected by process piping and signal wiring to provide monitoring and control of the HWC process.

9.5.9.3 Safety Evaluation

The HWC System is not a safety-related system and does not have any direct interface with any safety-related structure, system, or component. The failure of the HWC system or its components will not compromise any safety-related system or prevent a safe shutdown of the plant. The HWC equipment and components are non-Seismic Category I. The plant may be operated without the HWC System in-service.

The design of the HWC System complies, with some minor exceptions, with the NRC approved EPRI Guidelines contained in the document EPRI NP-5283-SR-A “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision”.

Exceptions to EPRI Guidelines are listed here:

- For hydrogen injection control, three flow control valves in parallel are used. Redundant flow control valves are not used. Oxygen flow control is performed by single flow control valve. This is a deviation from the EPRI guideline recommendation of redundant flow control valves. The justification is based on good GE field experience with flow control valve operation and reliability.

- The signal from high reactor recirculation water dissolved oxygen is not used. This signal was based on the original concept of hydrogen addition for protection of reactor recirculation piping. For in-vessel component protection, the hydrogen addition is sufficient to suppress the reactor recirculation water dissolved oxygen level to less than the detectable limit.

- Reactor scram is a recommended trip. The hydrogen injection system does not automatically trip on a reactor scram signal; however, the system trips at 30% power level based on the feedwater flow rate. Therefore, the power level trip serves the same function as a reactor scram trip. The hydrogen injection system can also be manually shutdown from the control room.

Excess flow check valves are installed in the hydrogen lines to restrict flow in case of a broken line. Bellows seal valves and welded piping are used in the hydrogen flow control panel to minimize the possibility of leakage of hydrogen. Feed water hydrogen injection lines contain check valves to prevent feedwater from entering the hydrogen lines and to protect upstream hydrogen gas components. Automatic isolation valves are installed to prevent hydrogen injection into a non-operating feedwater pump. Purge connections are provided to completely purge air from the system before hydrogen is put into the line. Hydrogen area monitors are provided to detect hydrogen leakage. Hydrogen area monitors alarm if hydrogen is detected and the HWC System shuts down if hydrogen approaches flammability limit.

The separation distances from the nearest safety-related building and air intakes to the liquid hydrogen and oxygen storage tanks and gaseous hydrogen receivers meets the requirements given in the NRC approved EPRI Guidelines contained in the document EPRI NP-5283-SR-A “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision”.

The injection of hydrogen causes readjustments in the reactor coolant water chemistry and the plants’ design basis radiation source terms. The effects are documented in FSAR Chapters 11 and 12.

9.5.9.4 Inspection and Testing

The HWC System will be pre-operationally tested.

9.5.9.5 Instrumentation and Control

Instrumentation for recording of parameters necessary to monitor and control the Hydrogen Injection System and to indicate and/or alarm abnormal and or undesirable conditions is provided. A Programmable Logic Controller (PLC) processes the measured variable and operator commands to perform the control functions. A CRT based graphic display Operator Interface Unit (OIU) is provided for operator information, data logging and operator input of flow control setpoint and flow control valve manual mode position demands. The HWC System is designed with alarms and trips on critical parameters in order to notify operators of system upsets and to automatically shutdown the system, if necessary.

Important control functions are listed below:

- Flow control is provided to automatically follow plant power levels (as determined from feedwater flow). Alternately, the operator may enter a hydrogen flow setpoint. Oxygen flow automatically follows hydrogen flow after an appropriate time delay. Setpoint changes are delayed by a ramping function to provide smooth flow control.

- Flow balancing between the three feedwater pumps is done by using three flow control valves in parallel. Each valve receives the same control air signal, thus the valves operate together. Each flow control valve is followed by an isolation valve. The isolation valve can open only when a “pump in service” signal is received by the HWC control system.

- Shutdown on selected signals is implemented by immediately closing the hydrogen flow control and isolation valves, but allowing the oxygen flow to ramp down after the preset time delay.

- Manual switches are provided for each of the automatic isolation valves. These switches allow closure of their respective valves regardless of the PLC logic.

- A manual shutdown switch on the HWC control panel and a switch in the control room provide for immediate system shutdown.

- Analog signals representing major process variables are transmitted to the plant computer.

9.5.10 PASSIVE ZINC INJECTION SYSTEM

The function of the Passive Zinc Injection System is to supply and inject depleted zinc into the feedwater system at a flow rate necessary to aid in reducing shutdown dose rates by reducing Co-60 deposition by controlling contamination buildup or plate out on the primary system pipe internal surfaces.

9.5.10.1 Design Bases

The Passive Zinc Injection System has no safety-related functions.

The system is designed to inject zinc into the reactor feedwater at the suction of the REACTOR FEED PUMP 'A' or ‘B’ to mitigate radiation buildup, primarily from Co-60, on the recirculation piping. The zinc in the reactor water causes the newly forming pipe film, after a chemical decontamination of the recirculation piping, to incorporate zinc and exclude the Co-60. (Reference: EPRI BWR Water Chemistry Guidelines 2000 Revision, TR-103515-R2)

9.5.10.2 System Description

The Passive Zinc Injection System will inject a zinc solution into feedwater by passing a small stream of feedwater from the REACTOR FEED PUMP 'A' or ‘B’ discharge pipe through the system containing pelletized zinc oxide. The zinc solution will be returned to the REACTOR FEED PUMP 'A' or ‘B’ suction pipe.

The system consists of a dissolution vessel, a strainer on the discharge of the vessel, a manual flow control valve, and manual isolation valves at the inlet and outlet of the skid. The skid will have local instruments to monitor the flow rate (nominally 20 to 100 gpm), the differential pressure across the vessel and the strainer, and the temperature of the vessel.

9.5.10.3 Safety Evaluation

The Passive Zinc Injection System is not a safety-related system and does not have any direct interface with any safety-related structure, system, or component. The failure of the system or its components will not compromise any safety-related system or prevent a safe shutdown of the plant. The Passive Zinc Injection equipment and components are non-Seismic Category I. The plant may be operated without the Passive Zinc Injection System in-service.

9.5.10.4 Inspection and Testing

The Passive Zinc Injection System will be pre-operationally tested.

9.5.10.5 Instrumentation and Control

Local instruments are used to monitor and control the Passive Zinc Injection System. Important control functions are listed in this section:

- A manual flow control valve is provided to control flow.
- A flow instrument is used to monitor the flow.
- A differential pressure instrument is used to monitor the pressure drop across the dissolution vessel and the outlet strainer.
- A temperature instrument is used to monitor the temperature of the dissolution vessel.

9.5.11 REFERENCES

9.5-1 Fire Protection Review Report

9.5-2 NEDO-10466, G. C. Minor, H. R. Clay, "Power Generation Control Complex Design Criteria and Safety Evaluation, "Licensing Topical Report, Class I, Revision 2, March, 1978.

9.5-3 EPRI NP-5283-SR-A “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision.”

9.5-4 EPRI TR-103515-R12 “BWR Water Chemistry Guidelines-2000 Revision.”

TABLE 9.5-1

THIS TABLE HAS BEEN DELETED

TABLE 9.5-2

THIS TABLE HAS BEEN DELETED

TABLE 9.5-3

EMERGENCY LIGHTING SYSTEM IN SUSQUEHANNA SES

AREA	EMERGENCY LIGHTING SYSTEM				
	EMERGENCY LIGHT SYSTEM				
	125V DC EMERG. LIGHTING POWER SYSTEM	SELF-CONTAINED BATTERY LIGHTING			
		EXIT LIGHT RATE 2½ HRS	STAIR LIGHT RATED 2½ HRS	EMERG. LIGHT UNIT RATED 8 HRS	EMERG. LIGHT CENTER RATE 8 HRS
TURBINE BUILDING					
EL 656'	YES				
EL 676'	YES			YES(3)	
EL 699'	YES			YES(3)	
EL 714'	YES				
EL 729'	YES			YES(3)	
STAIRWAYS			YES	YES(3)	
REMOTE SHUTDOWN PASS.				YES(3)	
RADWASTE BUILDING					
EL 646'	YES	YES			
EL 660'	YES	YES			
EL 676'	YES	YES			
EL 691'	YES	YES			
STAIRWAYS			YES		
REACTOR BUILDING	YES				
EL 645'	YES			YES(3)	
EL 670'	YES			YES(3)	
EL 683'	YES				
EL 719'	YES			YES(3)	
EL 749'	YES			YES(3)	
EL 779'	YES				
EL 799'	YES				
EL 818'					
STAIRWAYS			YES	YES(3)	
REMOTE SHUTDOWN PASS.				YES(3)	
NORTH & SOUTH					
GATE HOUSE		YES			
SCC	YES				

TABLE 9.5-3

EMERGENCY LIGHTING SYSTEM IN SUSQUEHANNA SES

	EMERGENCY LIGHTING SYSTEM				
	EMERGENCY LIGHT SYSTEM				
		SELF-CONTAINED BATTERY LIGHTING			
AREA	125V DC EMERG. LIGHTING POWER SYSTEM	EXIT LIGHT RATE 2½ HRS	STAIR LIGHT RATED 2½ HRS	EMERG. LIGHT UNIT RATED 8 HRS	EMERG. LIGHT CENTER RATE 8 HRS
CONTAINMENT					
EL 704'	YES				
EL 719'	YES				
EL 739'	YES				
EL 779'	YES				
CONTROL STRUCTURE					
EL 676'	YES				
EL 698'	YES			YES(3)	
EL 714'	YES				
EL 729' CONTROL RM					YES
EL 741'1" TSC				YES	
EL 754'	YES				
EL 771'	YES				
EL 783'	YES			YES(3)	
EL 806'	YES				
STAIRWAYS			YES	YES(3)	
REMOTE SHUTDOWN PASS.				YES(3)	YES
ESSW PUMPHOUSE		YES			
INTAKE STRUCTURE	YES				
CW PUMPHOUSE		YES	YES		
CHLORINE & SULFURIC BUILDING		YES			
DIESEL GENERATOR BLDG STAIRWAYS		YES		YES	
ADMINISTRATION BLDG		YES	YES		
DIESEL GENERATOR & FACILITY		YES(1)	YES(2)	YES	

(1) 90 minute battery rating
(2) 8 hour battery rating
(3) 8 hour emergency light units provided in these areas for the purpose of safe shutdown in accordance with 10CFR50 Appendix R.

TABLE 9.5-4

COMMUNICATION SYSTEMS

VITAL AREA	PAGE-TALK INTERCOM (5 CH.)	TELEPHONE PUBLIC SWITCHED	INTRAPLANT MAINT/TEST JACK PHONE	EMERGENCY ALARM SYSTEM	SECURITY COMMUNICATION	RADIO COMMUNICATION	APPENDIX R COMMUNICATION	SATELLITE TELEPHONE
U1 & U2 Reactor Building					**			
EL 818’	Yes	Yes	Yes	Yes				
EL 799’	Yes		Yes	Yes				
EL 779’	Yes		Yes	Yes				
EL 749’	Yes		Yes	Yes			Yes	
EL 719’	Yes	Yes	Yes	Yes			Yes	
EL 683’	Yes		Yes	Yes				
EL 670’	Yes	Yes	Yes	Yes			Yes	
EL 645’	Yes	Yes	Yes	Yes				
U1 & U2 Control Structure					**			
EL 806’	Yes		Yes	Yes			Yes	
EL 783’	Yes		Yes	Yes				
EL 771’	Yes	Yes	Yes	Yes				
EL 754’	Yes		Yes	Yes				
EL 741’	Yes	Yes		Yes				Yes
EL 729’	Yes	Yes	Yes	Yes			Yes	Yes
EL 698’	Yes	Yes	Yes	Yes			Yes	
U1 & U2 Turbine Building					**			
EL 676’	Yes	Yes	Yes	Yes				
EL 699’							Yes	
U1 & U2 Emergency Service Water Area					**			
EL 685’	Yes	Yes	Yes	Yes				
Diesel Generator Rooms ‘A-D’					**			
EL 710’								
EL 676’	Yes		Yes	Yes			Yes	
EL 660’								
Diesel Generator ‘E’ Building					**			
EL 708’	Yes		Yes	Yes			Yes	
EL 675’-6”	Yes		Yes	Yes				
EL 656’-6”	Yes		Yes	Yes				

** See Security System Section.

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-1, Rev. 50

AutoCAD Figure 9_5_1.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR FIGURE 9.5-2, Rev. 50

AutoCAD Figure 9_5_2.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-3, Rev. 50

AutoCAD Figure 9_5_3.doc

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-4, Rev. 50

AutoCAD Figure 9_5_4.doc

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR FIGURE 9.5-5, Rev. 50

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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FIGURE 9.5-6, Rev. 50

AutoCAD Figure 9_5_6.doc

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-7, Rev. 50

AutoCAD Figure 9_5_7.doc

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FIGURE 9.5-8, Rev. 50

AutoCAD Figure 9_5_8.doc

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-9, Rev. 50

AutoCAD Figure 9_5_9.doc

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FIGURE 9.5-10, Rev. 50

AutoCAD Figure 9_5_10.doc

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FIGURE 9.5-11, Rev. 50

AutoCAD Figure 9_5_11.doc

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR FIGURE 9.5-12, Rev. 50

AutoCAD Figure 9_5_12.doc

FIGURE 9.5-13 REPLACED BY DWG. E-408, SH. 1

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FIGURE 9.5-13 REPLACED BY DWG. E-408, SH. 1

FIGURE 9.5-13, Rev. 55

AutoCAD Figure 9_5_13.doc

FIGURE 9.5-14 REPLACED BY DWG. E-408, SH. 2

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FIGURE 9.5-14 REPLACED BY DWG. E-408, SH. 2

FIGURE 9.5-14, Rev. 55

AutoCAD Figure 9_5_14.doc

FIGURE 9.5-15 REPLACED BY DWG. E-409, SH. 1

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FIGURE 9.5-15 REPLACED BY DWG. E-409, SH. 1

FIGURE 9.5-15, Rev. 49

AutoCAD Figure 9_5_15.doc

FIGURE 9.5-16 REPLACED BY DWG. E-409, SH. 2

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FIGURE 9.5-16 REPLACED BY DWG. E-409, SH. 2

FIGURE 9.5-16, Rev. 50

AutoCAD Figure 9_5_16.doc

FIGURE 9.5-17 REPLACED BY DWG. E-411, SH. 1

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FIGURE 9.5-17 REPLACED BY DWG. E-411, SH. 1

FIGURE 9.5-17, Rev. 55

AutoCAD Figure 9_5_17.doc

FIGURE 9.5-18 REPLACED BY DWG. E-411, SH. 2

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FIGURE 9.5-18 REPLACED BY DWG. E-411, SH. 2

FIGURE 9.5-18, Rev. 55

AutoCAD Figure 9_5_18.doc

FIGURE 9.5-19 REPLACED BY DWG. M-120, SH. 1

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FIGURE 9.5-19 REPLACED BY DWG. M-120, SH. 1

FIGURE 9.5-19, Rev. 57

AutoCAD Figure 9_5_19.doc

FIGURE 9.5-20 REPLACED BY DWG. M-134, SH. 1

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FIGURE 9.5-20 REPLACED BY DWG. M-134, SH. 1

FIGURE 9.5-20, Rev. 56

AutoCAD Figure 9_5_20.doc

FIGURE 9.5-21 REPLACED BY DWG. M30-69, SH. 1

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FIGURE 9.5-21 REPLACED BY DWG. M30-69, SH. 1

FIGURE 9.5-21, Rev. 55

AutoCAD Figure 9_5_21.doc

FIGURE 9.5-22 REPLACED BY DWG. M30-71, SH. 1

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FIGURE 9.5-22 REPLACED BY DWG. M30-71, SH. 1

FIGURE 9.5-22, Rev. 55

AutoCAD Figure 9_5_22.doc

FIGURE 9.5-23 REPLACED BY DWG. M-738, SH. 1

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FIGURE 9.5-23 REPLACED BY DWG. M-738, SH. 1

FIGURE 9.5-23, Rev. 55

AutoCAD Figure 9_5_23.doc

FIGURE 9.5-24 REPLACED BY DWG. FF61604, SH. 3

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FIGURE 9.5-24 REPLACED BY DWG. FF61604, SH. 3

FIGURE 9.5-24, Rev. 56

AutoCAD Figure 9_5_24.doc

FIGURE DELETED

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FIGURE DELETED

FIGURE 9.5-25, Rev. 54

AutoCAD Figure 9_5_25.doc

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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DIESEL GENERATOR
AREA 44 PLAN ON EL. 677'-0"
INTAKE & EXHAUST

FIGURE 9.5-26, Rev 54

AutoCAD: Figure Fsar 9_5_26.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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DIESEL GENERATOR BUILDING

FIGURE 9.5-27, Rev 54

AutoCAD: Figure Fsar 9_5_27.dwg

FIGURE 9.5-28 REPLACED BY DWG. C-1006, SH. 1

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FIGURE 9.5-28 REPLACED BY DWG. C-1006, SH. 1

FIGURE 9.5-28, Rev. 56

AutoCAD Figure 9_5_28.doc

FIGURE 9.5-29 REPLACED BY DWG. C-1007, SH. 1

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FIGURE 9.5-29 REPLACED BY DWG. C-1007, SH. 1

FIGURE 9.5-29, Rev. 56

AutoCAD Figure 9_5_29.doc

FIGURE 9.5-30 REPLACED BY DWG. C-1032, SH. 1

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FIGURE 9.5-30 REPLACED BY DWG. C-1032, SH. 1

FIGURE 9.5-30, Rev. 55

AutoCAD Figure 9_5_30.doc

FIGURE 9.5-31 REPLACED BY DWG. EC-1, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-31 REPLACED BY DWG. EC-1, SH. 1

FIGURE 9.5-31, Rev. 57

AutoCAD Figure 9_5_31.doc

FIGURE 9.5-32 REPLACED BY DWG. EC-2, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-32 REPLACED BY DWG. EC-2, SH. 1

FIGURE 9.5-32, Rev. 55

AutoCAD Figure 9_5_32.doc

FIGURE 9.5-33 REPLACED BY DWG. EC-3, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-33 REPLACED BY DWG. EC-3, SH. 1

FIGURE 9.5-33, Rev. 55

AutoCAD Figure 9_5_33.doc

FIGURE 9.5-34 REPLACED BY DWG. EC-4, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.5-34 REPLACED BY DWG. EC-4, SH. 1 FIGURE 9.5-34, Rev. 54

AutoCAD Figure 9_5_34.doc

FIGURE 9.5-35 REPLACED BY DWG. EC-5, SH. 1

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-35 REPLACED BY DWG. EC-5, SH. 1

FIGURE 9.5-35, Rev. 49

AutoCAD Figure 9_5_35.doc

FIGURE 9.5-36 REPLACED BY DWG. EC-6, SH. 1

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FIGURE 9.5-36 REPLACED BY DWG. EC-6, SH. 1

FIGURE 9.5-36, Rev. 49

AutoCAD Figure 9_5_36.doc

FIGURE 9.5-37 REPLACED BY DWG. EC-7, SH. 1

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FIGURE 9.5-37 REPLACED BY DWG. EC-7, SH. 1

FIGURE 9.5-37, Rev. 48

AutoCAD Figure 9_5_37.doc

FIGURE 9.5-38 REPLACED BY DWG. EC-8, SH. 1

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FIGURE 9.5-38 REPLACED BY DWG. EC-8, SH. 1

FIGURE 9.5-38, Rev. 48

AutoCAD Figure 9_5_38.doc

FIGURE 9.5-39 REPLACED BY DWG. C-46, SH. 1

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FIGURE 9.5-39 REPLACED BY DWG. C-46, SH. 1

FIGURE 9.5-39, Rev. 56

AutoCAD Figure 9_5_39.doc

FIGURE 9.5-40 REPLACED BY DWG. C-901, SH. 1

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FIGURE 9.5-40 REPLACED BY DWG. C-901, SH. 1

FIGURE 9.5-40, Rev. 49

AutoCAD Figure 9_5_40.doc

FIGURE 9.5-41 REPLACED BY DWG. C-904, SH. 1

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FIGURE 9.5-41 REPLACED BY DWG. C-904, SH. 1

FIGURE 9.5-41, Rev. 49

AutoCAD Figure 9_5_41.doc

FIGURE 9.5-42 REPLACED BY DWG. C-905, SH. 1

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FIGURE 9.5-42 REPLACED BY DWG. C-905, SH. 1

FIGURE 9.5-42, Rev. 55

AutoCAD Figure 9_5_42.doc

FIGURE DELETED

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FIGURE DELETED

FIGURE 9.5-44, Rev. 54

AutoCAD Figure 9_5_44.doc

FIGURE DELETED

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FIGURE DELETED

FIGURE 9.5-45, Rev. 54

AutoCAD Figure 9_5_45.doc

FIGURE DELETED

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FIGURE DELETED

FIGURE 9.5-46, Rev. 54

AutoCAD Figure 9_5_46.doc

FIGURE 9.5-47 REPLACED BY DWG. E-412, SH. 1

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FIGURE 9.5-47 REPLACED BY DWG. E-412, SH. 1

FIGURE 9.5-47, Rev. 55

AutoCAD Figure 9_5_47.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-9A, Rev. 50

AutoCAD Figure 9_5_9A.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-9B, Rev. 50

AutoCAD Figure 9_5_9B.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-10A, Rev. 50

AutoCAD Figure 9_5_10A.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-10B, Rev. 50

AutoCAD Figure 9_5_10B.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-10C, Rev. 50

AutoCAD Figure 9_5_10C.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-11A, Rev. 50

AutoCAD Figure 9_5_11A.doc

FIGURE 9.5-16A REPLACED BY DWG. E-409, SH. 3

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FIGURE 9.5-16A REPLACED BY DWG. E-409, SH. 3

FIGURE 9.5-16A, Rev. 55

AutoCAD Figure 9_5_16A.doc

FIGURE 9.5-16B REPLACED BY DWG. E-409, SH. 4

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FIGURE 9.5-16B REPLACED BY DWG. E-409, SH. 4

FIGURE 9.5-16B, Rev. 50

AutoCAD Figure 9_5_16B.doc

FIGURE 9.5-16C REPLACED BY DWG. E-409, SH. 5

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FIGURE 9.5-16C REPLACED BY DWG. E-409, SH. 5

FIGURE 9.5-16C, Rev. 51

AutoCAD Figure 9_5_16C.doc

FIGURE 9.5-16D REPLACED BY DWG. E-409, SH. 6

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FIGURE 9.5-16D REPLACED BY DWG. E-409, SH. 6

FIGURE 9.5-16D, Rev. 49

AutoCAD Figure 9_5_16D.doc

FIGURE 9.5-16E REPLACED BY DWG. E-409, SH. 7

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FIGURE 9.5-16E REPLACED BY DWG. E-409, SH. 7

FIGURE 9.5-16E, Rev. 51

AutoCAD Figure 9_5_16E.doc

FIGURE 9.5-19A REPLACED BY DWG. M-120, SH. 2

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FIGURE 9.5-19A REPLACED BY DWG. M-120, SH. 2

FIGURE 9.5-19A, Rev. 57

AutoCAD Figure 9_5_19A.doc

FIGURE 9.5-19B REPLACED BY DWG. M-120, SH. 3

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FIGURE 9.5-19B REPLACED BY DWG. M-120, SH. 3

FIGURE 9.5-19B, Rev. 2

AutoCAD Figure 9_5_19B.doc

FIGURE 9.5-20A REPLACED BY DWG. M-134, SH. 5

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FIGURE 9.5-20A REPLACED BY DWG. M-134, SH. 5

FIGURE 9.5-20A, Rev. 55

AutoCAD Figure 9_5_20A.doc

FIGURE 9.5-20B REPLACED BY DWG. M-134, SH. 6

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.5-20B REPLACED BY DWG. M-134, SH. 6 FIGURE 9.5-20B, Rev. 49

AutoCAD Figure 9_5_20B.doc

FIGURE 9.5-20C REPLACED BY DWG. M-134, SH. 7

FIGURE 9.5-20C REPLACED BY DWG. M-134, SH. 7

FIGURE 9.5-22A REPLACED BY DWG. FF61604, SH. 7

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FIGURE 9.5-22A REPLACED BY DWG. FF61604, SH. 7

FIGURE 9.5-22A, Rev. 55

AutoCAD Figure 9_5_22A.doc

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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DIESEL GENERATOR
'E' BUILDING
INTAKE & EXHAUST PIPING

FIGURE 9.5-26A, Rev 54

AutoCAD: Figure Fsar 9_5_26A.dwg

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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DIESEL GENERATOR 'E' BUILDING
COMPOSITE PIPING
BASEMENT FLOOR EL. 656'-8"
PLAN, SECTIONS AND DETAILS

FIGURE 9.5-26B, Rev 54

AutoCAD: Figure Fsar 9_5_26B.dwg

FIGURE 9.5-30A REPLACED BY DWG. C-5028, SH. 1

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FIGURE 9.5-30A REPLACED BY DWG. C-5028, SH. 1

FIGURE 9.5-30A, Rev. 56

AutoCAD Figure 9_5_30A.doc

FIGURE 9.5-40A REPLACED BY DWG. C-5012, SH. 1

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FIGURE 9.5-40A REPLACED BY DWG. C-5012, SH. 1

FIGURE 9.5-40A, Rev. 50

AutoCAD Figure 9_5_40A.doc

FIGURE 9.5-41A REPLACED BY DWG. C-5013, SH. 1

FIGURE 9.5-41A REPLACED BY DWG. C-5013,
SH. 1

FIGURE 9.5-42A REPLACED BY DWG. C-5014, SH. 1

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FIGURE 9.5-42A REPLACED BY DWG. C-5014, SH. 1

FIGURE 9.5-42A, Rev. 55

AutoCAD Figure 9_5_42A.doc

FIGURE 9.5-42B REPLACED BY DWG. C-5015, SH. 1

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FIGURE 9.5-42B REPLACED BY DWG. C-5015, SH. 1

FIGURE 9.5-42B, Rev. 55

AutoCAD Figure 9_5_42B.doc

FIGURE 9.5-29-1 REPLACED BY DWG. C-1007, SH. 2

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FIGURE 9.5-29-1 REPLACED BY DWG. C-1007, SH. 2

FIGURE 9.5-29-1, Rev. 2

AutoCAD Figure 9_5_29_1.doc

FIGURE 9.5-43-1 REPLACED BY DWG. C-1029, SH. 1

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FIGURE 9.5-43-1 REPLACED BY DWG. C-1029, SH. 1

FIGURE 9.5-43-1, Rev. 57

AutoCAD Figure 9_5_43_1.doc

FIGURE 9.5-43-2 REPLACED BY DWG. C-1029, SH. 2

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FIGURE 9.5-43-2 REPLACED BY DWG. C-1029, SH. 2

FIGURE 9.5-43-2, Rev. 49

AutoCAD Figure 9_5_43_2.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-11B-1, Rev. 50

AutoCAD Figure 9_5_11B_1.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-11B-2, Rev. 50

AutoCAD Figure 9_5_11B_2.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR FIGURE 9.5-11B-3, Rev. 50

AutoCAD Figure 9_5_11B_3.doc

ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

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ALL FIRE PROTECTION FIGURES HAVE BEEN DELETED FROM THE FSAR

FIGURE 9.5-11B-4, Rev. 50

AutoCAD Figure 9_5_11B_4.doc

APPENDIX 9A

ANALYSIS FOR NON SEISMIC SPENT FUEL POOL COOLING SYSTEMS

As described in Subsection 9.1.3 the Spent Fuel Pool (SFP) Cooling Systems are designed as non-seismic Category I, Quality Group C systems. Consequently, the radiological consequences of a loss of spent fuel pool cooling due to a seismic event are evaluated. In order to perform this analysis it is necessary to assume the SFP will boil even though Section 9.1.3.3 establishes that the design basis of the plant for this event is to prevent boiling through the use of RHRFPC mode.

Since the cooling systems for both units are cross-connected and in close proximity it was assumed that a seismic event causes the loss of cooling to both spent fuel pools. In addition, in order to maximize both the heat loads and the iodine inventories in the pools, refuelings within 180 days were postulated. (Period of time between outages is nominally 365 days, thus use of 180 days is conservative.) The loss of cooling was assumed during the second refueling, just after isolation of the pools (i.e., refueling and cask pit gates installed). The RHR system is assumed to not be available for cooling the SFP even though it would be able to provide cooling in response to this event. Thus, it is assumed that the pools will boil. The analysis involved an evaluation of the time to pool boiling, the ability to maintain water level if the pool boils, and the dose consequences at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ) and the Control Room Habitability Envelope (CRHE) due to releases from the boiling pools.

The assumptions used in this analysis were consistently chosen to be conservative and bounding similar to those in Regulatory Guide 1.183 for design basis accidents. The combination of all of these design basis assumptions occurring at the same time would be extremely unlikely, making this accident as analyzed, one of very low probability.

Both a realistic and conservative analysis of the dose consequences resulting from a boiling spent fuel pool are evaluated. The realistic analysis assumes a conservative value for the number of assemblies in a reload offload batch operated at 4032 MW(t). The conservative analysis assumes a full core offload using the same decay timing characteristics as the smaller reload batch offload. A spiking and steady state release source term is implemented in this analysis. Both the spiking and steady state source term are obtained from Section 11.1.

The following event scenario is assumed for both realistic and conservative analyses of the dose consequences from a spent fuel pool boiling event. Radioactive iodine and noble gases present in the recently off-loaded irradiated fuel resident in the spent fuel pool are assumed to leak into the spent fuel pool water at given leakage rates during conditions when spent fuel pool cooling is unavailable. The leakage rates are conservatively assumed equivalent to worst case full power operation failed fuel leakage rates. The activity leakage consists of both a spiking and steady state source term. The spiking source term is assumed to exist between the start of the heatup of the spent fuel pool (when cooling is lost due to an assumed seismic event) and initiation of pool boiling, at which time the spiking source term terminates. At the time boiling begins, the steady state source term is assumed to initiate and continue for thirty days. The released iodine and noble gas activity for both spiking and steady state conditions is assumed to uniformly disperse throughout the pool water, and then be released into the air above the spent fuel pool at a rate equal to the boiling evaporation rate of the pool water. The evaporation rate is conservatively assumed to be equal to the maximum makeup rate of the Emergency Service Water (ESW) system of 70 gpm. No credit is taken for holdup of the released activity into the spent fuel pool area, or for iodine plateout on walls and equipment or washout by condensing water vapor in the refueling area. The released activity in the air above the spent fuel pool is assumed to be instantaneously released to the environment through the SGTS system vent. The carryover fraction of iodine from the boiling spent fuel pool water to the spent fuel pool atmosphere is assumed to be the carryover fraction for normal water chemistry conditions. Noble gases are assumed transported to the atmosphere without any partition effects.

The event sequences for the realistic and conservative cases are assumed to occur as follows.

Realistic Scenario:

t = 0 days:
Affected unit shutdown for refueling. Unaffected unit operates at full power with no recently discharged fuel in spent fuel pool, pool activity negligible due to clean up systems operation and normal decay processes. No releases in progress.

t = 24 Hours:
Fuel assemblies begin to be discharged from reactor vessel. Assume batch of 348 assemblies discharged at 7.5 fuel movements per hour. The number of hours to complete a reload offload is 46.4 hrs. No releases in progress.

t = 24 Hours + 46.4 hours = 70.4 hours:
All fuel assemblies in reload batch off-loaded; fuel pool cooling system assumed to fail; fuel pool clean up system fails; conservatively assume isolated fuel pool. Release of spiking activity from fuel to spent fuel pool initiates. Spent fuel pool begins to conservatively evaporate at a rate equal to the maximum ESW make up rate. Release from pool begins. Conservative accident period begins; offsite and control room dose integration begins. The 50% direction independent offsite X/Qs are used to determine the EAB and LPZ doses.

t= 24 hours + 46.4 hours + 25 hours = 95.4 hours = 3.975 days:
Per administrative controls, minimum time to spent fuel pool boiling is 25 hours. Release of spiking activity completes, steady state activity release from fuel into pool begins. Spent fuel pool boiling evaporation rate continues at maximum ESW make up rate. Accident period continues for 30 days after which spent fuel pool cooling is assumed to be restored.

Conservative Scenario:

Timing same as realistic case, except a full core offload (764) assemblies is assumed. This increases the spiking source term. The time period for the offload (46.4 hours) is conservatively maintained as that of the reload batch to minimize decay time. The 0.5% direction dependent offsite X/Qs are used to determine the LPZ dose.

As shown in Table 9A-1, the dose consequences of the boiling pool, without operation of the Standby Gas Treatment System, are well below the guideline values of 10CFR50.67 and Regulatory Guide 1.29. The doses were determined using the RADTRAD computer code (Reference 9A-1).

The following assumptions were used to calculate the EAB, LPZ and CRHE doses for the loss of cooling to the spent fuel pools.

1. Iodine in fuel from past refuelings (over 60 days) will be negligible due to the long decay times.

2. It is assumed that all of the defective fuel rods in the core are transferred to the SFP.

3. The iodine activity in the SFP water when cooling/cleanup is lost is assumed to be negligible compared to the activity released from the fuel during pool boiling. Activity in the core coolant or from a shutdown spike would have been cleaned up to acceptably low levels by the RWCU and SFP Cleanup Systems before fuel transfer began.

4. The activity released from the fuel is assumed to be uniformly mixed in the 48,690 ft^3 ($3.00x10^6$ 1bm mass) of water in one SFP.

5. It is assumed that makeup water is available prior to boiling, thus the mass of water is constant.
6. Iodine carryover fractions of 0.02 (design basis iodine carryover from reactor coolant to steam) and

7. 0.1 at the pool surface were used.

8. No credit was taken for iodine plateout on walls and equipment or washout by condensing water vapor in the refueling area.

9. No credit is taken for holdup of the activity in the SFP area or removal of iodine by the ventilation system; thus, the release to the air above the SFP is assumed to be instantaneously released to the environment.

9. The steady state release source term was conservatively based on full power design basis iodine and noble gas fuel leakage release rates. The design basis off gas release rate for noble gases is 100,000 µCi/sec after 30 minutes delay. For this analysis, noble gas release rates were back corrected to the full power t = 0 release rates. The design basis release rate for iodines corresponds to an I-131 leakage from the fuel of 700 µci/sec. These release rates are the basis for reactor coolant sources given in FSAR section 11.1.

10. A spiking release is assumed to occur during the heat up period after the spent fuel pool cooling system fails until full pool boiling occurs at 25 hours after the loss of spent fuel pool cooling. The spiking release is based on the full power depressurization spiking activities listed in Table 11.1-6.

11. Radiological consequences for the EAB and LPZ were evaluated using the 50% direction independent meteorology for the realistic case and 0.5% direction dependent meteorology for the conservative case. The control room X/Q values were for a release through the SGTS vent.

Conservative Case Offsite X/Q (0.5% Direction Dependent)

Exclusion Area Boundary:

0-2 hr	8.3×10^{-4} sec/m^3

Low Population Zone:

0-8 hr	4.9×10^{-5} sec/m^3
8-24 hr	3.5×10^{-5} sec/m^3
24-96 hr	1.7×10^{-5} sec/m^3
96-720 hr	6.1×10^{-6} sec/m^3

Realistic Case Offsite X/Q(50% Direction Independent)
Exclusion Area Boundary:

0-2 hr	$1.3x10^{-4}$ sec/m^3

Low Population Zone:

0-8 hr	$4.8x10^{-6}$ sec/m^3
8-24 hr	$3.8x10^{-6}$ sec/m^3
24-96 hr	$2.3x10^{-6}$ sec/m^3
96-720 hr	$1.1x10^{-6}$ sec/m^3

Control Room Habitability Envelope X/Q - SGTS Exhaust Vent:

0-2 hr	1.16x10-3 sec/m^3
2-8 hr	$8.64x10^{-4}$ sec/m^3
8-24 hr	$3.09x10^{-4}$ sec/m^3
24-96 hr	$1.87x10^{-4}$ sec/m^3
96-720 hr	$1.60x10^{-4}$ sec/m^3

12. The CRHE's nominal inlet air flow rate is 5810 cfm ± 10%. The analysis was performed using an inlet makeup flow of 6391 cfm, the maximum value for which the system is in compliance with the plant Technical Specifications. In addition, unidentified unfiltered inleakage of 500 cfm and unfiltered ingress/egress leakage through doors of 10 cfm was used.

13. The volume for the CRHE is 518,000 ft^3.

REFERENCES

9A-1 USNRC NUREG/CR-6604, "RADTRAD A Simplified Model for RADionuclide Transport and Removal And Dose Estimation", December 1997. Supplement 1, June 1999. Supplement 2, October 2002. Version 3.03.

TABLE 9A-1

RESULTS OF BOILING SPENT FUEL POOL ANALYSIS

Dose Location	Dose (1) (Rem TEDE)	
	Conservative Analysis	Realistic Analysis
2 Hour Exclusion Area Boundary	6.77E-03	2.34E-03
30 Day Low Population Zone	2.01E-02	6.64E-04
30 Day Control Room Habitability Envelope	3.02E-01	6.06E-02

(1) 6.77E-03 means $6.77X10^{-3}$

TABLE 9A-2

THIS TABLE HAS BEEN DELETED

APPENDIX 9B

COMPLIANCE WITH

NRC BRANCH TECHNICAL POSITION ASB 9-1

SUSQUEHANNA STEAM ELECTRIC STATION

UNIT 1 REACTOR BUILDING CRANE

The attached table compares the design of the Unit 1 crane with Branch Technical Position ASB 9-1.

Compliance with each regulatory position in the BTP is classified into one of the following categories:

a) comply

b) complied with based on our interpretation of the intent of regulatory position

c) complied
with by use of alternate means or methods

d) do not comply

Justification is provided for each item of noncompliance.

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks
B.I.a Separate Performance Specification		X			Item #1
b Environmental Operational Conditions Structural Movement Selection	X				
c Seismic Category I	X				
d NDE – Lamellar Tearing		X			Item #2
e Fatigue Analysis		X			Item #3
f Preheat-Postheat-Welding		X			Item #4
B.2.a Controls-Devices-Safe Holding Position	X				
b Auxiliary System, Dual Component Immobile Position	X				
c Means for Repairing		X			Item #5
B.3.a Dual Load Attachment Points	X				
b Lifting Devices- Redundant Design	X				
c Dual Hoisting Equipment 5 fpm limit	X				

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks
d Head Load Block Balance	X				
e Dual Reeving System Rope Standard	X				
f Fleet Angles					Item #6
g 200-Static Design Test				X	Item #7
h Sensor Over-Speed Over-Loading, etc.	X				
i Control System Motors-Torque		X			Item #8
j Two-blocking-Precautions, etc.		X			Item #9
k Drum Protection	X				
l Excessive Breakdown Torque		X			Item #10
m Hoisting Brakes Holding Brakes		X			Item #11
Dynamic-Static Alignment	X				
o Increment Drives	X				

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks
p Trolley + Bridge i. Motors ii. Speeds		X		X	Item #12
q Cab Located Controls	X				
r Safety Devices, Limit Devices	X				
s Operating Manuals – MWL	X				Item #13
t Change from Construction to Operating	X				
u Installation Instructions	X				
B.4.a Mechanical Check	X				
b 125% Static Test (2 – block) i. 125% static test ii. 2-block	X X			X	Item #14
c Preventive Maintenance Program	X				Item #15

NOTES:

Item #1

The load lifts during construction are not greater than those for plant operation, therefore no separate specifications have been prepared.

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks

Item #2

We consider that the Regulatory Positions is complied with to the extent that all major structural load carrying welds are 100% magnetic particle (MT) tested. Volumetric examination, in our opinion (RT or UT) of the welds used in the assembly of the crane will not produce meaningful results because of the joint geometrics, therefore, they are not performed.

Item #3

The crane is specified and has been designated as Service Class C, per CMAA-70. This standard determines allowable stresses for the crane structural and mechanical components as a function of the specified crane service class. Service Class C allows for 100,000 to 500,000 loading cycles, which by far exceeds our conservatively estimated 4,000 cycle life. Therefore, no additional fatigue analyses have been performed.

Item #4

This reaulatorv position is complied with to the extent that the preheat and postheat treatment of the welds is in accordance with AWS D1.1

Item #5

Provisions are made for manual operation of the main hoist holding brakes for lowering the load (Item #11). No special provisions are made for manually moving the immobilized bridge or trolley. However, there are options for moving the bridge or trolley if the electric power cannot be restored.

Item #6

The fleet angle from drum to lead sheave and between sheaves does not exceed 3-1/2 degrees (3'7" actual design). The NRC position recommends limiting the fleet angles between individual sheaves to 1-1/2 degrees. The use of the 3-1/2 degrees limit is justified because:

1. The 3-1/2 degree limitation has been proven to be a reliable parameter for rope leads off of drums which are more critical than rope leads from sheaves; the latter being more deeply grooved.
2. With redundant reeving, sheave spacings are double the normal spacings. Thus to maintain 1-1/2 degree fleet angle, the distance form the hook to the top of the crane would have to be needlessly and excessively increased to such a degree that it would be inconsistent with a good crane design. This would have necessitated, at least, eight to nine feet increase in the building height.

   The design ratio of running sheaves pitch diameters to the rope diameter is 24:1 instead of the 30:1 or 26:1 recommended by the NRC. The 24:1 ratio is justified because: Due to the large diameter of the wire rope used, 30:1 and 26:1 diameter ratio sheave blanks are not readily available. Also 24:1 ratio is recommended by ASME Standard Committee on the Design of Overhead and Gantry Handling Systems for Critical Loads at Nuclear Power Plants, in their comments to the NRC on RG 1.04 dated March 18, 1976, and is consistent with the recommendations of CMAA Specification #70.

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks

Item #7

The 200% load test is in conflict with current safety standard codes, specifically ANSI B.30.2 which states that the entire crane is to be load-tested in the field at 125% of the rated load. If this requirement for the load test of 200% of the rated load is to meet the safety requirements and be within the allowable stress values for the crane design, it would require a large crane. Also, the test may not proof the wire rope at 200% load as permanent deformation can result, and the rope will have to be discarded after the test. We do not recommend testing any portion of the crane at 200% load, except each redundant hook, which is specified to be tested at twice the rated load. However, the hoisting system components are all designed to support a static load of 200% of the design rated load.

Item #8

The electric controls are set to limit the motor torque to 150% of rated motor torque, and are field adjustable between 125% to 200% of that torque. Note that the "rated", not "required" torque is limited. The "required" rating of the motor is not clearly defined and opens the possibility for its misapplication. Ratios of motor horsepower are given in Items 10 and 12.

Item #9

The mechanical and structural components of the hoisting system should be protected against the possibility of two blocking or load hangup occurrence during hoisting. This protection is provided by a system of limit switches such that a second blocking could not occur after a first order failure. First order protection for raising and lowering is provided by a geared limit switch coupled to a shaft on the drive gear case and wired to stop the hoist motion and set a hoist brake by opening a reversing switch control circuit. The second order protection in the raising direction is provided by a power circuit limit switch wired to positively interrupt motor raising and lowering circuits and set brakes. The interruption by the power circuit limit switch will require manual release of the hoist holding brakes to lower the upper block and reset the switch. With this arrangement the operator will be alerted to the fact that the geared type lower upper limit switch has failed. The second order protection in the lowering direction is provided by a second geared limit switch coupled directly to drum shaft and wired so as to open the control circuit of the line contractor.

The first order protection against load hangup is an overload device in the hoisting train that senses the overload and interrupts motor raising circuit and set brakes. The overload device can be set as low as 110% of the rated load. The second order of protection is provided with "over current" and "current rate of rise" set at higher torque (load) level, than the overload device. This is necessary to allow for an additional torque required to accelerate the load and the hoist mechanisms from a standstill position.

Item #10

The hoist motor rating is limited to 105% of the combined calculated running and accelerating horsepower required to accelerate the rated load to the maximum design hoist speed. This regulatory position does not directly address the accelerating portion of the calculated design horsepower; however, the paragraph entitled," Drivers and Controls" on pages 1.104-3&4 of Regulatory Guide 104, dated February 1976 calls for its consideration. Based on the above interpretation, this regulatory position is considered implemented.

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks

Item #11

The crane design meets the requirements of this Regulatory Position except that holding brake heat dissipation will be accomplished by alternating the lowering and holding to provide time for cooling the braking mechanism. Also administrative controls (had held tachometer) will be used to limit the lowering speed to less than 3.5 fpm.

Item #12

The ratios of motor horsepower ratings to the combined calculated running and accelerating horsepowers required to accelerate the load to the maximum design speed are as follows:

trolley – 101%

bridge – 104%

Refer to Item 9 for a discussion of the inclusion of the accelerating horsepower to the motor horsepowers.

No special provisions are made for manual operation of the bridge and trolley holding brakes. If necessary, they can be released by using various methods not excluding brake partial disassembly.

The requirement that "opposite wheels on bridge and trolley have identical diameters", is not practical, since it has no tolerance allowance. Our specification calls for wheels ground true to .001 inch per inch of diameter. Trolley speed, with a critical load attached is a maximum of 30 fpm as recommended by NRC. However, the trolley speed, with a non-critical load attached is 50 fpm, therefore administrative controls must be maintained to prevent inadvertent running of the trolley with a critical load attached at the higher (50 fpm) speed.

The bridge speed (50 fpm) exceeds slightly the NRC recommended speed of 40 fpm. The substantial runway length (323 ft.) stepless type bridge speed control, and minor (10 fpm) difference between the NRC recommended and the specified speeds to not justify the reduction of the bridge speed from 50 fpm to 40 fpm.

Item #13

The unit 1 and 2 crane main hoist rated loads and design loads are the same and equal 125 tons.

TABLE 9B-1

COMPARISON OF UNIT 1 REACTOR BUILDING CRANE DESIGN WITH BTP ASB 9-1

Regulatory Position	Compliance	Compliance based on our interpretation of regulatory position	Use of alternative method to meet the intent of regulatory position	Non-compliance	Remarks

Item #14

As stated in Item 9, protective means are provided to prevent the occurrence of two-blocking or load hang-ups. Therefore, there is no need to run the recommended tests. In addition, the recommended tests present a potential for injuring personnel and for causing an undetectable damage to the hoist components. These conditions will exist whether the tests are performed in the vendor shop or at the site. Also, it would be difficult, after the tests, to assess any potential damages that might have resulted from those tests. Verification testing of the upper limit switches and the overloads will be performed to assure their proper functioning.

Item #15

The Unit 1 and 2 cranes will be maintained at their rated capacities, i.e., 125 tons main hoists and 5 tons auxiliary hoists.