CHAPTER 9 - AUXILIARY SYSTEMS

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9.1 FUEL STORAGE AND HANDLING

9.1.1 New Fuel Storage

9.1.1.1 Design Bases

The new fuel storage facilities have been designed to prevent criticality during normal and accident conditions, to provide storage capacity for 30 percent core loading (170 new fuel bundles), and to allow for reliable fuel handling. The new fuel storage vault design meets the requirements of General Design Criteria 61 and 62.

9.1.1.2 Facilities Description

The new fuel storage vault is a reinforced concrete structure designed to retain its integrity under seismic loading. The storage racks are full length, top entry, and spaced 11 inches by 6.5 inches center to center to prevent an accidental critical array. The new fuel bundles are stored dry, however, even if the vault becomes flooded, the effective multiplication factor will not exceed 0.95, providing a safe margin so that criticality will not occur. Vault drainage is also provided to prevent water accumulation.

New fuel is inspected on the new fuel inspection stand and then may either be stored in the new fuel storage vault or placed directly into the spent fuel storage pool. The only entrance to the vault is through concrete plugs at the top of the vault, on the 119 foot elevation of the Reactor Building. The new fuel storage vault holds 30 percent of a full core load. Refer to Drawing GE237E516.

The fresh fuel bundles are loaded into the racks through the top. Each space for a fuel bundle has adequate clearance for inserting or withdrawing the bundle from above. Guides are provided to align the fuel bundles for the full length of their insertion into and removal from the rack (see Figure 9.1-2). The design of the racks prevents the accidental insertion of a fuel bundle into a location not intended to hold fuel. The racks provide full longitudinal support and adequately support the bundle weight at the bottom. Restraints are provided to ensure that rack spacing does not vary under specified earthquake loads and to prevent lifting of the racks in the event of a fuel bundle or grappling device binding during removal.

9.1.1.3 Safety Evaluation

Calculations of the effective multiplication factor are based upon the geometrical arrangement of the fuel bundle array. Subcriticality does not depend on the presence of neutron absorbing material. In an abnormal event, which assumes that the storage vault is flooded with water and the fuel bundles are brought to their closest spacing, the effective multiplication factor will not exceed a value of 0.95. Fuel criticality calculations have not been performed for conditions of mists or fogs or partial flooding (i.e., with a protective bag around the fuel assembly and flooding outside the bag).

Therefore, plant procedures require: 1) free flooding of fuel in case of vault flooding, 2) that the Fire Protection System be valved out when the new fuel storage vault is open, and 3) a ban on the use of water or other systems which could cause partial moderation.

The design of the new fuel storage vault prevents vault damage as a result of earthquake loads. The floor drain prevents accumulation of water in the vault. Radiation protection and monitoring provisions are presented in Section 12.3. Seismic design is discussed in Section 3.7. No special tests and/or inspections are required for nuclear safety purposes.

9.1.2 Spent Fuel Storage

9.1.2.1 Design Bases

The spent fuel storage pool is designed to withstand the design earthquake acceleration, to prevent inadvertent criticality, and to provide efficient shielding and cooling. The pool is designed to store various core components, including irradiated fuel assemblies, in such a way that:

a. Spent fuel assemblies are arranged in safe criticality configurations with provisions for adequate removal of decay heat.

b. Movement of all radioactive material in the pool can be conducted under shielded conditions.

Compliance with Regulatory Guide 1.13 has been evaluated, although the facility does not meet some of the specific recommendations of this guide, the evaluation of compliance has concluded that the design provides reasonable assurances that the health and safety of the public will be protected. The design of the pool conforms to the guidance of General Design Criteria 61 and 62.

The spent fuel storage racks are designed to maintain fuel assemblies in a geometry that ensures an infinite multiplication factor less than or equal to 0.95.

9.1.2.2 System Description

9.1.2.2.1 Spent Fuel Storage Pool

The spent fuel storage pool is a reinforced concrete structure, completely lined with seam welded stainless steel sheets, themselves welded to reinforcing members embedded in the concrete. The pool was designed to withstand the anticipated earthquake loadings as a Class I structure. The spent fuel storage pool consists of 6 foot thick reinforced concrete walls and a 4 foot 6 inch reinforced concrete floor slab supported by reinforced concrete beams up to 13 feet 7 inches deep. The inside face of the pool is lined with Type 304 stainless steel. The liner is ¼” thick on the bottom of the pool, the north wall, and at the opening to the reactor cavity. The liner is a nominal 1/8” thick on the remaining walls. The liner is liquid tight, serving as a barrier to any moisture loss from the concrete. The top of the pool is at El. 119' in the Reactor Building.

The spent fuel storage pool is 27 feet by 39 feet in plan with a total water depth of approximately 37 feet 9 inches, and an actual physical depth of 38'-9". The depth of water to the top of the stored fuel is approximately 25 feet, providing some 200,000 gallons of water above the fuel. (Drawing GE237E516)

The drainage system beneath the stainless steel pool liner detects and collects leakage between the liner and concrete, preventing leakage even in the unlikely event the concrete develops cracks. Water collected by the system drains into the Reactor Building Equipment Drain Tank, where it can be recycled via the liquid radwaste system to the Condensate Storage Tank.

To avoid unintentional draining of the pool, there are no penetrations that would permit the pool to be drained below one foot above the active fuel. All lines extending below this level are equipped with suitable valving to prevent backflow. The passage between the fuel storage pool and the refueling cavity above the reactor vessel is provided with two double sealed gates with a monitored drain between the gates. This arrangement permits detection of leaks from the passage and repair of the gates in the event of such leakage. A liquid level switch monitoring pool water level is provided to detect loss of water and permit refilling of the pool from the condensate transfer system. In addition, a second level switch in the pool surge tank is provided to permit almost instantaneous water loss detection. Both detectors alarm locally and in the Control Room. A low-low level switch is provided to automatically trip the SFPCS pumps upon reaching set point. Radiation monitors on the operating floor near the spent fuel pool alarm on high radiation and initiate isolation of the Reactor Building and operation of the Standby Gas Treatment System.

The pool is presently licensed to store 3035 fuel assemblies. Other equipment, such as control rods, spent nuclear instrumentation, and small vessel components, are temporarily stored in the spent fuel pool. Additional storage for large components, such as the steam dryer and the steam separator, is provided in a separate storage pool adjacent to the drywell heat cavity.

The fuel pool cooling system (Subsection 9.1.3) cools, filters and demineralizes the fuel pool water. Failure of the fuel pool cooling system cannot cause the fuel to be uncovered. Normal demineralized water makeup to the pool is provided from the 525,000 gallon (nominal capacity) Condensate Storage Tank at a rate of 250 gpm by a single condensate transfer pump. The makeup capability from this system is increased to about 420 gpm if both condensate transfer pumps are used. Makeup water is added directly to the pool's surge tanks by manual valve operation on El. 119'. Additional makeup, at a rate of 150 gpm, can be provided from the (nominal) 175,000 gallon Demineralized Water Storage Tank by the demineralized water transfer pumps through the use of hoses. Other sources of water are also available through the use of fire hoses or portable pumps. The makeup system for the spent fuel pool is not a Seismic Category I system. The 2000 gpm diesel driven fire pumps for the Fire Protection System can be used to provide makeup water from the Fire Pond to the Condensate Storage Tank through a permanent connection.

The two skimmer surge tanks which handle pool level surges contain a total of about 3,500 gallons at normal level (up to 7,000 gallons if full) which can be pumped into the pool at a rate of 1,000 gpm by the fuel pool cooling pumps. The tanks are provided with four inch outlet lines which join together as a six inch line; reactor cavity drains joins this line to become an eight inch pipe that leads to the suction of the fuel pool pumps.

The spent fuel pool water level is monitored, and high or low level is alarmed. Since the pool has no installed drains, level cannot be lowered by the cooling system below the level of the weirs. At the normal 400 gpm flow rate, the pool level is about three inches above the weir level, and the overflow just equals the 400 gpm being supplied to the pool from the diffusers. At normal level, the pool contains a depth of 38 feet of water (25 feet above the fuel), providing adequate shielding for normal building occupancy by operating personnel.

The pool is designed with substantial capability for withstanding the effects of a tornado. The design makes removal of more than five feet of water, due to tornado action, highly improbable. Protection is provided against all tornado generated missiles, having a probability of hitting the fuel larger than once per 1.4 billion reactor lifetimes.

The refueling floor and fuel storage facility have been designed to accommodate the movement of heavy loads. The only heavy loads that are moved into the spent fuel pool are spent fuel casks and shield plugs, other shielded casks used for waste handling, the fuel pool gates (during re-fueling), and other miscellaneous load movements. Travel for the casks is in and out of the Cask Drop Protection System area of the pool. The Cask Drop Protection System is no longer used for cask drop attenuation (see discussion in Section 9.1.2.2.3). The fuel pool gates normally hang on the south wall of the pool, and are lifted over the first row of racks and inserted into place. Travel paths for other miscellaneous load movements are evaluated by analysis on a case by case basis.

The fuel storage facility is completely enclosed within the Reactor Building, which is a controlled leakage building. The Standby Gas Treatment System consists of two filter trains, either one capable of drawing a 0.25 inch of water vacuum in the building. The Reactor Building superstructure siding is constructed of panels which extend from the refueling floor to the roof. The panels are supported by structural steel framing with girths spaced on approximately eight foot centers. The Reactor Building superstructure has been modified to increase its capability to withstand wind loads as discussed in Subsection 3.8.4.5.4. Loads calculated assume the siding and roof would remain intact. The load capacity of the superstructure is greater than the siding/roofing. A failure of the siding/roofing will increase the capability of the superstructure to withstand wind loads. The failure of the metal siding may create a tornado missile. However, the impact loading that could be generated by the missile on the fuel racks is bounded by the loading generated by the postulated drop of a fuel assembly which has been analyzed and found acceptable (Reference 4). The Reactor Building roof consists of built-up roofing over light weight concrete on metal roof decking. The metal roof decking is supported on purlins spaced on approximately nine foot centers. The minimum panel length used in construction was about 18 feet. Thus, the roof panels are continuous over at least two spans, reducing the likelihood of tornado generated missiles.

9.1.2.2.2 Spent Fuel Storage Racks

OC spent fuel pool has two types of high density poison racks of similar design. Ten (10) BORAFLEX racks (2645 spaces) manufactured by Joseph Oats Corporation were installed in 1987. An additional four BORAL racks (390 spaces) manufactured by HOLTEC containing BORAL as poison material were installed in year 2000.

The storage racks, except for their support spindles, have been fabricated from type 304 stainless steel sheet, plate and forgings and from fixed poison sheets. The support spindles were fabricated from SA564-Alloy 630. The pool layout is shown in Figure 9.1-3. The storage racks have been designed, constructed and assembled in accordance with ANSI N210-1976 (ANS 57.2); ASME Section III, Subsection NF, ASME Section IX. The racks are designed to Seismic Category I requirements.

Boraflex Racks

The fixed poison in BORAFLEX racks consists of B-10 enriched boron carbide dispersed in a silicone polymer matrix. The storage cells of the racks are assembled from preformed stainless steel sheets to form a series of double square channel. During the assembly, strips of the fixed poison sheets are sandwiched between the double walls. The nominal interior dimension of the storage cells is 6.0 inches and the nominal center to center distance between storage cells is 6.198 inches. The storage cells will accommodate fuel assemblies with nominal outside dimensions of 5.438 x 5.438 inches. The rack storage capacities range from 176 to 320 fuel assemblies and their weights range between 18,000 and 38,000 pounds. The bottom end of the assembled storage cells is welded to a 5/8 inch thick stainless steel base plate which has coolant flow holes in it that are on the same lattice spacing as the storage cells. The base plate is supported off the fuel pool floor by four support legs. This forms a lower plenum to permit coolant to flow laterally over the pool floor and enter the bottom of the storage rack via the flow holes in the base plate. The vertical dimension of the support legs is six inches on eight of the racks and 11 ½ inches on the two remaining racks. The nominal and maximum gaps between storage racks are 1 ½ inches and 4 inches respectively, which assures that a fuel assembly cannot be inadvertently inserted into a non-designated space within the storage rack array.

9.1.2.2.2.2 Boral racks

These racks have BORAL as a poison material which consists of finely divided particles of boron carbide (B4C) uniformly distributed in type 1100 aluminum powder, clad in type 1100 aluminum and pressed and sintered in a hot rolling process. The cells are fabricated from 0.075" thick type 304L stainless steel sheet material. Boral neutron-absorber material strips are placed between the cell walls and a stainless steel cover plate. Each storage cell side is equipped with one integral Boral sheet. The cells are welded together in a specified manner to become a free standing structure which is seismically qualified without depending on neighboring modules or fuel pool walls for support. The inside dimension of a cell is 5.9305 inches and the nominal center to center spacing of the cells are 6.106 inches. A one (1) inch thick base plate provides a continuous horizontal surface for supporting the fuel assemblies. The base plate is attached to the bottom of the cell assemblage by fillet welds and extends horizontally ¼ inch beyond the periphery of the rack cells. There are four (4) support pedestals per rack except Rack P which has five support pedestals.

9.1.2.2.3 Cask Drop Protection System

NOTE: Amendment Number 223 to Oyster Creek's Facility Operating License Number DPR-16, as accepted by the Nuclear Regulatory Commission, eliminates Technical Specifications 5.3.1.B and 5.3.1.C. These Technical Specifications restricted the movement of heavy loads over irradiated fuel stored in the Spent Fuel Pool. Elimination of these Technical Specifications also eliminates the requirements for the design functions of the Cask Drop Protection System. The justification for eliminating these Technical Specifications and the Cask Drop Protection System is that the Reactor Building Crane has been upgraded to be single-failure-proof as defined by NUREG-0612. Since the Cask Drop Protection System is not being physically removed from the Spent Fuel Pool, the following section will remain in the UFSAR for historical purposes only; it's design functions are no longer required.

The Cask Drop Protection System function is no longer necessary to attenuate the effects of a cask drop accident since the Reactor Building Crane is Single Failure Proof (see discussion in section 9.1.4.2.3). A cask or load drop accident is no longer credible when the cask or load is handled with the Reactor Building Crane.

The Cask Drop Protection System guide structure will be left in place in the spent fuel pool and be used as the staging area for casks or heavy loads entering the spent fuel pool. The base energy absorbing pipes of the Cask Drop Protection System must be evaluated for adequacy for cask loads or any heavy load prior to use.

The guide structure for the Cask Drop Protection system is a cylindrical stainless steel guide structure assembly that is permanently installed in the northeast corner of the spent fuel pool, as shown in Figure 9.1-6. The guide structure assembly consists of an upper guide cylinder and a lower dashpot cylinder. A section of the upper guide cylinder is presented in Figure 9.1-7. Six equally spaced guide cylinder stiffeners are provided around the periphery of the guide cylinders.

The upper guide cylinder is approximately 23 feet long and has a minimum shell thickness of 0.375 inch. The inside diameter at the top of the guide is 130 inches, tapering to a diameter of 118 inches at the flanged connection with the dashpot cylinder. The fuel transfer opening in the guide cylinder consists of a simple hinge shell section, or gate, which is closed at all times when handling the cask over the fuel pool. The hinged shell section, when open, provides a 30 inch wide vertical slot along the full length of the guide cylinder for the transfer of fuel into the cask when it is resting on the bottom of the pool. This gate is provided with a continuous hinge consisting of 2 inch Schedule 160 austenitic stainless steel pipe segment and 1 9/16 inch diameter pins. The latch assembly is similar in design, utilizing the same diameter components and A-286 stainless steel pins. The pins are withdrawn to permit opening the door.

Inside the guide cylinder, eight vertical spacers extend from the top of the guide cylinder to about four feet above the bottom flange. The purpose of the spacers was to guide the lower end of the cask into the dashpot section and to reduce the maximum amount of lateral motion of the cask base plate in the event of a cask drop accident. The function of these spacers is no longer required since the cask drop accident is no longer credible. The effective diameter in the portion of the upper guide cylinder containing the vertical spacers is nominally 117 inches, with the exception of the top 5 inches which provides 116 inches in diameter (see Figure 9.1-8).

A top plate covers the upper guide cylinder at El. 119' of the Reactor Building. The opening at the top plate is 120 inches in diameter. This top plate is one inch thick. Tapered transition pieces are provided between the 120 inch diameter opening in the top plate to the 117 inch effective diameter at the top of the vertical spacers. The tapered transition pieces overlap the top five inches of the vertical spacers reducing the diametral clearance at that location to 116 inches.

The lower dashpot cylinder is approximately 16 feet long and has a shell thickness of 0.500 inch. The inside diameter tapers from 118 inches at the flange connection with the upper guide cylinder to 110 1/2 inches at the bottom. These diameters, in conjunction with the guide cylinder dimensions, provide a straight taper from the 130 inch diameter at the top of the guide cylinder to the 110 1/2 inch diameter at the bottom of the dashpot.

Two lateral support plates are provided for the system. The upper lateral support plate is at the elevation of the top most guide cylinder stiffener, the lower support plate is at the elevation of the flange connection between the upper guide cylinder and the lower dashpot cylinder. The complete guide structure rests on a reinforcement plate over the bottom of the spent fuel pool (see Figure 9.1-6).

At the bottom of the dashpot is a series of horizontal stainless steel pipe segments welded to the bottom head of the dashpot. These pipes prevent developing a suction on the dashpot bottom head during normal lifting of the cask from the pool. Also 4.5 inch ODx0.500 inch wall, stainless tubes are on the lateral support plates at the areas where they bear against the walls of the spent fuel pool, as shown in Figure 9.1-9.

The CDPS is attached to the spent fuel pool wall by means of two stainless steel tie rods. This arrangement is presented in Figure 9.1-10. The tie rods are attached to the upper guide cylinder at one end and to a two inch by four inch rectangular tie bar at the other. The tie bar is bolted to a jib crane base plate anchored to the operating floor adjacent to the northeast corner of the pool. The tie bars, in conjunction with the lateral support plates, provide the necessary lateral support for the guide structure to ensure that it will not detach itself from the corner of the pool.

In operation, when a cask or load is lowered into the CDPS, the displaced water is directed upwards within the guide cylinder shells isolating any hydraulic affect of the cask from any components in the pool.

Openings are provided to allow water from the pool to re-enter the cylinder as the cask is removed. These openings consist primarily of the leakage area around the hinges of the fuel transfer gate. The total leakage flow area is about 5 ft^2. This area permits water to enter the guide cylinder at a rate which will prevent any significant difference in water level between the guide cylinder and the pool.

9.1.2.2.4 Handling of Spent Fuel Casks

The handling of spent fuel casks/shielded canisters will be by the Reactor Building Crane during all modes of plant operation. The crane has been upgraded to a single-failure-proof design as discussed in Section 9.1.4.2.3. The handling system used to rig the spent fuel casks/shielded canisters shall meet the single failure proof criteria from ANSI N14-6.

Transport of spent fuel casks/shielded canisters in the reactor building shall be controlled by procedures. The procedure shall contain requirements (discussed in Section 9.1.4.2.3) that ensure compliance with NUREG-0612, Section 5.1.1 and 5.1.6 criteria.

9.1.2.3 Safety Analysis

9.1.2.3.1 Seismic and Structural Considerations

Spent Fuel Pool Structural Analysis

The OCNGS spent fuel pool slab is a reinforced concrete plate structure with additional beams and end walls. An analysis was performed to demonstrate structural integrity for all postulated loading conditions and compliance with ACI-349 and NUREG-0800 guidelines.

The floor slab was modeled with plate elements, and the reinforced concrete beams were represented by beam elements. The walls were not represented in the model. The floor slab was assumed to be clamped at the reactor wall and simply supported at the remaining walls.

The stiffness and strength properties were based on complete cracking of concrete. All of the racks were assumed to be fully loaded and a 40 ft column of water was included in dead weight.

The dynamic analysis considered both seismic excitation and impact loading from rack analysis. The model was based on nine master degrees of freedom, which correspond to the locations of concentrated loads, with 4% damping for OBE events and 7% damping for SSE events. The dynamic mass included the reinforced concrete mass and the virtual mass of water.

The following critical loading combinations were considered:

a. 1.4D + 1.9E

b. (1.4D + 1.4 To)

c. (1.4D ± 1.4 To ± 1.9E)

d. D ± (To + É)

where:

D = Dead load of slab plus 40 foot column of water and dead weight of fully loaded racks
To = thermal loading due to 60°F temperature differential across the slab depth
E = OBE seismic load
É = SSE seismic load

The moments due to thermal gradient were based on an equivalent homogeneous slab with all floor curvatures suppressed and slab rigidity based on cracked condition.

The results of the dynamic analysis indicate a fundamental frequency of 28.3 Hz and amplification factors of 0.005 for the seismic event and 0.919 for the rack impact loads. The exceptionally low value of amplification factor (0.005) was shown to be produced by the summation of nearly equal positive and negative contributions related to the particular earthquake used. A slightly different earthquake would produce a much larger amplification factor. However, there is ample margin in the structure.

The results also show that the actual factored values of slab and beam moments and shears are lower than the ACI allowable values by a factor ranging from approximately 1.5 to 3.0.

Mathematical Modeling and Seismic Analysis of Spent Fuel Racks

The spent fuel storage rack modules are totally immersed in the spent fuel pool, wherein the water in the pool produces hydrodynamic coupling between the fuel assembly and the rack cell, as well as between the fuel rack module and adjacent modules. The hydrodynamic coupling significantly affects the dynamic motion of the structure during seismic events. The modules are free standing, that is, they are not anchored to the pool floor or connected to the pool walls. Thus, frictional forces between the rack base and the pool liner act together with the hydrodynamic coupling forces to both excite and restrain the module in horizontal and vertical directions during seismic events. As a result, the modules exhibit highly nonlinear structural behavior under seismic excitation, for which it is necessary to adopt time history analysis methods to generate accurate and reliable analytical estimates.

Pool slab acceleration data used in the analysis were derived from the latest approved pool floor response spectra. Structural damping of 4% for the racks was assumed for the safe shutdown earthquake (SSE) condition. The latest approved pool floor response is bounded by the original pool floor response spectra; therefore, the current analysis shows improved margins.

A lumped mass dynamic model was formulated in accordance with computer code DYNARACK (most current QA'd version) to simulate the major structural dynamic characteristics of the modules. A description of the model of a rack for dynamic analysis purposes is given below:

A rack module was simulated by lumped elements at the top and bottom of the rack. The lumped elements have mass and inertia properties associated with each of three directions of displacement and rotation and have values calculated to reflect the structural mass and inertia of the spent fuel rack without fuel assemblies.

The rack module was simulated as a twelve degree of freedom dynamic system with appropriate elastic springs connecting the two elements to simulate the structural characteristics of the rack. The elastic springs were defined to model the rack capability to bend in two planes, to extend or compress, and to twist. The fuel assemblies were represented by five lumped masses located at the base, at quarter height, at half height, at three quarter height, and at the rack top. These five masses represented the totality of the fuel assembly mass in the rack at each level. The lumped masses could be located at a specified offset from the centerline of the rack to simulate partial loading of a rack with fuel.

The lump masses of fuel assemblies were linked to those of the rack by compression only gap elements (nonlinear springs). The compression only springs were used between the lumped masses of the fuel assemblies and those of the fuel rack to simulate the effect of impact between them. The spring rates of these impact springs were determined from the local stiffness of a vertical panel and computed by finding the maximum displacement of a 6.0 inch diameter circular plate built in around the bottom edge and subject to a specified uniform pressure.

Similar impact springs, located at the base and top of each rack, were included to evaluate the potential for and the occurrence of impacts between adjacent racks and between racks and the pool walls.

Frictional elements (springs) were used to represent the frictional force between the rack base and pool liner and compression only gap elements were used to represent the vertical load carrying capacity of the pedestals. Linear frictional springs in two orthogonal directions were placed at four corner positions on the rack base to represent the effect of the static frictional force between each mounting pad and the pool liner. The forces developed in these frictional springs at any instant in time were related to the current compressive force calculated by the simulation code in the compression only gap elements representing the pedestals. Thus, lift-off of a pedestal was correctly simulated. Angular frictional springs about the vertical axis of each pad representing the distribution of pad friction under angular motion were not provided in the model. Review of the application of angular frictional springs indicated that their contribution to the displacement solution would be negligible.

Hydrodynamic mass effects were included to approximate the coupling effect between the water and the structure. The hydrodynamic mass effects are derived from first principles of classical fluid mechanics and represent the resisting effect of fluid in the small annular spaces between fuel assemblies and cell wall, between racks, and between racks and the pool walls.

All racks in the spent fuel pool were included in the dynamic model, and the model was subjected to the simultaneous application of three orthogonal seismic time history acceleration loads derived from the approved floor response spectra.

The results generated from the dynamic model, in terms of nodal displacements and forces in the various elements, were then used to compute the detailed stresses and corner displacements in the module, loads on the floor, and evaluate the potential for impact between racks and between racks and pool walls.

The resulting stresses at potentially critical locations of the module were examined for design adequacy in accordance with the acceptance criteria.

Stresses in the locations deemed limiting for the spent fuel racks, namely the gross cross section of the cellular structure just above the baseplate, and the gross cross section of the pedestals just below the baseplate are demonstrated to meet the required structural integrity limits.

The following assumptions were used in the analysis:

All rack models in the spent fuel pool are modeled and subjected to the three directional seismic motion. The hydrodynamic coupling between all racks in the pool is correctly simulated without any simplifying assumptions on the relative motion between adjacent rack modules.

Within a rack, all fuel rod assemblies were assumed to move in phase. This produces the maximum effects of the fuel assembly/storage cell impact loads.

The effect of fluid drag was conservatively omitted.

The lumped mass approach was used wherein the mass and mass moment of inertia of the fuel rack was lumped at two locations. The mass of the base plate and support structure was lumped with the bottom node. For the fuel assemblies, five lumped masses were used with 1/8 of the fuel mass located at the top and at the bottom nodes, and ¼ of the fuel mass located at the three intermediate nodes. For vertical motion, all of the mass of the fuel assembly was coupled to the bottom rack node.

The fuel assembly was modeled as a blunt square body inside a square cross section container. The hydrodynamic coupling mass utilizes Fritz's well known correlations for infinitesimal motions. Inclusion of finite amplitude motions (which is the case for a rattling fuel assembly) is known to significantly reduce the peak rate seismic response (vide, "Dynamic Coupling in a Closely Spaced Two Body System Vibrating in a Liquid Medium," by A. I. Soler and K. F. Singh, Proc. of the Third International Conference on Vibration in Nuclear Plant, Keswick, D. K. 1982). Therefore, Fritz's equation used in the analysis lead to an upper bound on the solution.

The lumped mass model of a single rack included 22 degrees of freedom which inlcuded 12 for the rack and 2 horizontal degrees of freedom per fuel assembly mass. The vertical motion of each fuel assembly mass was assumed equal to the motion of the rack base.

The structural behavior of the lumped mass model of each rack was completely described in terms of 22 equations of motion, one for each degree of freedom, which were obtained through the Lagrange equations of motions. Coupling between racks occurred through the hydrodynamic terms in the mass matrix, and through the closure of rack-to-rack impact elements if the solution indicated gap closures at any instant in time.

With respect to seismic excitation, three seismic time histories were applied to each rack in the pool and represented the seismic movement of the pool slab. Dynamic response runs were performed for those rack modules which represent the worst case condition..

The analyses have concluded that rack displacement due to a combination of sliding and tilting is less than one half of the 1.5 inch clearance gap between adjacent rack modules. The maximum top corner rack displacement of any rack in the pool under any of the simulations is 0.256”. No impacts are predicted between any of the spent fuel racks above the base plate elevation nor are any impacts predicted between the racks and the spent fuel pool walls. Finally, all stresses in regions of high loads are within the allowable limits required by the applicable stress criteria.

Seismic Analysis of the Cask Drop Protection System

The effect of the additional load of the CDPS on the pool structure in case of a seismic event was evaluated. At the refueling floor level, the acceleration of the spent fuel pool structure expected under a hypothesized 1/2 SSE (as defined in 10CFR100, Appendix A) is approximately 0.18g. Assuming conservatively that the vertical accelerations are of the same magnitude as the lateral vibrations, the vertical loads on the fuel pool floor due to deadweight loads would be increased by about 18%. Evaluation of loadings and resulting shears and moments shows that if the deadweight loads are increased by 18%, the resulting maximum shears and moments would be increased by less than 5%. Since the resulting moments and shears are still below the allowables, it was concluded that the SFP is capable of sustaining the additional seismic loads.

9.1.2.3.2 Thermal Effects

Analyses have been made of the original pool design to evaluate the temperature gradients across the spent fuel pool walls and floor for both summer and winter conditions. The results of these analyses indicate that the maximum temperature differences between the pool water and the environment should be less than +60°F (pool water warmer than environment) and -25°F (pool water cooler than environment). Thermal stresses caused by these through-wall gradients are additive to the maximum tensile stress produced at critical sections by worst case cask drop impact loadings only in the case where the water in the pool is cooler than the environment. The thermal stress is not additive when the pool water is warmer than the walls.

Structural calculations were performed for a temperature gradient of -25°F through the wall of concrete. These calculations indicate that the maximum effect of such a gradient is approximately 10% to 15% of the ultimate moment capacity and less than 3% to 4% of the ultimate shear capacity of the member. Therefore, it is concluded that thermal effects will not affect the strength of the spent fuel pool structure to any significant degree.

Additional structural analyses were performed for the increase of storage capacity of the Spent Fuel Storage Pool. These analyses included loading due to thermal gradients in the pool floor and walls. The thermal analysis for normal operating conditions was based on a fuel pool water temperature of 125°F, and it showed that the pool structure can accommodate these thermal loads. This temperature limit of 125°F is a Technical Specification requirement.

9.1.2.3.3 Concrete Shrinkage Effects

The size and shape of a concrete specimen influences the loss (or gain) of moisture under given environmental conditions, and thereby affects the rate of volume changes, i.e., shrinkage. The spent fuel storage pool consists of 6'-0" thick reinforced concrete walls and a 4'-6" thick reinforced concrete floor slab supported by reinforced concrete beams up to 13'-7" deep. The inside face of the pool is lined with a liquid-tight liner which serves as a barrier to any moisture loss from the concrete. Therefore, drying out shrinkage will occur only at the outer, exposed surface. The shrinkage effects of a concrete element (wall or slab) lined on one face are similar to the shrinkage of an unlined element at twice the thickness.

Under drying conditions, shrinkage of the concrete near the surface will develop tensile stresses which are in equilibrium with compressive stresses near the center. These stresses, which are active over extended periods of time, will cause a plastic yielding (creep) of the concrete, permanently elongating the tensile fibers and shortening the compressive fibers so that the stresses induced by shrinkage will be appreciably less than the stresses induced by short term strains.

Bending moments that induce a compressive force on the inside face of the pool will not be affected by the drying out shrinkage occurring in the outer region containing the tensile steel reinforcing. Furthermore, the ultimate bending moment capacity that induces compressive stresses on the outside face will not be changed to any significant degree by these small shrinkage cracks. At the ultimate capacity of the member, the elastoplastic strains become so high that these cracks will close and transmit compressive stresses. Even in the unlikely event that the shrinkage cracks remain open, and thereby reduce the effectiveness of the member by the full depth of the cracks, the ultimate bending strength of the wall is estimated to be reduced by less than 9%. The effect on the ultimate shear strength is negligible.

In conclusion, shrinkage will not affect to any significant degree the strength of the spent fuel pool structure.

9.1.2.3.4 Dewatering by Tornado

The spent fuel pool design makes removal of more than five feet of water due to tornado action highly improbable, and since 25 feet of water cover the racks, the loss of five feet of water is of little concern from a fuel cooling and shielding standpoint.

9.1.2.3.5 Tornado Generated Missiles

Protection is provided against all tornado generated missiles having a probability of hitting the fuel larger than once per 1.4 billion reactor lifetimes.

Large equipment stored on the refueling floor, such as the reactor vessel head, shielding blocks, and other components, have a mass-to-surface area ratio such that they cannot become missiles under the postulated tornado conditions and, thus, could not be blown into the pool. Some smaller sized objects, such as hand tools and stored materials at El. 119', might be blown into the pool, but it is doubtful that even minor fuel damage would occur due to the protection afforded the fuel assemblies by the spent fuel racks; in any event, fuel damage should be slight and such an object should not cause damage to the pool liner which could result in loss of water.

The Reactor Building superstructure has been modified to increase its capability to withstand wind loads as discussed in Subsection 3.8.4.5.4. Loads calculated assume the siding and roof would remain intact. The load carrying capacity of the superstructure framing is greater than the capacity of the siding and roofing to a degree which assures that the panels will fail long before the framing becomes overstressed. Once the panels fail, the wind loads on the framing will be reduced. Thus, there are no pieces of the superstructure framing which could become missiles during a tornado. The failure of the metal siding may create a tornado missile. However, the impact loading that could be generated by the missile on the fuel racks is bounded by the loading generated by the postulated drop of a fuel assembly which has been analyzed and found acceptable (Reference 4).

From the above discussion, it is concluded that there is very little chance that either the spent fuel pool or the fuel stored in the pool could be seriously damaged as a result of tornado effects on the building or its contents.

Further evaluation of tornado generated missiles affecting the spent fuel pool considered a utility pole 35 feet long by 14 inches in diameter, having a velocity of 200 mph striking the pool slab as a cylinder in its worst orientation. The possibility of a large object such as a compact automobile being dropped into the pool is considered to be incredible and has not been considered. The analysis predicts that the 62 inch thick slab could not be perforated by the postulated missile. The maximum penetration of a 2050 lb utility pole was estimated to be 1.68 inches.

9.1.2.3.6 Failure of Facility Stack

The failure of the stack is not considered credible. Nevertheless, a 20 foot stack length and a 40 foot stack length (weighing 33,800 lbs and 83,800 lbs, respectively) were conservatively assumed to strike the spent fuel floor slab, with the smaller end as a cylinder, after falling from the top of the stack. Penetration was calculated to be one inch for the 20 foot segment and 4.5 inches for the 40 foot segment. The floor slab will not be perforated by a stack missile.

9.1.2.3.7 Turbine Missiles

The effects of turbine missiles have been calculated. The results for the high angle and low angle trajectories are presented in Section 3.5.1.3. Pool structural integrity will be maintained.

9.1.2.3.8 Protection Against Radioactivity Releases

The fuel storage facility is completely enclosed within the Reactor Building, which is a controlled leakage building. The Standby Gas Treatment System (see Subsection 6.5.1) provides effluent purification in the event of radioactivity releases, to minimize environmental discharge. The refueling accident is evaluated in Chapter 15, and results demonstrate that the design of the building and ventilation system are adequate for keeping offsite doses resulting from the event well below the guidelines of 10CFR100.

9.1.2.3.9 Criticality Considerations

The high density spent fuel storage racks for Oyster Creek are designed to assure that the neutron multiplication factor (k_{eff}) is equal to or less than 0.95 with the racks fully loaded with fuel of the highest anticipated reactivity and the pool flooded with unborated water at a temperature corresponding to the highest reactivity. The maximum calculated reactivity includes margin for uncertainty in reactivity calculations and in mechanical tolerances, statistically combined, such that the true K_{eff} will be equal to or less than the 0.95 with a 95% probability at a 95% confidence level (see technical specification 5.3.1). Reactivity effects or abnormal and accident conditions have also been evaluated to assure that under credible abnormal conditions, the reactivity will be maintained less than 0.95. Two separate criticality analyses have been performed as described above, one for high-density racks containing Boraflex and the other for high-density racks containing Boral.

Applicable codes, standards, and regulations, or pertinent sections thereof, include the following:

- General Design Criteria 62, Prevention of Criticality in Fuel Storage and Handling.
- USNRC Standard Review Plan, NUREG-0800, Section 9.1.2, Spent Fuel Storage.
- USNRC Regulatory Guide 1.13, Spent Fuel Storage Facility Design Basis, Rev. 2 (proposed), December, 1981.
- ANSI-8.17-1984, Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors.
- USNRC letter of April 14, 1978, to all Power Reactor Licensees – OT Position for Review and Acceptance of Spent Fuel Storage and Handling, Applications, including modification letter dated January 18, 1979.

The criticality of fuel assemblies in the Oyster Creek SFP is prevented by maintaining a minimum cell pitch of 6.207 inches and by inserting a neutron absorber material, either Boraflex or Boral, between the structural material of the racks. The criticality analyses specific to each type of absorber material are discussed in Sections 9.1.2.3.9.1 and 9.1.2.3.9.2.

9.1.2.3.9.1 High Density Spent Fuel Racks Containing Boraflex

The Oyster Creek Boraflex spent fuel racks have been analyzed for the GNF2 fuel type with uniform initial enrichment (Reference 28). Maximum reactivity bundles with gadolinia for this fuel type have been specified and analyzed with representative gadolinia loadings which result in a reference assembly design that is anticipated to be more reactive than designs that will be fabricated and inserted into the reactor. Analyses have demonstrated that the maximum k_{eff} of the Oyster Creek Boraflex spent fuel racks is less than 0.95 when loaded with peak reactivity bundles of the GNF2 fuel design which bounds older 7x7, 8x8 and 9x9 fuel types.

The maximum k_{eff} for the Oyster Creek Boraflex spent fuel racks will not exceed the 0.95 limit when conservatively loaded with GNF2 fuel with the high bundle planar enrichment specified in Reference 28. When the worst case accident is imposed upon these conditions, k_{eff} remains below the accident condition regulatory limit of $\leq$ 0.95 and maintains a margin to the design limit with 95 percent probability at a 95 percent confidence level.

The Reference 28 analysis also accounts for the reactivity effects of Boraflex degradation. The Boraflex degradation assumptions in the analysis remain valid given the following Boraflex degradation acceptance criteria are satisfied:

- Total measured Boraflex panel degradation is less than 25% (including uniform thinning, local dissolution and gaps)
- Measured average uniform thinning loss is less than 14%

- Measured maximum panel thinning loss is less than 16%
- Maximum measured gap size is less than 1-2/3 inches
- Average size of all measured gaps is 1.5 inches or less
- Total panel shrinkage is less than 4 inches

The criticality analysis utilized the stochastic three-dimensional Monte Carlo code, KENO V.a, as well as the two-dimensional deterministic code, CASMO-4, to compute the reactivity of a three-dimensional array of fuel assemblies. KENO V.a is a module in SCALE 5.0, a collection of computer codes and cross section libraries used to perform criticality safety analyses for licensing evaluations. CASMO-4 is a two-dimensional multi-group transport theory code useful to calculate fuel assembly burnup analysis in-core or in typical fuel storage racks. These codes have been verified for use in spent fuel rack design evaluations by using them to model critical experiments. The results of the validation effort, including benchmark biases, are found in Reference 28. Conservative assumptions of the criticality analysis are described in Reference 28.

The following abnormal/accident conditions were evaluated to determine the effects on fuel pool criticality:

- Fuel assembly misload
- Fuel assembly drop
- Rack lateral movements
- Fuel assembly alongside rack
- Moderator density and temperature variations

The worst case condition was the misloaded assembly, as analyzed with KENO V.a. The reactivity increase associated with this event still allowed margin to the $k_{eff} \leq 0.95$ limit for accident conditions.

The reactivity effects of combined local dissolution, shrinkage induced gaps, and uniform thinning of Boraflex were converted to a value for uniform panel thinning. This effect was modeled in the base eigenvalue (k_{eff}).

Using methods and assumptions detailed in Reference 28, the k_{eff} of the spent fuel racks including all uncertainties is below the regulatory limit of ≤ 0.95 with 95 percent probability at a 95 percent confidence level.

Boraflex has been observed to be subject to in-service degradation from the combined effects of gamma radiation from spent fuel and long term exposure to the aqueous pool environment (Reference 16 and 17). To assure acceptable in service Boraflex performance a multi-prong surveillance program has been initiated. This program includes monitoring pool reactive silica levels, BADGER testing (Reference 18) and tracking the current and projected performance of each panel of Boraflex in the Oyster Creek pool with RACKLIFE (Reference 19 and 20). BADGER test campaigns have been completed in 1997 (Reference 7), 2001 (Reference 21), 2005 (Reference 24), 2008 (Reference 25), 2011 (Reference 31), and 2014 (Reference 30). The Oyster Creek RACKLIFE model has been verified using data from all six BADGER campaigns. This model has been used to predict the in-service degradation of each Boraflex panel.

The methodology applied to the Oyster Creek racks has been used for assessing Boraflex degradation at other LWRs (Reference 23). The Boraflex testing (neutron transmission) is necessary to assure the Boraflex panels are capable of meeting their intended function as a neutron absorber. The Oyster Creek corrective actions for dealing with Boraflex degradation are outlined in the GPUN response to NRC generic letter 96-04 (Reference 8). The NRC has accepted the Oyster Creek Boraflex Rack Management program, using periodic BADGER testing to benchmark RACKLIFE calculations, in the SER for Oyster Creek License Renewal (Reference 27), as part of the overall Aging Management Program.

9.1.2.3.9.2 High Density Spent Fuel Racks Containing Boral

The Oyster Creek BORAL spent fuel racks have been analyzed for the GNF2 fuel type with uniform initial enrichment (Reference 29). Maximum reactivity bundles with gadolinia for this fuel type have been specified and analyzed with representative gadolinia loadings which result in a reference assembly design that is anticipated to be more reactive than designs that will be fabricated and inserted into the reactor. Analyses have demonstrated that the maximum k_{eff} of the Oyster Creek BORAL spent fuel racks is less than 0.95 when loaded with peak reactivity bundles of the GNF2 fuel design which bounds older 7x7, 8x8 and 9x9 fuel types.

The maximum k_{eff} for the Oyster Creek BORAL spent fuel racks will not exceed the 0.95 limit when conservatively loaded with GNF2 fuel with the high bundle planar enrichment specified in Reference 29. When the worst case accident is imposed upon these conditions, k_{eff} remains below the accident condition regulatory limit of $\leq$ 0.95 and maintains a margin to the design limit with 95 percent probability at a 95 percent confidence level.

The criticality analysis utilized the stochastic three-dimensional Monte Carlo code, KENO V.a, as well as the two-dimensional deterministic code, CASMO-4, to compute the reactivity of a three-dimensional array of fuel assemblies. KENO V.a is a module in SCALE 5.0, a collection of computer codes and cross section libraries used to perform criticality safety analyses for licensing evaluations. CASMO-4 is a two-dimensional multi-group transport theory code useful to calculate fuel assembly burnup analysis in-core or in typical fuel storage racks. These codes have been verified for use in spent fuel rack design evaluations by using them to model critical experiments. The results of the validation effort, including benchmark biases, are found in Reference 29. Conservative assumptions of the criticality analysis are described in Reference 29.

The design basis storage rack cell consists of an egg-crate structure with fixed neutron absorber material (Boral) of 0.0162 g/cm^2 boron-10 area density (0.015 gms boron-10/cm^2 minimum) positioned between the fuel assembly storage cells in a 0.077 inch channel. This arrangement provides a nominal center-to-center lattice spacing of 6.106 inches. Manufacturing tolerances, used in evaluating uncertainties in reactivity, include Boron loading, Boral width, lattice spacing, SS thickness, fuel enrichment and fuel density. The uncertainty in burnup, effects of channel removal, eccentric assembly location and the effect of channel bulge are included. The 0.075-inch stainless steel box, which defines the fuel assembly storage cell, has a nominal inside dimension of 5.93 inches. This allows adequate clearance for inserting/removing the fuel assemblies, with or without the zircaloy flow channel.

The following abnormal/accident conditions were evaluated to determine the effects on fuel pool criticality:

- Fuel assembly misload
- Fuel assembly drop
- Rack lateral movements
- Fuel assembly alongside rack
- Moderator density and temperature variations

The worst case condition was the misloaded assembly, as analyzed with KENO V.a. The reactivity increase associated with this event still allowed margin to the $k_{eff} \leq 0.95$ limit for accident conditions.

Using methods and assumptions detailed in Reference 29, the k_{eff} of the spent fuel racks including all uncertainties is below the regulatory limit of S 0.95 with 95 percent probability at a 95 percent confidence level.

9.1.2.3.10 Deleted

9.1.2.3.11 Movement of Heavy Loads Over Spent Fuel Pool

The refueling floor and fuel storage facility have been designed such that heavy loads need not be moved over the spent fuel storage pool, except as discussed in Subsection 9.1.2.2.1, and as follows. The Reactor Building Crane is single failure proof, a load drop accident is not credible. Heavy loads can be moved over spent fuel in the spent fuel pool and over spent fuel in a loaded cask only when the Reactor Building Crane is used to make the lift. Procedures shall be used to control these load moves and shall contain requirements that ensure full compliance with NUREG-0612 Phase 1 criteria. See Subsection 9.1.4.2.3, Cranes and Hoists – Reactor Building Crane for more detail.

9.1.2.3.12 Consideration of Uplift Forces

The refueling platform auxiliary hoists have been derated from their previous rating of 1000 pounds to 750 pounds. Considering that the new free standing storage racks weigh a minimum of 18,000 pounds, the NRC staff has concluded that the maximum uplift force developed by the refueling platform auxiliary hoist cannot cause damage to the storage racks or the pool liner.

9.1.2.3.13 Materials Compatibility

The pool liner, rack lattice structure and fuel storage cells are of stainless steel, which is compatible with the storage pool environment. The corrosion rate of type 304 stainless steel in spent fuel pool water is so small as to be considered nonexistent.

Dissimilar metal contact corrosion (galvanic attack) between the stainless steel of the pool liner, rack lattice structure, fuel storage tubes, and the Inconel and the Zircaloy in the spent fuel assemblies will not be significant because all of these materials are protected by highly passivating oxide films and are therefore at similar potentials.

9.1.2.3.13.1 Boraflex

The neutron absorber is composed of non metallic materials and therefore will not develop a galvanic potential in contact with the metal components. The selected absorber, Boraflex, has undergone extensive testing to study the effects of gamma irradiation and suitability as a neutron absorbing material. While these tests showed that the Boraflex was unaffected by the pool water environment and would not be degraded by corrosion, Oyster Creek and industry experience with Boraflex revealed Boraflex to be subject to certain other types of degradation (3).

Oyster Creek racks and other similar designs to the Oyster Creek racks have the Boraflex bonded to the rack structure with a silicone sealant during manufacture of the racks. Borflex shrinks with irradiation until shrinkage reaches a maximum of 4.2% at about 2×10^{10} rads. As the Boraflex shrinks gaps may form since the Boraflex cannot move freely in the rack. For racks of this design, gaps have been shown to occur in the Boraflex panels. The formation of gaps reduces the effectiveness of the Boraflex material as a neutron absorber and the gaps must be taken into account in the criticality analysis (see section 9.1.2.3.9)

Boraflex has also been shown to degrade due to the dissolution of the silica into the spent fuel pool. The silica levels at Oyster Creek are continually increasing as a result of the silica dissolution. The rate of dissolution depends on the amount of irradiation, temperature of the water, and the degree of communication between the rack annulus space containing Boraflex and the fuel pool, primarily through the vent holes. Venting of the annulus allows gas generated by the chemical degradation to escape, and prevents bulging or swelling of the inner stainless steel tube.

9.1.2.3.13.2 Boral

Based upon results of accelerated test programs and industry experience, it has been concluded that Boral has good general corrosion resistance in the fuel storage environment due to formation of tightly adherent oxide layer. Galvanic corrosion due to coupling of aluminum cladding with stainless steel structural material should be minimal in pure condensate grade or demineralized water due to high resistivity of the electrolyte. Pitting of aluminum, however, may occur particularly in creviced areas if dissolved salt, metal ions, oxygen or other gases accumulate.

Although accelerated test programs and industry experience has shown that Boral is a satisfactory material and will fulfil its design function over the lifetime of the racks, OCNGS has taken a prudent and cautious approach by establishing a Surveillance Program for monitoring Boral performance. The purpose of this surveillance program is to monitor the integrity and performance of Boral on a continuing basis to assure that slow and long-term synergistic effects, if any, do not become significant. The stated program is capable of detecting the onset of any significant degradation with ample time to take necessary corrective action. This is achieved by using two separate surveillance techniques (a)-periodic removal and examination of test coupon properties (including neutron absorption test) which has been deliberately subjected to accelerated radiation dose in the fuel pool, and (b)- In Situ neutron absorption test of Boral panels in the pool, in case degradation are suspected or seen.

9.1.3 Spent Fuel Pool Cooling System

9.1.3.1 Design Bases

The function of the Spent Fuel Pool Cooling System (SFPCS) is to remove decay heat from spent fuel assemblies that are stored within the Spent Fuel Storage Pool (SFSP) during all modes of operation, decay heat from the water inventory contained within the Reactor Cavity and Equipment Storage Cavity during refuel outages, minimize thermal stresses within the floor and walls of the SFSP and maintain the chemistry of the SFPS water inventory within acceptable EPRI quidelines.

The SFPC System operates continuously to circulate the SFSP water inventory and maintain the SFSP water inventory at a temperature of $T \leq 125°F$, near the water surface. This temperature limitation prevents the generation of excessive temperature gradients across the floor and walls of the SFSP. As a result , the corresponding thermal stresses/loads will not compromise the structural integrity of the SFSP. Furthermore, this temperature limitation provides assurance that that the cladding temperature of the spent fuel assemblies will be maintained sufficiently low, such that, nucleate boiling or voiding of the SFSP water inventory is precluded on the surface of the fuel rods. Therefore, steaming of the SFSP water inventory is minimized and dose releases from the spent fuel assemblies are maintained within 10 CFR 100 limits. The SFPC System also maintains proper SFSP water chemistry, which preserves the clarity and purity of the SFSP water inventory and prevents excessive corrosion of either the SFSP or its contents.

The maximum normal decay heat load for the SFPC System corresponds to the decay heat from a normal refuel offload (~188 spent fuel assemblies) with the SFSP full from sucessive normal refuel offloads. The maximum normal decay heat load, ten days after a reactor shutdown, has been calculated at 8.66 MBTU/HR.

The maximum augmented decay heat load for the SFPC System corresponds to the decay heat from a full core offload (560 spent fuel assemblies) with the SFSP full from successive normal fuel offloads. Approximately 95% of this decay heat load is generated from the full core offload and the last two normal fuel offloads. The maximum augmented decay heat load, ten days after a reactor shutdown, has been calculated at 20.07 MBTU/HR. The ten-day duration is the minimum time necessary to offload the entire reactor core into the SFSP and to replace the gate between the SFSP and the Reactor Cavity. This duration is based upon past reactor refueling outages.

The following specific criteria have been considered in the design of the SFPCS:

a. The SFPCS, related systems and the components within these systems are designed for both normal and accident conditions. The accident which must be considered is the loss of offsite power coincident with a single active component failure.

b. The system and its components are designed to permit periodic inspection of components and equipment.

c. The system and its components are capable of operational testing to insure structural integrity and system leak tightness, operability, and adequate performance of active system components.

d. The system is designed to prevent the reduction in fuel storage coolant inventory during accident conditions.

e. The system is designed with sufficient monitoring systems to detect conditions that could result in the loss of decay heat removal, and to initiate appropriate safety actions.

f. Deleted

In addition, the system provides the capability to control changes in pool level during insertion and removal of large pieces of equipment, and is provided with adequate makeup capacity to maintain a water level on the pool which ensures proper shielding.

9.1.3.2 System Description

The SFPCS is presented in Drawing GE237E756. The SFPC System consists of two systems – the Original SFPC System and the Augmented SFPC System. These two systems are located in the Reactor Building (RB) El. 75'3" and operate independently from each other except for a common suction flowpath and a common discharge flowpath. The Augmented SFPC System may be operated in parallel with the Original SFPC System or it may be operated separately, if SFSP cleanup capability is not required. The design data for the major system components is listed in Table 9.1-2.

The design flowrate from the SFSP to the SFPC System is limited to 900 GPM. This flowrate represents the total flow capacity of the two adjustable skimmer weirs located in the SFSP and is based upon a maximum SFSP water level elevation at RB El. 118'3". The maximum flowrate from the SFSP is limited to 800 GPM by the system operating procedure.

The Original SFPC System consists of two skimmer surge tanks, two pumps, two heat exchangers, a filter, a demineralizer, associated piping and valves, and interconnections to both Condensate Transfer System and Condensate/Feedwater System. The Augmented SFPC System consists of two augmented pumps and one augmented plate heat exchanger. These components tie-in downstream of the skimmer surge tanks (common suction flowpath) and the demineralizer (common discharge flowpath).

During normal operation, the SFPC System is cooled by the Reactor Building Closed Cooling Water (RBCCW) System and the RBCCW System, in turn, is cooled by the Service Water (SW) System. The RBCCW System cooling water temperature to the SFPC System is ~5°F greater then the SW System cooling water temperature to the RBCCW System. The cooling water temperature of the SW System may approach an intake canal ambient temperature of 95°F.

9.1.3.2.1 Original SFPC System Operation

During normal operation, the Original SFPC System removes decay heat from the spent fuel assemblies that are stored within the SFSP. The system circulates the SFSP water inventory and maintains the SFSP water inventory at a temperature of $T \leq 125°F$, near the water surface. Water flows from the SFSP, over two adjustable skimmer weirs located in the SFSP and into the skimmer surge tanks. The water is pumped from the tanks through the heat exchangers, filter and demineralizer and returns to the SFSP through two diffusers. The system pumps are each rated at a design flowrate of 500 GPM. The pump design flowrate is throttled to establish a system operating flowrate of 400 GPM through the filter and demineralizer as limited by the system operating procedure.

Normally, both trains of the Original SFPC System are inservice; therefore, either pump can supply SFSP water to the heat exchangers. When the SFSP decay heat loading drops sufficiently, one pump and one heat exchanger, can be removed from service.

The skimmer surge tank outlets are four inch lines which join into a six inch header. The reactor cavity drains merge into this header through a check valve, and the drain header then continues as an eight inch pipe to the pump suction lines. Carbon steel pipe is used for the SFPCS System up to the filter, return piping is constructed of aluminum or stainless steel downstream of the filter.

The two Original SFPC System pumps are located in the Reactor Building at El. 75'-3". These pumps are designed for continuous service and run when there are spent fuel assemblies stored within the SFSP. The pumps discharge is through check valves. Inlet and outlet block valves are provided. The pumps are normally operated from the old Radwaste Building by a remote manual controller, but they can also be operated locally at the pumps. Both pumps are interlocked to trip with low-low surge tank level, with low filter discharge flow and with low suction pressure at the pump. The low flow trip must be manually reset at the Old Radwaste Building. A keylock permissive switch located at the Old Radwaste Building is used for cooling system flow with filter low flow bypassed. Low pump discharge pressure is indicated. The seals are cooled by pump discharge water and seal leakage is drained separately.

The two Original SFPC System heat exchangers are located near the pumps. They are stacked one above the other in saddle mounts. Normally both heat exchangers are valved in for service, with the single interconnecting valve open at the inlet lines so either pump can supply both heat exchangers. RBCCW System flow is adjusted to each heat exchanger by butterfly valves. SFSP water outlet temperatures from each heat exchanger are recorded, and high temperature is annunciated.

Downstream of the heat exchangers, the discharge lines join into a common header which goes to the filter and demineralizer. The filter and demineralizer can be individually isolated during filter sludge backwash, filter precoat, or demineralizer resin transfer. There are two bypass lines which branch off the header. The first is a line on Reactor Building El 75’-3” which bypasses both the filter and demineralizer. Flow to the SFSP is controlled by a ball valve. The second line bypasses the filter and flow to the SFSP is controlled by an angle valve in Old Radwaste Building.

A flow control valve provided upstream of the filter, is adjusted from a flow element downstream from the filter. Both the filter and demineralizer are located in the Old Radwaste Building. Filter pressure drop is indicated and high pressure drop is annunciated. Filter pressure drop is indicated and high pressure drop is annunciated. Filter flow is remotely indicated near the Original SFPC System pumps. A pump and a tank serve to add a precoat of powdered resin and fiber to the filter prior to operation. Resin type and volume for the fuel pool and condensate demineralizers are the same, thus the demineralizer resins are new or partially exhausted condensate demineralizer resins that are slurried in the Condensate Demineralizer Regeneration System and transferred to the FP demineralizer.

The water from the Original SFPC System is returned to the SFSP through a single line. Flow is indicated locally on RB El 75’-3”. At the SFSP, the return header branches into two lines which discharge through diffusers near the bottom of the pool, at the southeast and southwest corners. The diffusers are positioned to sweep return cooling water flow horizontally across the pool, providing optimum circulation without distortion due to temperature or flow patterns. The cooling system return pipes each have a check valve at the pool to prevent siphoning through these lines. In addition, each return line check valve has an anti-siphon hole located in the valve to add additional assurance to prevent siphoning. The holes are located approximately 8 inches below the pool water level.

A trench sump in the pool, with a portion of the pool floor sloped to the trench, allows crud to collect in the trench. An underwater vacuum cleaner can be used to clean the trench, walls, floor and objects within the SFSP.

9.1.3.2.2 Augmented SFPC System Operation

During a refuel outage, the Reactor Cavity and Equipment Storage Cavity are filled, and the gate is removed from the SFSP. The Augmented SFPC System removes decay heat from the spent fuel assemblies that are stored within the SFSP, as well as, decay heat from the water inventory contained within the Reactor Cavity and Equipment Storage Cavity. The system circulates the SFSP water inventory and maintains the SFSP water inventory at a temperature of $T \leq 125°F$, near the water surface. Water flows from the SFSP, over two adjustable skimmer weirs located in the SFSP, four skimmer weirs located in the Reactor Cavity and skimmer weirs located in the Equipment Storage Cavity and into the skimmer surge tanks. The water is pumped through the augmented plate heat exchanger and returns to the SFSP through two diffusers and the Reactor Cavity through two diffusers. The pump design flowrate is throttled to establish a system operating flowrate of 800 GPM as limited by the system operating procedure; therefore, either pump can supply SFSP water to the augmented plate heat exchanger.

The maximum normal decay heat load corresponds to the decay heat from a normal refuel offload (~188 spent fuel assemblies) with the SFSP full from successive normal refuel offloads. The maximum normal decay heat load, ten days after a reactor shutdown, has been calculated at 8.66 MBTU/HR. The heat removal capacity of the Augmented SFPC System, ten days after a reactor shutdown, has been calculated at 9.65 MBTU/HR. This heat removal capacity is based upon a maximum flowrate from the SFSP of 800 GPM, a maximum SFSP water inventory temperature of 125°F (near the water surface), a maximum RBCCW System cooling water flowrate of 2000 GPM and a maximum RBCCW System cooling water temperature of 100°F. The Augmented SFPC System is capable of removing decay heat from a normal refuel offload, ten days after a reactor shutdown, based upon an expected RBCCW System cooling water temperature range of 45°F - 95°F. The OC Reactor Refueling Station Procedure provides adequate controls to ensure that the decay heat from a normal refuel offload is within the heat removal capacity of the Augmented SFPC System. The heat removal performance of the Augmented SFPC System, based upon a normal refuel offload, is presented graphically in Figure 9.1-12.

The maximum augmented decay heat load corresponds to the decay heat from a full core offload (560 spent fuel assemblies) with the SFSP full from successive normal refuel offloads. Approximately, 95% of this decay heat load is generated from the full core offload and the last two normal refuel offloads. The maximum augmented decay heat load, ten days after a reactor shutdown, has been calculated at 20.07 MBTU/HR. The heat removal capacity of the Augmented SFPC System, ten days after a reactor shutdown, has been calculated at 21.14 MBTU/HR. This heat removal capacity is based upon a maximum flowrate from the SFSP of 800 GPM, a maximum SFSP water inventory temperature of 125°F (near the surface water), a maximum RBCCW System cooling water flowrate of 2000 GPM and a RBCCW System cooling water temperature of $T=70°F$. The Augmented SFPC System is capable of removing decay heat from a full core offload, ten days after a reactor shutdown, based upon an expected RBCCW System cooling water temperature range of 45°F - 70°F. This temperature range corresponds to a SW System cooling water temperature range of 40°F - 65°F. When the RBCCW System cooling water exceeds a temperature of ~70°F, the Augmented SFPC System is not capable of removing decay heat from a full core offload, ten days after a reactor shutdown. The OC Reactor Refueling Station Procedure provides adequate controls to ensure that the decay heat from a full core offload is within the heat removal capacity of the Augmented SFPC System. The heat removal performance of the Augmented SFPC System, based upon a afull core offload, is presented graphically in Figure No. 9.1-13.

The plate heat exchanger is made up of a number of pressed metal plates bolted in a frame. On each plate, a boundary gasket confines a flow path inward from one port, across the heat transfer surface, and out the other port. Two ring gaskets confine the flow path of the cooling water into and out of the space on the opposite side of the plate. Flow in alternate spaces between the plates are in opposite directions to achieve counter current heat exchange. Herringbone patterns on the plates are arranged alternately, point up and point down. As a result fluid flow patterns are turbulent, thus enhancing heat transfer. All heat transfer surfaces and all gaskets are accessible for inspection, cleaning, repair or replacement when the unit is disassembled. The plate heat exchanger can also be provided with cooling water from the Turbine Building Closed Cooling Water System, as described in Section 9.2.1.5.

The pumps motors are rated at 100 hp and receive 460 Vac power from vital MCCs 1A23 and 1B23, located in the Reactor Building. Each pump is controlled locally and trips on low suction pressure. Low-low surge tank level is alarmed to warn the operator so that the pumps are manually tripped. Trouble with the pumps is also alarmed. In connection with the augmented pool cooling system, a thermocouple in the pool monitors surface temperature, with local indication at El. 119". An alarm in the Control Room alerts to indicate high pool temperature.

As an alternative, the reactor cavity and equipment storage cavity can be drained to the Main Condenser hotwell or to radwaste through the reactor cleanup demineralizer system after installing the refueling gates.

The Reactor Cavity and Equipment Storage Cavity are drained, after installing the refueling gates, through lines at the bottom of these pools to the suction of the fuel pool pumps, and thence to the Main Condenser Hotwell or to Radwaste. Supplementary drains from these cavities are directed to the Reactor Building Equipment Drain Tank. Telltale drains with annunciated flow indicating switches detect leakage through the bellows seal at the reactor vessel to Drywell joint and detect leakage into the space between the refueling gates. There is a curb around the cavities to direct any overflow to drains.

9.1.3.2.3 Affects on the SFSP Upon Loss of the SFPC System

A loss of the SFPC System may cause an increase in the temperature of the SFSP water inventory. This temperature increase may result in the heat-up and eventual boil-off of the SFSP water inventory. It would take ~14.5 HRS for the SFSP water inventory to heat-up from an initial temperature of 90°F and reach the boiling temperature. Similarly, it would take ~10.3 HRS for the SFSP water inventory to heat-up from an initial temperature of 125°F and reach the boiling temperature. These durations assume a maximum augmented decay heat load of 20.0 MBTU/HR, the SFSP gate is installed, an initial SFSP water inventory level at RB El. 117-11", the top of the spent fuel storage rack at RB El 94'-9" and no compensatory operator actions.

Boil-off of the SFSP water inventory from RB El 117'-11" to RB El. 94'-9" is equivalent to a boil-off rate of 41.2 GPM. Therefore, boil-off of the SFSP water inventory would have to continue for ~69.0 HRS in order to expose the top of the Spent fuel storage racks. The total elapsed time to heat-up and boil-off the SFSP water inventory to the top of the spent fuel storage rack is ~85.5 HRS and ~79.2 HRS when the SFSP water inventory is at an initial temperature of 90°F and 125°F, respectively. A loss of the SFSP System will require compensatory operator actions in accordance with station procedures to prevent heat-up and eventual boil-off of the SFSP water inventory.

9.1.3.3 SFPC System Evaluation

The heat removal performance of the SFPC System, based upon a normal refuel offload, is presented graphically in Figure No. 9.1-12. Similarly, the heat removal performance of the SFPC System, based upon a full core offload, is presented graphically in Figure 9.1-13. The RBCCW System cooling water temperature to the SFPC System is ~5°F greater than the SW System cooling water temperature to the RBCCW System. The cooling water temperature of the SW System may approach an intake canal ambient temperature of 95°F.

The SFPC System is capable of removing decay heat from a normal refuel offload, ten days after a reactor shutdown, based upon an expected RBCCW System cooling water temperature range of 45°F - 100°F. Therefore, the SFPC System has sufficient heat removal capacity to maintain the SFSP water inventory at a temperature of T ≤125°F, near the water surface. The SFPC System is capable of removing decay heat from a full core offload, ten days after a reactor shutdown, based upon an expected RBCCW System cooling water temperature range of 45°F - 70°F. When the RBCCW System cooling water exceeds a temperature of 70°F, the SFPC System is not capable of removing decay heat from a full core offload, ten days after a reactor shutdown. The OC Reactor Refueling Station Procedure provides adequate controls to ensure that the decay heat from either a normal refuel offload or a full core offload is within the heat removal capacity of the Augmented SFPC System.

The design temperature of the SFSP's outlet stream is 125°F and calculations have shown that a temperature of 140°F can be tolerated. For added conservatism, an alarm annunciates in the Control Room before SFSP surface temperature reaches 120°F.

Heat load calculations used in the design of the SFPC System for the normal refueling and full core unload cases, with all available spent fuel storage racks in use, yield conservative results when compared to the NRC Standard Review Plan, Branch Technical Position APCSB 9-2.

Assuming a loss of the SFPC System and a maximum augmented decay heat load of 20.0 MBTU/HR, it would take ~14.5 HRS for the SFSP water inventory to heat-up from an initial temperature of 90°F and reach the boiling temperature. Similarly, it would take ~10.3 HRS for the SFSP water inventory to heat-up from an initial temperature of 125°F and reach the boiling temperature. The boil-off rate of the SFSP water inventory would be ~14.2 GPM. The total elapsed time to heat-up and boil-off the SFSP water inventory to the top of the spent fuel storage rack is ~83.5 HRS and ~79.3 HRS when the SFSP water inventory is at an initial temperature of 90°F and 125°F, respectively. A loss of the SFSP System will require compensatory operator actions in accordance with station procedures to prevent heat-up and eventual boil-off of the SFSP water inventory.

During refueling activities, the SFSP water inventory can reach a temperature of T=110°F - 115°F. A Control Room alarm will annunciate prior to the SFSP water inventory reaching a temperature of T = 120°F. Furthermore, station procedures instruct the plant operators to maintain the SFSP water inventory at a temperature of T $\leq$125°F, near the water surface.

The specific design criteria listed in Subsection 9.1.3.1 are met as follows:

a. The SFPC System is designed to operate with the failure of a single active component. The system has redundant components operated from redundant onsite power supplies.

b. The SFPC System is provided the capability of isolating components for periodic inspection and maintenance.

c. Portions of the SFPC System are in continuous operation, therefore their components do not require additional surveillance. The augmented fuel pumps and heat exchanger operate intermittently, and so surveillance activities are conducted prior to each anticipated use such that satisfactory performance can be verified. Sufficient instrumentation has been provided to monitor performance during operation and surveillance activities. Instrumentation and controls for the SFPCS are presented in Table 9.1-3.

d. The SFPC System is designed to prevent the loss of pool water inventory by providing suction for the system flow from the surface of the pool, and returning the coolant through diffusers, which are provided with backflow prevention devices to eliminate the potential for siphoning.

e. The SFPC System is provided with sufficient instrumentation (see Table 9.1-3) to detect and alarm loss of heat removal capability.

f. The Original SFPC and Augmented SFPC Systems are designed, fabricated, constructed and tested to the appropriate Codes (see Standard ES-001 for further details). They also meet the requirements of NRC Branch Technical Position 9.5.1 (see Section 9.5.1 for more details)

During 1986, a seismic analysis of the SFPC System revealed that the Original SFPC System did not satisfy Seismic Class 1 stress criteria. However, the Augmented SFPC System, added as part of the SFSP expansion described in Amendment 78 of the original FDSAR was found to satisfy Seismic Class 1 stress criteria.

A portion of the Original SFPC System was upgraded to Seismic Class I during the 1986 Cycle 11 Refueling Outage. Seismic qualification was based upon the SEP response spectra and an operability criteria consistent with ASME Section III, Division I, Appendix F. The non upgraded portion of the original SFPCS piping is located in the old Radwaste Building and the connecting tunnel. This piping became isolatable by the addition of a new gate valve, V-18-116, to the system.

9.1.3.4 Inspection and Testing Requirements

Those portions of the SFPC System that are in continuous operation do not require additional surveillance. A surveillance program for the Augmented SFPC System has been established. Inspection and testing of components is performed in accordance with the latest revision of the "Oyster Creek In-Service Testing Program," and the plant Technical Specifications.

A materials surveillance program has been formulated to reveal any instances of deterioration of the spent fuel storage cell neutron absorber that may lead to the loss of neutron absorbing power during the life of the racks. This program will ensure that, in the unlikely event of absorber deterioration, sufficient time will be available to take appropriate corrective action. Surveillance samples are in the form of recoverable stainless steel clad neutron absorber sheets, which are proto typical of the fuel cell storage walls. The specimens will be recovered and examined periodically.

9.1.4 Fuel Handling System

9.1.4.1 Design Basis

The fuel handling equipment is designed to permit safe refueling of the reactor core with minimum outage time. The control of heavy loads has been evaluated against the requirements and recommendations of NUREG 0612, and found to be in compliance by the NRC (Phase 1). Lifting equipment has been evaluated against the criteria of ANSI N14.6-1978. The Reactor Building Crane design has been compared to ANSI B30.2 and CMAA-70 specifications. In July 2000, the Reactor Building Crane was upgraded to a single-failure-proof design in accordance with NUREG-0612, NUREG-0554, CMAA-70 specification and ASME NOG-1-1998. ASME NOG-1-1998 was used for criteria in areas where NUREG-0554 does not specify detailed criteria. See also Subsection 9.1.4.2.3, Cranes and Hoists – Reactor Building Crane for more detail.

9.1.4.2 System Description

New fuel is brought into the Reactor Building through the equipment entrance, and hoisted to El. 119' utilizing the Reactor Building Crane. The unirradiated fuel is stored within the Reactor Building in the new fuel dry storage vault (see Subsection 9.1.1), and serviced by the work area equipment. The location of major refueling equipment is shown in Figure 9.1-14.

The handling of spent fuel is performed within the Reactor Building. This operation employs a refueling platform for underwater fuel transport, storage racks for fuel (Subsection 9.1.2), underwater fuel preparation stations, floor mounted jib cranes, the shipping cask, and the Cask Drop Protection System (Subsection 9.1.2.2.3). Fuel assemblies are transferred from the core and stored in the spent fuel storage racks. Control rods are suspended from special hangers attached to the fuel pool wall lip. Flow channels can be removed from the fuel assemblies in the pool and are either reused or temporarily stored in fuel locations until discarded.

The refueling and reactor servicing work area is located on the top floor of the Reactor Building, at El. 119'. This area provides the necessary space for the fuel storage pool, reactor well, and steam separator and dryer storage pool. In addition, laydown space is provided for such items as the drywell head, reactor vessel head, removable shielding, lifting slings and other bulky equipment and components used for refueling. Work space is also provided adjacent to the fuel pool for fuel inspection and preparation. The new fuel storage vault is also located in this area. Rails for the refueling platform are installed along each side of the fuel pool and extend along each side of the reactor well.

The Reactor Building Crane traverses the refueling and reactor service areas. This overhead traveling crane handles all heavy equipment in the building. The small hoist may be used to transport new fuel from the receiving area to the storage vault.

9.1.4.2.1 Fuel Preparation

Two fuel preparation machines are mounted on the wall of the spent fuel storage pool farthest from the reactor well. The east fuel preparation machine is used for processing irradiated fuel or components which includes, but is not limited to, channel removal/replacement and inspection. The west fuel preparation machine has been dedicated for processing unirradiated fuel and components only. Each machine has two guide tubes attached to the wall of the pool. A platform which hold the fuel assembly is driven in the vertical plane by a motor driven chain drive which is continuously variable speed.

For the east fuel preparation machine, limit switches for upward travel prevent lifting the irradiated fuel assembly beyond a level which may result in excessive exposure to the operators. These limit switches are backed up by mechanical stops. Both the limit switches and the mechanical stops on the west fuel preparation machine have been removed to support new fuel processing. This allows the machine to be raised to a level at which the top of the unirradiated assembly is above the water surface for new channel installation and ease of handling.

There are jib crane mounting fixtures on the fuel preparation work area floor. Cranes are mounted on these fixtures for lifting fuel channels and other non-fuel components and transferring them to the spent fuel pool. The auxiliary hoist of the Reactor Building Overhead Crane is used for transferring new fuel assemblies. Fuel assemblies are moved between the spent fuel storage racks and the reactor using the refueling platform.

9.1.4.2.2 Refueling and Internals Handling Equipment

Refueling Platform

The refueling platform is a motor driven bridge and trolley which traverses the space between the reactor well and the fuel storage pool. The bridge travels on 60 lb. rails extending on both sides of the fuel storage pool and the reactor well. The trolley runs on rails located on top of the bridge. The fuel grapple is mounted on the trolley.

Two auxiliary hoists are provided: one electrically operated, pendant controlled, auxiliary hoist is mounted on the main trolley frame; one electrically operated, pendant controlled, auxiliary hoist is monorail mounted with a motorized trolley. These hoists are used with an assortment of refueling and component handling tools. Together with the fuel grapple, they perform all necessary tasks in handling the irradiated fuel and the core components.

The refueling platform is provided with refueling interlocks. The operator rides on a platform attached to the bridge trolley. The fuel grapple, which is used for all fuel handling operations, is attached to a structural member through a bearing surface at the top of the trolley.

Fuel Grapple

The fuel grapple is a special motor driven cable hoist with stainless steel cylindrical telescoping sections surrounding the cable. The fuel grapple itself is attached to the cable at the bottom of the telescoping sections. The grapple has an air-cylinder-actuated hook to engage the fuel element lifting bail. This hook is so designed that it cannot become disengaged when the grapple is supporting the weight of a fuel element, even if the air control is advertently actuated.

The fuel grapple hoist (main Hoist) is driven by a variable speed motor which allows continuously variable hoisting speed between 0 and 50 fpm. A dual hoist cable is used on the main hoist. Either cable is capable of supporting the full load with a minimum safety factor of 5. The hoist cable is a waterproof lubricated, stainless steel, nonspinning type. A load cell interlocks the raise motor circuit to prevent fuel grapple overload. The cable is long enough for approximately 50 feet on lift. Two independent, electrically operated, fail safe, automatic brakes are provided. Each is designed to bring the hoist and load to a safe, vibrationless stop from full speed within approximately 2 seconds. The brakes are capable of holding 150 percent of normal hoisting load when power to the motor is cut off, or in case of complete power failure.

Control consoles contain all controls required to operate the platform and fuel hoist through any direction of motion and through the speed ranges specified. The consoles are mounted directly to the grapple. The operator can conveniently actuate the various motor speed controllers with his hands on the console grips. Pendant control is provided in the trolley.

Auxiliary Hoist

Two auxiliary hoists are mounted on the refueling platform. One of the hoists is mounted to the main trolley; the second hoist is monorail mounted. Each of these hoists is a 1000 pound capacity motor driven hoist with stainless steel, waterproof-lubricated, nonspinning cable with hoisting speeds of 10 and 30 feet per minute. Each auxiliary hoist has a dual brake system similar to that used on the fuel grapple hoist, and each has a load cell to prevent overload in the raise direction. Both of the auxiliary hoists are load limited to 500 pounds during refueling.

Each of the auxiliary hoists has a pendant control station, some controls are duplicated at the main control console. Some refueling platform trolley and bridge motions are controllable from the auxiliary hoist pendants. However, trolley and bridge motions are limited to approximately 10 fpm when they are controlled from the pendants. Controls of the refueling platform bridge and trolley are interlocked so they cannot be controlled by more than one operator at a time.

Bridge and Trolley

The refueling platform bridge and trolley are driven by centrally located, variable speed motors. Bridge and trolley traversing speeds are continuously variable from 0 to 60 fpm and 0 to 40 fpm, respectively.

Control Rod Grapple

The control rod grapple is an air actuated tool for handling the control rods. The control rod is unlatched from the control rod drive before it is lifted with the grapple. Unlatching is performed from the control rod drive or by the latch tool. The control rod grapple is designed for use with the refueling platform auxiliary hoist and an actuator pole to provide positioning guidance. The grapple features a lower guide to locate the control rod bail into the tool and a swing hook to capture the bail. Design of the hook and guide is such that the control rod cannot be unhooked while the grapple carries the rod weight.

Control Rod Latch Tool

The control rod latch tool is a tool used to unlatch the control rod blade from the core if the control rod drive cannot be fully withdrawn and the blade unlatched from below the vessel. The tool consists of a long arm which, in the operating position, extends below the fuel support casting into the guide tube to reach the control rod latch.

Control Rod Servicing Tool (Take 2 Tooling)

The control rod servicing tooling (Take 2 Tooling) is used for the exchange and shuffle of control rods in the reactor vessel. The control rod servicing tool consists of the control rod/fuel support, a control rod latch tool, an interim storage rack called a quiver, a jib arm, and a grid guide.

Control Rod Guide Tube Grapple

The control rod guide tube grapple is an air actuated tool used to remove and replace the control rod guide tubes. This tool is built to attach to the refueling platform auxiliary hoist and may be used with the actuator pole for guidance. The guide tube grapple consists of a pipe section with cruciform guide members on the top and bottom. The pipe section is machined to fit into the top of the guide tube as does the fuel support casting. Radial orientation is provided by a slotted ear which engages the core support plate pin. For lifting the guide tube, air cylinders actuate plungers which engage two opposed coolant ports. Upon lifting, the guide members guide the tube through the grid.

Fuel Support Installation Tool

The fuel support installation tool is an air actuated tool for removing and replacing the fuel support castings. This tool is built to attach to the refueling platform auxiliary hoist and may be used with the actuator pole for guidance. The tool is a grapple designed to fit the fuel support casting. Air actuated engagement pistons attach the grapple to the casting.

Air Supply Connector

The air supply connector is a special hose clamp used on the refueling platform auxiliary hoists to fasten the air supply lines to the tool to be used. The connector clamps to the air line and attaches to a tab on the grapple through a clevis and pin arrangement. The air hose is fed from the spring reel at the same rate that the tool is being lowered to prevent undue strain on the hose connections.

Instrument Handling Tool

The instrument handling tool is a grapple used to install and remove incore instrumentation and the neutron sources. The tool, used with the instrument strongback and water seal cap, consists of a latch which grips the instruments on the upper spring loaded plunger assembly. Used with the actuator pole and the instrument strongback, the instrument handling tool locates the instrument into its recess on the underside of the upper grid assembly.

Instrument Strongback

The instrument strongback is required for handling of the LPRM and dry tube assemblies. The tool is a 41 foot long structural member upon which is mounted a series of latches to capture the instrument. The strongback is used to remove those instruments which cannot be bent at any appreciable radius (without damage) from a shipping box lying horizontally adjacent to the pool, and move them to their vertical position in the vessel. Latching of the instrument handling tool to the instrument, and positioning the instrument into the reactor with the strongback is necessary to protect the instrument.

Water Seal Cap

The water seal cap is used with the instrument handling system. It consists of a section of pipe about four feet long which is fastened onto the bottom of the incore housing flange at the bottom of the vessel, after removing the incore seal nut. This effects a vessel seal, permitting removal of the incore instrument.

Incore Guide Tube Seal

The incore guide tube seal is a plug used to seal the top of the incore guide tube located at the core support plate if the incore thimble flange must be removed. This tool consists of a 14 foot long extension handle and a rubber plug. The handle hooks over the top grid, thus guiding and securing the plug in place.

Incore Flange Seal Test Plug

The incore flange seal test plug is used to test the integrity of the incore flange O-rings before startup if the flange has been removed or the seal otherwise disturbed. The tool consists of a short section of pipe which threads into the flange, and through an expendable seal seals the incore housing above the flange. By pressurizing the annulus between the seal and incore housing, the O-ring seal integrity can be verified independently of the total vessel.

Fuel Preparation Machines

Two fuel preparation machines are used for stripping reusable channels from the spent fuel and for rechanneling new fuel. The machines are located as a semipermanent fixture in the fuel storage pool. They consist of an aluminum frame, 40 feet long, and a carriage for the fuel bundle which runs the full length of the frame. Power for the carriage is supplied by an air hoist or electric motor mounted under the operator platform at the top.

Channel Handling Tool

The channel handling tool is a device, usually hung from the channel handling boom spring balancer, used to lift channels from spent fuel assemblies and lower channels onto new fuel assemblies. It is actuated by turning a knob at the top of its pole handle to extend or retract jaws that engage the clips at the top diagonal corners of the channel. Rotational guidance for channel removing is provided by fabricated channel section which engages the fuel bundle handle. Guidance for transporting a bare channel is provided by the jaws wedging into the channel corners under the channel clips or tabs.

Channel Bolt Wrench

The channel bolt wrench is a manually actuated, pole handled device for removing and installing the channel bundle fastener. It employs a set of three wedge actuated spring fingers which grip a detent groove in the fastener as soon as the fastener is loosened and until the fastener is reinserted or intentionally removed by screwing it into a transfer block or similar device. Orientation over the center line of the fastener hole is obtained by a guide which rests on the outside of the channel spring and guard hardware.

Defective Fuel Storage Container

The defective fuel storage container is a remotely sealable container sized to contain a complete fuel assembly after removal from the core and confirmation by sipping that a fuel assembly is defective. The container is built to be stored in the defective fuel storage rack (a control rod storage rack set aside for defective fuel). The can is designed so that a complete fuel assembly can be inserted and the fastener and channel subsequently removed to prevent loss of broken cladding or fuel fragments into the pool and environment. The lid of this container carries all the seals and other parts of the equipment which might deteriorate or otherwise need service at any time after the fuel bundle is stored in the container. This container is also equipped to serve as a dry sipping container for sampling suspected defective fuel in the spent fuel pool. It comes complete with all necessary fittings and internal plumbing for this purpose. This body or can is made of stainless steel and all internal surfaces are contoured to facilitate decontamination for repeated usage.

Fuel Handling Sampler (Sipping Can)

The fuel bundle sampler is a vacuum sipping system for accurately and quickly determining the integrity of fuel bundles. Only one bundle can be sampled at one time.

Thermal Sleeve Installation Tool

The thermal sleeve installation tool is a manually operated device for handling the control rod drive thermal sleeve. The two threaded brass pieces are screwed into diametrically opposed holes on the CRD flange. The slack is then removed from the rope, the tube section is inserted and keyed into the thermal sleeve, the weight of the thermal sleeve is taken up by the rope and pulley assembly, the thermal sleeve is turned 45 degrees to unlock it from the control rod guide tube, and the thermal sleeve is lowered by the rope. This is normally a two man operation with one man guiding the sleeve into or out of the thimble while the other man handles the rope and controls the load.

Dryer Holddown Tool

The dryer holddown tool is an attachment for the actuator pole which bayonet locks (either right or left handed) onto the dryer holddown and permits raising and rotating of the holddown assembly. It is fastened directly to a male Bedendieck fitting in place of the normal bottom pole section of the actuator pole.

Main Crane Auxiliary Hoist Sling

This sling is designed to carry the general purpose grapple from the auxiliary hook of the main building crane when new fuel is transferred from the storage vault to the fuel pool. The length is regulated so that operators can more easily engage the actuator pole on the stud of the general purpose grapple.

General Purpose Grapple

This is a manually actuated device designed to carry fuel assemblies, control rods and any auxiliary equipment having a bail with the same configuration as that of a fuel bundle. The general purpose grapple may be carried from any hoist with a 7/16 inch - 14 stud termination or from any safety hook when used in conjunction with the "Sling, Auxiliary Hook, Main Crane." The primary purpose of the device is to transfer fuel bundles from new fuel storage to the pool, and in-pool transfers of fuel in the area of the fuel preparation machines in conjunction with the jib cranes. Latching and unlatching are done by hand in the case of new fuel or blade transfers out of the water and by use of the actuator pole under water. Load limit for this grapple is 1000 pounds.

Actuator Pole

The actuator pole is a general purpose tool used to actuate and guide several of the reactor servicing tools. The pole, consisting of sections each approximately 15 feet long, includes an actuator section and extension sections. The actuator sections mate to the square stud on the various grapples and attach to extension sections through rigid connections.

Viewing Aid

This is a water box which consists primarily of a frame with a clear plastic bottom. Its purpose is to smooth out the action of a disturbance on the surface of the water.

General Area Underwater Light

This consists of a reflector with a 1000 watt incandescent bulb. The light is directed downward and is primarily used to illuminate fairly large areas.

Drop Light

This consists of an outer jacket enclosing a 1000 watt quartz line lamp. The light is directed primarily to the sides. Its use is primarily for general viewing in tight areas, such as in a fuel cell or in the guide tube area where a fairly general light is wanted in the lateral direction.

Local Area Underwater Light

The local area light is a small diameter light of approximately 400 watts. Its light is primarily directed down and it is used in close areas such as the bottom of the vessel or other areas that are immediately below the light.

Head Stud Rack

This rack is used to store those vessel studs which are removed from the area of the fuel pool gate. The rack and studs are handled by the reactor building service crane.

Stud Tensioner

This is a hydraulic driven tool which stretches four studs at one time. The tension loads are determined by the hydraulic pressure. The proper operation of this tensioner is thoroughly described in the Reactor Vessel Instruction Manual (VPF1238-146-2). An extensiometer is used to ascertain proper stud tensioning. After the nuts have been snugged up, dial indicator readings are taken of the distance between the top of the stud and the top of the master stud measuring rod which is inserted in the hole provided in the center of the stud.

Head Tensioner Carousel

The Reactor Pressure Vessel Head Tensioner Carousel Assembly combines the functions of the GPUN spreader beam rack for four Biach hydraulic stud tensioners, a nut and washer storage rack, and a storage rack for the thread protector caps for the RPV studs. The benefit of this combined function equipment is reduced outage time, manhours and manrem exposure for the stud tensioning operations. In addition, the carousel will support future modifications that will allow the use of eight Biach stud tensioners.

Head Holding Pedestal

There are three supports for the reactor vessel head when it is removed from the vessel. These are located on the reactor building refueling floor.

Closure Nut Wrench

This spanner wrench is used with the stud tensioner to snug up and loosen the vessel head stud nuts.

Stud Wrench, Stud Lifting Attachment, Stud Protectors

These are tools for handling the vessel studs, and for covering the threads to provide protection against damage during refueling.

Bushing Wrench, Nut and Bushing Lifting Attachment

These are tools for removing stud bushings and for lifting nut and bushings. The lifting attachment threads into the nut or bushing which is listed by an auxiliary crane.

Head Nut and Washer Rack

These are boxes for storing vessel head nuts and washers, six each per box. These boxes are stacked on the refueling floor for storage. Each nut weighs about 70 pounds.

Heat Strongback

This is a special sling lifting device for moving the vessel head.

Insulation Removal Sling Assembly

This is a special sling for handling sections of insulation from the reactor pressure vessel head and flange.

Steam Dryer and Separator Sling

This is a special sling for handling the dryer assembly and the steam separator assembly.

Shroud Head Bolt Wrench

This is a long extension wrench for loosening and tightening the shroud bolts while working from the service platform.

Blade Guide

These double blade support structures guide the control rod in a fuel cell without any fuel assemblies. They provide support and guidance for control rods, either fully inserted or at any withdrawn position, and also can be used for scram testing the control rod drive with a control rod attached.

Control Rod Guide Tube Seal

This provides a water seal in the control rod guide tube to permit control rod drive removal when the control rod is not in the reactor. The normal seal for drive removal is provided by the control rod itself, sealing at the bottom of the guide tube. This seal tool permits drive removal even if the drive index tube cannot be retracted into the drive.

Peripheral Orifice Grapple

This grapple is used to insert or remove the peripheral fuel orifices from the lower grid structure.

9.1.4.2.3 Cranes and Hoists

The cranes and hoists in the facility have been reviewed for conformance with NUREG 0612 criteria. Although some of the cranes and hoists noted in this section are not involved in refueling operations, they have been included to verify their safety requirements, as appropriate.

Pertinent data for the Turbine Building Crane, Reactor Building Crane, and Heater Bay Crane are presented in Tables 9.1-5 through 9.1-7**.** Limits of travel for these cranes are shown in Figures 9.1-15 through 9.1-17 and 9.1-20 and 9.1-21.

With regard to the Spent Fuel Pool jib cranes, no specific loads in excess of 800 lbs have been identified that must be lifted with these handling systems. The refueling platform auxiliary hoists and the main fuel grapple have been administratively derated to 750 lbs so as to exclude them from the NUREG-0612 review.

The major handling system affected by the NUREG-0612 review include: the Reactor Building Crane. Only the Reactor Building Crane is utilized for fuel handling operations.

Reactor Building Crane

The Reactor Building Crane is of the electric overhead traveling type (See Table 9.1-6), and is mounted with the bridge traveling along the north-south axis. Bridge rails are 25 feet above the operating floor, and the limits of travel are shown in Figure 9.1-16.

The crane was designed and fabricated by Whiting Corporation to the specifications in EOCI-61, "Specifications for Electric Overhead Traveling Cranes - 1961," and the design has been compared to CMAA-70-1975 and ANSI B30.2-1976 and found acceptable under the requirements of NUREG 0612.

The original Reactor Building Crane trolley was replaced with a new upgraded single-failure-proof trolley that satisfies the guidelines of NUREG 0612, Section 5.1.6 “Single Failure Proof Handling Systems”. The new trolley main hoist is rated for 105 tons and the auxiliary hoist is rated for 10 tons maximum critical load. Table 9.1-6 contains pertinent data for the Reactor Building Crane. The design is in accordance with NUREG 0612, NUREG 0554 and specification CMAA-70 for Class D cranes. ASME NOG-1-1998 rules for construction of overhead and gantry cranes are used wherever detailed criteria were not provided in NUREG-0554. The trolley was designed and tested for 125 tons maximum critical load but is rated for a maximum of 105 tons.

The Reactor Building Crane bridge girders and rail girders were evaluated for the maximum critical load, 105 tons, concurrent with the Safe Shutdown Earthquake and determined to be adequate.

The Reactor Building steel superstructure that supports the crane was re-evaluated for the 105 tons maximum critical load concurrent with the Operating Basis Earthquake and the Safe Shutdown Earthquake. A modification was performed to strengthen the lateral ties between the rail girder and the building steel columns.

The design and testing of the Reactor Building Crane satisfy the criteria from NUREG 0612 and NUREG-0554 for Single-Failure-Proof Cranes. The need to analyze the effects of load drops per the evaluation criterion of Section 5.1 of NUREG 0612 is eliminated when the Reactor Building Crane is used with lifting devices and rigging that meet the associated requirements in Section 5.1.6 of NUREG 0612. Heavy loads handled by the Reactor Building Crane shall be procedurally controlled.

Furthermore, the original crane design complied with the requirements of OSHA 29 CFR 1910, Subpart N, Section 1910.179 (1970), with the following exceptions:

a. The bridge and hoist controls do not face in the direction of the crane motion.

b. When the load is being lifted up the shaft from the railcar unloading floor, it cannot be seen by the operator until it reaches the refueling floor elevation. However, a voice/radio communications system and backup visual signal system is established between the rigger(s) and the crane operator.

Item 'a.' above is not a concern since the design of the control console layout complies with the requirements of ASME B30.2-1990. Item 'b.' above was addressed by the crane upgrade performed in 1995. The upgrade incorporated a radio control that allows the operator to be in close visual range of any load being moved by the crane, both on 119'-3" and in the hatch area down to 23'-6" elevation.

The unloaded weight of the Reactor Building Crane is 242,000 pounds, of which 168,000 pounds corresponds to the bridge and 74,000 pounds to the trolley.

Heavy Loads – NUREG-0612 defines a heavy load as a load carried in an area that contains irradiated fuel or carried over safe shutdown equipment, and weighs more than the combined weight of a spent fuel assembly and its associated handling tools below the crane hook (800 pounds at Oyster Creek).

Heavy loads evaluation in response to NUREG-0612 (Phase I) and NRC approval, is documented in References 14 and 15.

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). (References 11, 12, and 13)

Since there are different safety concerns for each of the heavy loads that must be handled by the Reactor Building Crane and there are a large variety of heavy loads that must be handled, defining safe load paths in the manner described in NUREG-0612, Section 5.1.1(1), is neither required nor prudent for every situation. To do so, such as trying to put markings on the floor for each load, would cause unnecessary confusion. To address this problem, the possible load handling situations that could be encountered have been identified in Table 9.1-10. Each load handling situation has been assigned a safety class designation, roughly in order of safety significance. As an alternative to the specific requirement in NUREG-0612, Section 5.1.1(1) but to still satisfy the intent of NUREG 0612, safe load path and load handling procedural requirements have been defined for each safety class as shown in Table 9.1-9.

Each of the heavy loads evaluated has been assigned to one or more safety classes (See Table 9.1-10). In some cases, more than one safety class assignment is required because more than one of the load handling situations could be encountered when handling the load.

For each of the heavy loads listed in Table 9.1-10, the safe load path/ procedural requirements corresponding to the assigned safety class have been added to the appropriate plant operating or maintenance procedures. When more than one safety class assignment was made for a particular load, the safe load path/procedural requirements of all safety class assignments were included in the procedures.

9.1.4.2.4 Refueling Operations

In the process of refueling and servicing a reactor, there may be about 400 separate operations to be performed. This is only an order of magnitude, and is given to illustrate that with this large number of operations, an efficient, safe refueling servicing procedure is strongly dependent on planning, preparation and performance.

Before each outage, each step is carefully planned with specific tasks assigned to each man performing the various operations.

There are certain sequences of steps to be performed at each refueling outage. During each outage, these sequences may be refined to provide the safest, most efficient method of performing the function. The planning includes equipment inspection before starting and periodic checks of equipment during operations.

Speed alone is not the primary objective. Safety is the first consideration, for much time may be lost by a single mishap. Efficient, safe operation is achieved by careful preparation before the start of each operation to be performed. All equipment to be used is carefully inspected and placed in perfect working order. During the outage, careful observations and equipment checks are included as part of the operating procedures.

For the most current refueling procedures refer to the plant operating procedures manual.

9.1.4.2.5 Spent Fuel Transfer Out of Reactor Building

The transfer of spent fuel from the spent fuel pool to locations outside of the Reactor Building involves the handling of heavy transfer casks and spent fuel. The accidental dropping of a cask during transfer operations could result in significant damage to the Reactor Building floor and nearby safety systems and equipment. To preclude accidents of this nature, and the associated consequences thereof, crane upgrades (discussed in Section 9.1.4.2.3) have been implemented. The single failure proof Reactor Building Crane will be used to handle spent fuel casks in the Reactor Building. This activity will be controlled by special procedures.

9.1.4.3 Safety Evaluation

During refueling operations, the reactivity potential of the core is being altered. It is necessary to require certain interlocks and restrict certain refueling procedures such that there is assurance that inadvertent criticality does not occur. A Senior Reactor Operator must supervise all refueling operations.

Addition of large amounts of reactivity to the core is prevented by operating procedures, which are in turn backed up by refueling interlocks on rod withdrawal and movement of the refueling platform. When the mode switch is in the REFUEL position, interlocks prevent the refueling platform from being moved over the core if a control rod is withdrawn and fuel is on the hoist. Likewise, if the refueling platform is over the core with fuel on the hoist control rod motion is blocked by the interlocks. With the mode switch in the REFUEL position only one control rod can be withdrawn.

The rod withdrawal interlock may be bypassed in order to allow multiple control rod removal for repair, modifications, or core unloading. The requirements for simultaneous removal of more than one control rod are more stringent than the requirements for removal of a single control rod since, in the latter case, Technical Specification requirements assure that the core will remain subcritical.

The refueling interlocks may be inoperable provided that all 137 control rods are verified to be fully inserted and control rod withdrawal has been disabled prior to commencing or recommencing fuel handling operations with the head off the reactor vessel. This will ensure that all control rods remain fully inserted during fuel handling operations with the head off the reactor vessel. Therefore, Technical Specification requirement are met and the core will remain subcritical during fuel handling operations.

It is not the intent of the alternative option, found in the above paragraph, to eliminate the first performance of the refueling interlock Technical Specification Surveillance prior to in-vessel fuel movement. It is expected that the refueling interlocks would be operable during fuel moves except for equipment failures or during maintenance that would otherwise result in false indications of rod withdrawal during which all rods will be verified as fully inserted and rod withdrawal prevented.

Fuel handling is normally conducted with the fuel grapple hoist. The lowest possible load on this hoist when the interlock is required consists of the weight of the fuel grapple, bottom mast section and the fuel assembly. This total is approximately 680 lbs in the extended position. The load trip settings on the auxiliary hoist motors are adequate to trip the overload interlocks on the motors, if an attempt is made to handle a fuel bundle during refueling.

The source range monitors provide neutron flux monitoring capabilities when the reactor is in the refueling and shutdown modes. Technical Specification requirements assure that redundant monitoring capability is available to detect changes in the reactivity condition of the core. The Technical Specifications require the operability of at least two source range monitors during core alterations and when control rods are to be removed.

The design of fuel handling tools has considered ease of operation, and the prevention of fuel or fuel assembly damage during handling.

As indicated in Subsection 9.1.4.2.3, measures have been taken to ensure that load handling operations with the Reactor Building Crane remain within safe loadpaths. Work involving heavy lifts includes overview by job supervisors, who are responsible for enforcing procedural requirements.

The Reactor Building Crane is single-failure-proof. A single active failure on the crane will not cause it to drop the load. If the crane fails the load will not drop. The crane can be repaired without unloading it for minor mechanical or electrical failures. Under other circumstances the load can be lowered by manual operation of the hoisting brakes. The emergency stop disc caliper brakes are provided with an air accumulator on the trolley which will allow the brakes to be cycled under no power, as well as emergency conditions.

Single-failure-proof crane design and load handling equipment, safe load paths, procedural controls, crane operator training, and the preventative maintenance and inspection programs for the crane ensure a heavy load handling system of sufficient reliability to preclude the consideration of load drops. See Subsection 9.1.4.2.3, Cranes and Hoists – Reactor Building Crane for more detail. Technical Specification requirements provide additional restrictions for heavy loads over irradiated fuel stored in the spent fuel pool.

Technical Specification requirements, plant procedures and handling system design ensure the prevention of inadvertent criticality, and minimize the potential for accidents which could result in a release of radioactive material from the fuel elements.

9.1.4.4 Inspection and Testing Requirements

All fuel handling equipment is inspected and tested in accordance with plant procedures prior to their use. Procedures for inspection, testing and maintenance for the Reactor Building Crane satisfy the criteria in ANSI B30.2.0 -1976, Chapter 2-2.

9.1.4.5 Instrumentation Requirements

Interlocks are provided for the refueling equipment to minimize the potential for the postulated fuel handling accident described in Chapter 15, and to prevent inadvertent criticality.

The Reactor Building Crane is designed such that simultaneous motion of the hoist, bridge and trolley can be prevented, by enabling the ‘simultaneous movement interlock’ with a key switch.

Briefly, this postulated accident results from dropping a fuel bundle onto the top of the core. This is only possible if the fuel assembly handle, the fuel grapple, or the grapple cable breaks, or improper grappling occurs. A second important purpose of the interlocks is to prevent withdrawal of two adjacent control blades and so prevent the possibility of achieving a critical condition in the core during refueling. To provide this protection, the interlocks block control rod withdrawal for certain conditions and interrupt power to the main hoist on the refueling platform. For most situations, the system is redundant so that no single interlock failure can allow for inadvertent criticality to occur.

Interlock and Control Devices

The following interlock devices are provided:

a. Individual Control Rod Position Indicators

Reed switches in the control rod drive are used to sense the control rod position of each control rod drive. This knowledge is then used to establish the rod-block and/or the rod-permissive function of the system.

b. Fuel Grapple Full-Up Position Switch

This switch is open when the fuel grapple hoist is not in the full-up position.

c. Hoist Load Switches

A load sensing switch is provided for the fuel grapple hoist. This switch is set to sense that the weight of a fuel element is being lifted by the hoist.

d. Bridge Position

Bridge position is sensed by a microswitch on the bridge structure near one of the bridge rails. This switch opens when the bridge begins traversing the reactor cavity.

e. Reactor Mode Selector Switch

This switch and its contacts are used to determine the state of the reactor operation and to establish the required safety system condition for each mode of operation.

f. Hoist Maximum Load Limit

All hoists are equipped with load limiting switches which open when the hoist is loaded to a particular maximum allowable value.

g. Hoist Position Limit Switches

Each hoist is provided with both a full-up and a full-down limit switch which interrupt power to the hoists at their limits of travel. The full-up position switches on the auxiliary hoists are equipped with bypass switches which allow the hoists to be raised above the upper limit for such purposes as changing tools. To raise the hoist above the upper limit, the bypass switch and the UP control switch must be actuated simultaneously. In addition to the position limit switches, there is a slack cable contact on the fuel grapple which interrupts power to the lowering circuit if the hoist cable load ever becomes less than 50 pounds.

Refueling Platform Rod Permissive Interlocks

a. With the reactor mode selector switch in the REFUEL position, rod withdrawal is limited to one rod, provided no fuel movement is in progress.

b. If the refueling platform is positioned over the reactor vessel, rod withdrawal permissive is prevented, if the fuel grapple hoist is loaded with fuel. This interlock is bypassed if the refueling platform is not over the reactor well.

Refueling Platform Hoist Power Interlocks

a. Fuel Grapple Hoist Power

If the refueling platform is over the reactor vessel and all rods are not fully inserted, power is interrupted to the hoist drive motor, if the fuel grapple is loaded.

b. Frame Mounted Auxiliary Hoist Power

Refueling interlocks have been provided for the fuel grapple hoist only. Therefore, during refueling, fuel handling with auxiliary hoists is prohibited. In addition, the auxiliary hoist overload trip setting will be set to trip the hoist motor if an attempt is made to handle a fuel bundle during refueling.

c. Trolley Mounted Auxiliary Hoist

Refueling interlocks have been provided for the fuel grapple hoist only. Therefore, during refueling, fuel handling with auxiliary hoists is prohibited. In addition, the auxiliary hoist overload trip setting will be set to trip the hoist motor if an attempt is made to handle a fuel bundle during refueling.

Bridge Drive Power Interlocks

Power to the refueling bridge drive motor is not permitted (refueling pool to reactor well) if the following conditions are met:

a. All rods are not fully inserted, the bridge is over the reactor vessel, and the fuel hoist is loaded, or

b. The reactor mode switch is in the STARTUP position.

The STARTUP position of the reactor mode selector switch permits free withdrawal of the control rods according to a specified sequence to bring the reactor critical.

To assure safe operation in this mode with the reactor vessel head removed, two interlocks are provided. A rod block is applied if the refueling platform is over the reactor vessel with the mode selector switch in the STARTUP position. With the mode selector switch in the STARTUP position, movement of the refueling platform from the fuel pool to the reactor vessel well is prevented by interrupting power to the bridge drive motor in combination with the fuel interlock switch.

A complete discussion of the reactor mode selector switch can be found in Section 7.2.

9.1.5 References

(1) TDR 1131 "Boraflex Gap Evaluation for the O. C. Spent Fuel Pool Racks", J. H. Sedar, Rev 2, October 1994.

(2) Safety Evaluation 000254-001, "Increase in Spent Fuel Pool Enrichment Limit To 4.0% U-235", J. H. Sedar, Rev 1, October 1994.

(3) NRC Information Notice 95-38: Degradation of Boraflex Neutron Absorber in Spent Fuel Racks, September 8, 1995

(4) NRC Letter to GPU dated December 7, 1992, “Evaluation of Upper Reactor Building and Non-Safety Architectural Components Subjected to Tornado-Wind Loading, Items 1 and 11 of SEP Topic III-2.

(5) K. Lindquist et al., “Inspection and testing of Boraflex Surveillance Coupons from the Oyster Creek Station,” prepared for GPU Nuclear Corporation by Northeast Technology Corp. NET-124-01 dated June 1997.

(6) S.E. Turner, “Criticality Safety Evaluation of Oyster Creek Spent Fuel Storage Racks with Fuel up to 4.2% Enrichment,” Holtec Report HI-931049 July 1993 prepared for GPU Nuclear Corporation

(7) K. Lindquist et al., “Zinc Demonstration Program: Badger Test Campaign at Oyster Creek Nuclear Station”, prepared by Northeast Technology Corp. NET-092-06, Rev 0, March 1998.

(8) Letter to U.S. Nuclear Regulatory Commission from M.B. Roche (GPUN), “Response to Generic Letter 96-04”, October 15, 1996, 6370-96-2300.

(9) “Licensing Report for Storage Capacity Expansion of Oyster Creek Spent Fuel Pool,” prepared for GPU Nuclear, Inc. by Holtec International, Holtec Report HI-982983 Rev. 1, April 1999.

(10) Safety Evaluation 000882-004, “Single Failure Proof Modification of the Rx Building Crane/OC Load Lift Management Procedure/Operation of the Reactor Building Overhead Crane/PFU,” July 2000.

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(12) NEI 08-05, Rev. 0, “Industry Initiative on Control of Heavy Loads”

(13) NRC Letters to NEI dated May 16, 2008 and May 27, 2008, “Industry Initiative on Control of Heavy Loads”

(14) NRC Letter to OCNGS dated June 21, 1983, Docket No. 50-219/LS05-83-06-045, “Control of Heavy Loads (Phase I) – NUREG-0612 – Oyster Creek Nuclear Generating Station”

(15) Technical Evaluation Report TER-C5506-377, “Control of Heavy Loads (Phase I), Jersey Central Power and Light, Oyster Creek Nuclear Power Plant, NRC Docket No. 50-219”

(16) "An Assessment of Boraflex Performance in Spent-Nuclear-Fuel Storage Racks,” Northeast Technology Corp. for the Electric Power Research Institute, NP-6159; December 1988.

(17) "Boraflex Test Results and Evaluation," EPRI/TR-101986, prepared by Northeast Technology Corp. for the Electric Power Research Institute; February 1993.

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(20) "The Boraflex Rack Life Extension Computer Code - RACKLIFE: Verification and Validation." EPRI TR-109926. Electric Power Research Institute: Palo Alto, CA; March 1999.

(21) "BADGER Test Campaign at Oyster Creek," NET-187-01. Northeast Technology Corp.: Kingston, NY; 29 March 2002.

(22) Deleted.

(23) Orechwa, Y and Golla, J., "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 227 to Facility Operating License No. DPR-26 Entergy Nuclear Operations Inc., Indian Point Nuclear Generating Unit No. 2 Docket No. 50-247," 05/29/2002.

(24) "BADGER Test Campaign at Oyster Creek," NET-245-01. Northeast Technology Corp.: Kingston, NY; 10 March 2005.

(25) "BADGER Test Campaign at Oyster Creek," NET-288-01. Northeast Technology Corp.: Kingston, NY; 27 June 2008.

(26) Deleted.

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(28) Design Analysis NET-356-03 Rev. 2, "Criticality Analysis of the Oyster Creek Boraflex Spent Fuel Racks," June 2015.

(29) Design Analysis NET-356-02 Rev. 0, "Criticality Analysis of the Oyster Creek BORAL Spent Fuel Racks," October 2010.

(30) "BADGER Test Campaign at Oyster Creek," NET-300082-01, Revision 0, NETCO, Lake Kathrine, New York, December 2014.

(31) "BADGER Test Campaign at Oyster Creek," NET-300000-01, Revision 0, NETCO, Lake Kathrine, New York, April 2012.

TABLE 9.1-2
(Sheet 1 of 5)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM EQUIPMENT

Skimmers and Surge Tanks

Number of Skimmers	
Pool	2
Reactor Cavity	4
Equipment Storage Cavity	6
Skimmers Weirs	3 ft
Width	Adjustable elevation 118 ft 2 in.
Height	(+ 0 in, - 4 in)
Number of Surge Tanks	2
Surge Tank Volumes, each (minimum required)	500 ft^3 total at weir elevation 250 ft^3 surge at high-level alarm 100 ft^3 water at low-level alarm 50 ft^3 water at low-low pump
Cutoff	
Surge Tank Dimensions	5 ft 0 in by 4 ft 6 in rectangular, 23 ft high below weir elevation
Normal Surge-Tank Water Level	99 ft 8 in to 107 ft 2 in elevation
Surge-Tank Material	Concrete, lined with carbon steel; debris screen, stainless steel

Fuel Pool Pumps

Number	2
Type	Horizontal, single stage centrifugal, close coupled, with mechanical seals and greased bearings
Motor Drive	60 hp, 3600 rpm, 440 volt, 3 phase, 60 cycle
Flow	500 gpm
Developed Head	325 ft
Suction Conditions	140°F, 21 ft available NPSH
Design Conditions	200 psig, 150°F

TABLE 9.1-2
(Sheet 2 of 5)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM EQUIPMENT

Fuel-Pool Heat Exchangers

Number and Type	Two U-tube, horizontal, removable channel and tube bundle, each approximately 14 ft long with 14 inch diameter
Heat Capacity, each	2.95 x 10^6 Btu/hr with 125°F inlet tube-side fluid temperature and 90°F inlet shell-side fluid temperature
Material	
Tubes	72 U-bends, 3/4 inch OD, 304SS
Shell and Plate	ASME SA 53B seamless or SA 516 GR 70 carbon steel
Tube Side	
Fluid	Fuel pool water
Design Flow	500 gpm
Inlet Temperature	125°F
Outlet Temperature	114°F
Pressure Drop	10 psi maximum
Design Conditions	200 psig. 150°F
Shell Side	
Fluid	Reactor Building Closed Cooling Water
Design Flow	500 gpm
Inlet Temperature	90°F
Outlet Temperature	101°F
Pressure Drop	10 psi maximum
Design Conditions	150 psig, 300°F

Augmented Fuel Pool Pumps

Number	2
Type	Horizontal centrifugal
Capacity	1200 gpm
Discharge Pressure	75.8 psig
Total Head	175 feet
Available NPSH	32 feet
Materials (all wetted components)	316 SS
Design Pressure	200 psig
Design Temperature	212°F

TABLE 9.1-2
(Sheet 3 of 5)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM EQUIPMENT

Augmented Fuel Pool Pumps (Continued)

Motor Drive	100 hp, 1780 rpm, 460 volt, 3 phase, 60 cycle

Augmented Fuel Pool Heat Exchanger

Number and Type	One plate heat exchanger, Alfa-Laval Type A-35H
Heat Capacity	18.2 x 10^6 Btu/hr with 125°F inlet pool water temperature and 90°F inlet RBCC water temperature.
Materials	
Plates	242 plates, 0.8 mm thickness, 316 SS
Covers	Carbon Steel 150 lbs ANSI
Gaskets	Nitril
Process Side	
Fluid	Fuel pool water
Design Flow	1200 gpm
Inlet Temperature	125°F
Outlet Temperature	94°F
Pressure Drop	10 psi
Design Conditions	200 psi, 150°F
Cooling Water Side	
Fluid	Inhibited demineralized water (RBCCW)
Design Flow	2000 gpm
Inlet Temperature	90°F
Outlet Temperature	113°F
Pressure Drop	10 psi
Design Conditions	200 psig, 150°F

Filter-Flow Control Valve FCV IM 198

Size and Type	6 in body, equal percentage plug
Operator	Air diaphragm, air to open, spring to close, with electromagnetic transducer from flow controller (FRCS IM 105)
Design Conditions	150 psig, 120°F
Flow and Pressure Drop	20 psi at 500 gpm maximum

Fuel-Pool Filter

Type	Pressure-precoat

TABLE 9.1-2
(Sheet 4 of 5)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM EQUIPMENT

Fuel-Pool Filter (Continued)

Precoat Material	Powder resin
Flow	400 gpm
Unit Flow Rate	2 gpm/ft^2 of filter area
Design Conditions	150 psig, 150°F, 150 psid
Differential Pressure across Clean Filter Cake	5 psid
Differential Pressure Required to Hold Filter Cake	2 psid
Operating Differential Pressure	30 psid high differential pressure alarm setpoint
Backwash Conditions	2 gpm/ft^2, 400 gpm for 40 seconds
Materials	Stainless steel wire-bound elements; rubber lined, carbon-steel shell

Filter-Aid Pump

Type	Proportioning
Motor	1/4 hp, 110 volt, 60 cycle

Fuel-Pool Demineralizer

Type	Mixed bed with approximately 3 ft minimum depth
Resin Volume	Approximately 150 ft^3
Resin	New or partially expended resin from the Condensate Demineralizers
Design Flow Rate	400 gpm, 10 gpm/ft^2 of resin bed
Clean Bed Pressure Drop	10 psi maximum at 400 gpm, from inlet nozzle to outlet nozzle including resin, distributor and under drain
Operating Temperature	90°F or 115°F
Effluent Quality	1.0 microS/cm maximum @ 25°C
Design Conditions	150 psig, 150°F, 150 psid

TABLE 9.1-2
(Sheet 5 of 5)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM EQUIPMENT

Fuel-Pool Demineralizer (Continued)

Materials	
Shell	Rubber-line carbon steel
Support screens	Stainless steel, Type 304
Shell Size	Approximately 10 ft high, 7 ft diameter

TABLE 9.1-3
(Sheet 1 of 3)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM CONTROLS AND INSTRUMENTATION

Sensing Instrument	Objective
Pressure Sensors	Trip fuel-pool pump A or B on low pump suction pressure, to protect pump; set point assures adequate NPSH.
Pressure Indicators	Indicate cooling pump discharge pressure at pumps. Turn on alarm light for low pump discharge pressure.
Temperature Sensor	Records fuel-pool cooling system temperature from heat exchangers. This same recorder is used for the shutdown cooling system.
Differential Pressure Sensor	Annunciates high pressure drop across fuel-pool filter on panel in Radwaste Building. Indicates fuel pool filter differential pressure.
Flow Sensor	Indicates fuel-pool-filter flow.
Flow Instrument	Annunciates low fuel-pool filter flow on panel in Radwaste Building. Trips both fuel-pool pumps, filter-aid pump and filter outlet valve on low fuel-pool- filter flow, to keep dropped filter-cake material out of fuel pool. Records flow.
Differential Pressure Sensor	Annunciates high pressure drop across fuel-pool demineralizer on panel in Radwaste Building. Indicates demineralizer differential pressure.

TABLE 9.1-3
(Sheet 2 of 3)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM
CONTROLS AND INSTRUMENTATION

Sensing Instrument	Objective
Conductivity Sensor	Indicates conductivity on panel in old Radwaste Building.
	Annunciates high-conductivity fuel-pool demineralizer effluent on panel in old Radwaste Building.
Level Sensor	Annunciates fuel pool high level in the Control Room.
	Annunciates fuel pool low level in the Control Room.
Level Sensors	Annunciates skimmer tank high level on 119' elevation
	Annunciates skimmer tank low level in the Control Room.
	Trips both fuel pumps on skimmer low-low level to protect pump.
Flow Sensor	Annunciates fuel pool gates high level in the Control Room.
	Flow indicator and alarm light for excessive leakage through fuel gate.
Level Indicator	Indicates reactor cavity water level;pressure gauge used during cavity filling and draining.

TABLE 9.1-3
(Sheet 3 of 3)

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM CONTROLS AND INSTRUMENTATION

Sensing Instrument	Objective
Flow Sensor	Annunciates refuel seal high leak in the Control Room. Used to detect leakage through reactor vessel to drywell bellows seal. Turns on alarm light for refuel seal leak.
Thermocouple	Monitors pool water surface temperature. Alarms in the Control Room when the temperature exceeds a selected value.
Pressure Sensors	Trip augmented fuel pool pumps on low suction pressure. Alarms in the ORW Building indicate pump trouble.
Level Sensors	Monitor surge tank level locally and alarm on low-low level. Alarm in the Main Control Room.

TABLE 9.1-5
(Sheet 1 of 1)

TURBINE BUILDING CRANE

Capacity

Main Hoist	150 Tons
Auxiliary Hoist	40 Tons

Performance

	Main Hoist	Auxiliary Hoist	Trolley Traverse	Bridge Travel
Speeds (fpm)				
Full Load	4 1/2	18	50	150
No Load	4 1/2	18	50	150
Motor Horsepower	60	50	7 1/2	40
Motor Speed (rpm)	900	900	1200	1200

Motors	Squirrel Cage motors, open drip-proof, ball bearing, rated 60 minute, 700°C rise
Controllers	Solid state variable frequency control system with 5 separate speed point, in air-conditioned enclosures.
Switchboard	Main breaker plus manual switches and control circuit transformer
Magnetic Brakes	Solenoid operated brakes for all motions. Bridge brake for parking only
Cab	Semi-open, located at end of span on drive girder side, with footgong, 2-lb CO_2 extinguisher, 100 watt light, and ladder to footwalk
Power Source	MCC 1A13

TABLE 9.1-6
(Sheet 1 of 1)

REACTOR BUILDING CRANE

Capacity	
Main Hoist	105 Tons
Auxiliary Hoist	10 Tons

Performance

	Main Hoist	Auxiliary Hoist	Trolley Travel	Bridge Travel
Speeds (fpm)				
Minimum	0.25	1.35	2	2
Full Load	5	27	20	40
No Load	7	45	20	40
Motor Horsepower	50	20	2	10
Motor Speed (rpm)	1200	1200	1800	1200

Motors	Totally Enclosed, Non-Ventilated, Inverter Duty Induction Motors with 60 Minute Duty cycle for Hoists, 60 Minute Duty for Bridge and Continuous Duty, 60 minute rated with high temperature insulation for the Trolley.
Motor Drives	Flux Vector Drives for Hoists, Variable Frequency Drives for Bridge and Trolley
Primary Brakes	AC Disc Brake Integral to each Motor.
Redundant Brakes	Disc caliper air brakes located on the drum.
Cab	Semi-open, located at west end of span on drive girder side; with foot operated warning bell, 2 lb CO_2 fire extinguisher, 100 watt light, and ladder to footwalk
Control Options	Cab Control Console or Radio Transmitter
Power Source	MCC 1B2
Operation Limit	The minimum operating temperature is +45° F.

TABLE 9.1-7
(Sheet 1 of 1)

HEATER BAY CRANE

Capacity	25 Tons		
Performance			
	Hoist	Trolley Traverse	Bridge Travel
Speed (fpm)	6 1/2	50	90
Motor Horsepower	20	1 1/2	10
Motor Speed (rpm)	1800	900	1200
Motors	Wound rotor, totally enclosed, ball bearing, 75°C temperature rise, 30 minute rating		
Controllers	Contactors in NEMA-4 enclosures; five point variable speed on all motors		
Brakes	Load brake is roller ratchet shoe type motor brakes		
Power Source	MCC 1A13		

TABLE 9.1-9
(Sheet 1 of 2)

LOAD SAFETY CLASSES AND SAFE LOAD PATH ACTIONS

Heavy Load[1] Handling System	Safe Load/Path Procedural Actions Required
Safety Class 1. Load must be carried directlyover (i.e., there are no intervening structures such as floors) irradiated fuel, the reactor vessel or safe shutdown equipment	Procedurally limit time and height load is carried over the area of concern; define laydown area; show on drawings included in the procedure the prescribed laydown area.
Safety Class 2. Load could be carried directly over irradiated fuel, the reactor vessel or safe shutdown equipment, i.e., load can be handled during the time when spent fuel or the reactor vessel is exposed or safe shutdown equipment is required to be operable and there are no physical means (such as interlocks or mechanical stops) available to restrict load movement over these objects.	Procedurally limit time and height load is carried over area of concern; define laydown area; show on drawings attached to procedure the prescribed safe load path and laydown area.
Safety Class 3. Load could be carried over irradiated fuel or safe shutdown equipment, but the fuel or equipment is not directly exposed to the load drop, i.e., intervening structures such as floors provide some protection	Define safe load paths that follow, to the extent practical, structural floor members. Define laydown areas. Limit load travel height to minimum height practical. Load paths and laydown areas shown on drawings attached to procedures.

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[1] A heavy load is defined as a load that is greater than the weight of a fuel assembly and its associated handling tool.

TABLE 9.1-9
(Sheet 2 of 2)

LOAD SAFETY CLASSES AND SAFE LOAD PATH ACTIONS

Heavy Load[1] Handling System	Safe Load/Path Procedural Actions Required
Safety Class 4. Load cannot be carried over irradiated fuel or over safe shutdown equipment when such equipment is required to be operable, i.e., design or operational limitations prevent movement over fuel or safe shutdown equipment	No safe load path required.

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[1] A heavy load is defined as a load that is greater than the weight of a fuel assembly and its associated handling tool.

TABLE 9.1-10
(Sheet 1 of 2)

HEAVY LOADS(1) CARRIED BY THE REACTOR BUILDING CRANE*

Load	Safety (2) Class	Weight (Tons)	Lifting Device
Drywell Head	1/3	62	Head Strongback
Reactor Vessel Head	1/3	75.3	Head Strongback
Cavity Shield Plugs (eight provided)	3	85 ea.	Slings, Shackles, and Adapters
Reactor Vessel Head Insulation	3	5	Slings
Steam Dryer	1/3	26	Steam Dryer/ Separator Sling Assembly (Wet Lift Rig)
Steam Separator	1/3	44	Steam Dryer/ Separator Sling Assembly (Wet Lift Rig)
Fuel Pool Gates (two provided)	2	Approx. 1	Slings, Shackles
Spent Fuel Cask	2/3	Note 4	Associated Cask Yoke
Fuel Transfer Shield ("Cattle Chute")	2	16.5	Slings, Shackles
Equipment Storage Pool Shield Plugs (four provided)	2/3	37.5 to 39(3)	Slings and Adapters (Dry Lift) Equipment Storage Pool Shield Plug Strongback (Wet Lift Rig)
Dryer/Separator Sling Assembly	2	3	Main Hook

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* For footnotes, see Sheet 2 of 2.

TABLE 9.1-10
(Sheet 2 of 2)

HEAVY LOADS(1) CARRIED BY THE REACTOR BUILDING CRANE*

Load	Safety (2) Class	Lifting (Tons)	Device
Fuel Storage Pool Shield Plugs (four provided)	2/3	4.5 ea	Slings, Shackles
Plant Equipment	3	less than 20 tons	Slings
New Fuel and Shipping Containers	3	1	Slings
Head Strongback	2	3.75(5)	Main Hook
Stud Tensioner Assembly	2	24(6)	Main Hook
Equipment Storage Pool Shield Plug Strongback	2/3	3	Main Hook
Dry New Fuel Storage Vault Plugs	3	3	Slings
Auxiliary Work Platform	3	2.75	Slings

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1. NUREG 0612 defines a heavy load as one that weighs more than the combined weight of a single fuel assembly and its associated handling tool. For reference, the weight of a spent fuel assembly and its handling tool at Oyster Creek is approximately 800 lbs.

2. Safety Class designations are explained in Table 9.1-9.

3. The top Equipment Storage Pool Shield Plug weighs 39 tons; the remaining three plugs weigh 37.5 tons each.

4.

NAC-1:	30 Tons, Base Plate – 4 Tons
GE-200:	5 Tons
TN-9:	40 Tons, Base Plate – 3 Tons
CN-355	29 Tons, Base Plate – 4 Tons
FSV	24 Tons, Base Plate – 3 Tons
NUHOMS: OS-197 (TC) and 61 BT (DSC)	105 Tons

5. Does not include weight of the six turnbuckles, clevises, and shackles that are normally fastened to strongback.

6. Includes four tensioners, four trolleys, traction motor, nuts washers, thread protectors, four studs, hydraulic pump, hose manifold, hoses.

TABLE 9.1-11
(Sheet 1 of 1)

SUMMARY OF CRITICALITY ANALYSIS FOR RACKS CONTAINING BORAFLEX

(GE-11 Fuel)	2.82 w/o, No Gd_2O_3	4.6 w/o, w/7 Gd_2O_3 Rods
Nominal k_{eff} (includes model bias)	0.92176	0.92425
Space between modules, Δk	0	0
Tolerances and Uncertainties:		
Fuel Assembly Parameters		
- U-235 Enrichment	0.00585	N/A
- UO2 Density	0.00423	0.00073
- Gd_2O_3 Loading	N/A	0.00732
- Pellet Diameter	0.00307	0.00307
- Cladding Diameter	0.00685	0.00685
Rack Construction		
- Cell-to-Cell Pitch	0.00221	0.00221
- Cell Wall Thickness	0.00128	0.00128
- Boraflex Width	0.00162	0.00162
- B_{10} Loading	0.00679	0.00679
Assembly Position	0.00000	0.00000
Fuel Channel Bulge	0.00010	0.00010
Burnup Uncertainties	------------	0.00513
Methodology Bias (95/95)	0.00953	0.00953
Calculation Uncertainty (95/95)	0.00049	0.00049
Square Root of Sum of Squares:	0.01597	0.01685
Self-Shielding	0.00332	0.00332
BADGER Measurement bias	0.00521	0.00521
Leakage (Credit)	-0.00183	-0.00183
K_{eff} (95 x 95)	0.94443	0.94781
Margin	0.00557	0.00219

TABLE 9.1-12
(Sheet 1 of 1)

SUMMARY OF CRITICALITY ANALYSIS FOR RACKS CONTAINING BORAL

Temperature assumed for analysis		4°C
Fuel Enrichment (average)		4.6
Reference CASMO k_∞		
8x8R Fuel		0.9184
GE-9B Fuel		0.9202
GE-11 Fuel		0.9206
GE-11 Fuel (top, w/missing rods)		0.9232
Uncertainties		
Removal of flow channel		negative
Eccentric assembly location		negative
Tolerances		
Boron Loading 0.0162 ± 0.0012 gm/cm^2	±0.0032	
Boral Width 5.0 ± 1/16 inches	±0.0017	
Lattice Spacing 6.106 ± 0.03 inches	±0.0013	
SS Thickness 0.075/0.0235 ± 0.008 inches	±0.0016	
Fuel Enrichment** 3.1 ± 0.05% U-235	±0.0040	
Fuel Density 10.41 ± 0.20 g/cm^3	±0.0021	
Statistical Combination*		±0.0061
Uncertainty in Depletion Calculations		±0.0040
Statistical Combination		±0.0073
Effect of Channel Bulge		±0.0033
Allowance for Vendor Calculations		±0.0100
Maximum Reactivity		
8x8R Fuel	0.9317±0.0073 = 0.9390	
GE-9B Fuel	0.9335±0.0073 = 0.9408	
GE-11 Fuel	0.9339±0.0073 = 0.9412	
GE-11 Fuel (top, w/missing rods)	0.9365±0.0073 = 0.9438	

**Effect of enrichment tolerance is significantly smaller at higher enrichments

*Square root of sum of squares of all independent tolerance effects

9.2 WATER SYSTEMS

9.2.1 Station Service Water Systems

9.2.1.1 Service Water Systems

9.2.1.1.1 Design Bases

The Service Water System (SWS) performs the following functions:

a. Provides seawater cooling to the tube side of the two Reactor Building Closed Cooling Water (RBCCW) heat exchangers during normal plant operation.

b. Provides alternate, and/or supplementary seawater cooling to the tube side of the two Turbine Building Closed Cooling Water (TBCCW) heat exchangers.

c. Maintains the Emergency Service Water (ESW) side of the Containment Spray heat exchangers full.

The SWS was designed to dissipate the expected heat load of the RBCCW System during normal operation and immediately after plant shutdown with 85°F Water System supply. The SWS design temperature and pressure are 85°F and 110 psig, respectively. Operating procedures require that sufficient pump discharge pressure be maintained to prevent pump runout. Inlet water temperature ranges from 30°F to 85°F were utilized for the design of the system.

During the first half hour following reactor scram, for normal shutdown conditions, the RBCCW System heat load is about 180 percent of the heat load during normal power operation. When the water supply is at or below 75°F, one SWS pump and one RBCCW heat exchanger satisfy 100 percent of the RBCCW System cooling requirements for normal full load operation.

9.2.1.1.2 System Description

The Service Water System is included in Drawing BR 2005. Major components of the system are listed in Table 9.2-1. The system is comprised of two pumps, associated piping and valves, two RBCCW heat exchangers, and controls and instrumentation. The TBCCW heat exchangers are also included in Table 9.2-1.

The two 50 percent design capacity service water pumps are located at the intake structure (See drawing 3E-168-02-001, directly downstream of the traveling screens. At least one pump must be in continuous operation during all normal modes of plant operation; both pumps are required to provide the necessary cooling flow during the period following a plant shutdown when the Shutdown Cooling System is being utilized to achieve cold shutdown. During normal plant operation, when the circulating water temperature is sufficiently low, only one pump may be required to operate. During abnormal plant conditions, both SW pumps may be removed from service provided that the heat removal functional requirements are accomodated by other means and are evaluated on a case-by-case basis.

The SWS pumps discharge through check valves and manual block valves into a 20 inch service water main at El. 53' in the Reactor Building. The service water main contains a venturi flow meter located at El. 51'-3". The flow then branches into the two parallel 50 percent design capacity RBCCW heat exchangers, which are located at El. 51'-3" (centerline at El. 58'). Water flow and temperature are controlled manually through manipulation of the RBCCW and SW System valves as provided in the operating procedures.

From the RBCCW heat exchangers, service water flows into a single line which leaves the Reactor Building via a Seal Well located outside of the east wall of the building at El. 33'-6". The Seal Well reduces the head requirements of the SWS by providing a siphon discharge.

There is cross-connect line between the Emergency Service Water system I and Service Water system. The ESW connection is located upstream of the Containment Spray Heat Exchangers and the SW connection is located upstream of the RBCCW Heat Exchangers. Isolation valve was added in SW header piping to allow system isolation to operate the cross-connect line during plant shutdown. This cross-connect line only will be used during outages to perform maintenance on the Service Water System unless a specific evaluation is performed.

The service water and emergency service water (discussed in Section 6.2.2) discharge lines join together with the radwaste discharge line and run underground to the plant's discharge canal.

On the line upstream of the Seal Well there is a set of valves and a blind flange which provide the capability to install a temporary line and divert Service Water from the Seal Well. This feature provides the capability of establishing a temporary flow path in order to inspect the Seal Well and the discharge line.

A two inch line comes off of one the service water discharge lines of the Emergency Service Water (ESW) System pumps (normally shut down), upstream of the Containment Spray heat exchangers, to ensure that the ESW headers are full and ready to perform their emergency function.

The TBCCW heat exchangers, located on the Turbine Building basement floor at El. 10'-0", are provided seawater cooling from either the Circulating Water (CWS) or Service Water systems. The Circulating Water is supplied through a 24 inch line (refer to Subsection 9.2.1.3). If cooling from the CWS is not available, or desired, then a 20 inch crosstie line from the Service Water system may be manually valved into service as another cooling source for the TBCCW heat exchangers. The CWS supply valve must be closed after the Service Water system is placed in service. Service water which flows through the TBCCW heat exchangers goes directly into the discharge tunnel.

During normal shutdown, the CWS is kept in operation during steaming to the main condensers. The Turbine Bypass System is discussed in Section 10.4. Following reactor scram, the circulating water pumps may be shutdown or not, depending upon the desired rate of cooling in the shutdown heat exchangers, environmental considerations, or the desire to make liquid effluent discharges. If the CWS pumps are shut down too soon after scram, and TBCCW System loads are transferred to the SWS, the flow of reactor cooling water through the shutdown heat exchangers must be throttled to limit the temperature rise in the RBCCW System and cooling time for the reactor will be increased.

All SWS valves are manually operated. There are isolation valves for each RBCCW heat exchanger inlet and outlet line, and shutoff valves in each line branching from the service water main. The shutoff valves necessary to achieve the cross-connect between the SWS and the TBCCW heat exchangers are located in the Turbine Building basement.

The internal and external surfaces of carbon steel Service Water piping has been thoroughly protected from its environment. Certain lengths of this piping are internally coated with a Type B coal tar primer, and coal tar enamel. Some external surfaces are coated in a similar manner, and a bonded single asbestos felt wrapped on the pipe lines which was then covered with a water resistant whitewash finish. Other internal and external surfaces are coated with an epoxy coating. Some of these epoxy coated external pipe surfaces are underground, and are also wrapped with Polyken tape.

9.2.1.1.3 Safety Evaluation

The Service Water System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related.

Loss of one service water pump or one RBCCW heat exchanger does not require immediate reduction in plant load. The RBCCW System heat loads are relatively insensitive to power level and plant operation may be possible under favorable conditions of intake water temperature. When conditions are not favorable, excessive closed cooling water temperature will trip the cleanup demineralizer and will isolate the nonregenerative heat exchanger, thereby removing 70 percent of the heat load on the RBCCW System.

Following complete loss of station and auxiliary power, the Circulating Water System, the Steam, Condensate and Feedwater Systems, and the Reactor Recirculation System are shutdown. Thus, very little heat load remains on the RBCCW and TBCCW Systems. One service water pump, operated on emergency generator power, can provide cooling to both of these closed cooling water systems until power is restored.

9.2.1.1.4 Testing and Inspection Requirements

The Service Water System is a non-ISI class system. However, the Service Water pumps and certain valves are covered by IST. Plant procedures establish the routine inspection and testing of this system.

9.2.1.1.5 Instrumentation Requirements

Line instruments and alarms are identified in Table 9.2-2. An off line radiation monitor provides continuous radiation monitoring of the Service Water System discharge. The monitor is located outside the ReactorBuilding. The monitor draws a sample from the SWS Seal Well and returns it to the SWS Seal Well. The service water pumps are operated from START-STOP switches with pull-to-lock controls on panel 5F/6F in the Control Room. The pumps will restart automatically, in about 120 seconds, via the Emergency Diesel Generator sequence timers on loss of normal power supply except if a LOCA signal is present.

9.2.1.2 Radwaste and Augmented Offgas Buildings Service Water Systems (New Service Water System)

9.2.1.2.1 Design Bases

The New Radwaste Service Water (NRWSW) System provides a heat sink for the closed cooling water systems in both the Augmented Offgas Building and the New Radwaste Building. The system is designed to provide seawater from the intake structure (See Drawing 3E-168-02-001) to the Augmented Offgas Closed Cooling Water (AOGCCW) System and the New Radwaste Closed Cooling Water (NRWCCW) System heat exchangers and discharge back to the intake canal. An alternate inlet connection is installed upstream of the 'A' AOGCCW Heat Exchanger to provide for the use of an alternate source of service water in the event NRWSW is unavailable for an extended period or to backwash the “A” Heat Exchanger. Each time this connection is used it will be evaluated and controlled as a temporary variation in accordance with station procedures.

The piping associated with the NRWSW System was designed, fabricated, inspected and erected in accordance with ANSI B31.1 for steel portions of the system and in accordance with ANSI B31.3 for FRP (fiberglass reinforced plastic) portions. Since there are no safety related components in this system, it has been classified as non seismic and non safety related.

9.2.1.2.2 System Description

The NRWSW System is shown on Drawing BR 2005, Sh. 3, and component data are listed in Table 9.2-3. The system is comprised of two vertical pumps, four heat exchangers (two for the AOGCCW System and two for the NRWCCW System), and associated piping and valves.

The new service water pumps are located at the intake structure. Check valves are provided at the discharge of each pump, followed by manually operated butterfly valves. The two 100 percent capacity pumps discharge into a common 10 inch header containing a duplex strainer and bypass line. The header discharges to a 12 inch header which branches to supply cooling seawater to each AOGCCW and NRWCCW heat exchanger. The 12 inch main runs underground to the south side of the New Radwaste Building to service the NRWCCW heat exchangers which are located at El. 29'-3" inside the Heat Exchanger Building, which abuts the Radwaste Building. A four inch branch line is run underground from the main to the AOGCCW heat exchangers, located at El. 23'-6" in the Offgas Building.Service water returns from the Offgas Building to the Heat Exchanger Building through a four inch line, which combines with the NRWCCW heat exchangers discharge and flows through a 12 inch line back to the intake canal.

Manually operated valves are provided for isolation of each heat exchanger. An eight inch bypass line around the NRWCCW heat exchangers allows for the normal operation of the NRWSW pumps during period when there are no NRWCCW loads but the AOGCCW System is operating. Under normal operation one NRWSW pump operates to supply one NRWCCW heat exchanger and one AOGCCW heat exchanger. One pump is capable of providing sufficient cooling flow to both AOGCCW heat exchangers and one NRWCCW heat exchanger. If both NRWCCW heat exchangers are used, two pumps are required to provide adequate cooling flow.

The NRWSW pumps are located such that their operation is not affected by normal high and low water levels. During a design basis flood, the pumps will not be operable.

Since the NRWSW System shell side flow operates at pressures much greater than tube side flow for the AOGCCW and NRWCCW Systems, the potential for radioisotopic leakage is eliminated.

The NRWSW System includes a chlorination subsystem to prevent biological fouling. The subsystem consists of two chlorine tanks and a feed regulator, one of which is used at any one time. The chlorine injection operation is controlled by a preset timer which allows injection for a short period of time. This subsystem is located at the north end of the intake structure.

9.2.1.2.3 Safety Evaluation

The NRWSW System is neither required for the safe shutdown of the reactor nor to mitigate the consequence of postulated accidents. Loss of function of the system has no adverse consequences on plant releases of radioactive effluents.

9.2.1.2.4 Testing and Inspection Requirements

No special tests and/or inspections are required for the NRWSW System beyond normal checks. Plant procedures establish the routine inspection and testing of this system.

9.2.1.2.5 Instrumentation Requirements

For each NRWSW pump a START/STOP switch and a pressure indicator are provided at the intake structure. Low service water pressure in the Offgas Building is alarmed on the AOG System control cabinet. This alarm is converted to a common "Offgas Building Trouble" alarm at the Control Room. Similarly, low service water pressure in the Radwaste Building is alarmed on the building's main control cabinet, this shows up as a "Radwaste Building Trouble" alarm at the Control Room.

Table 9.2-4 lists instruments for the NRWSW System.

9.2.1.3 Augmented Offgas Closed Cooling Water System

9.2.1.3.1 Design Bases

The Augmented Offgas Closed Cooling Water (AOGCCW) System provides inhibited demineralized water cooling to AOG System equipment. This water is in turn cooled by the AOGCCW heat exchangers.

The AOGCCW System also serves as an intermediate barrier separating the radioactive offgas in the Augmented Offgas System from the environment.

The piping for this system was designed, fabricated, inspected and erected in accordance with ANSI B31.1. Valves for the system are manual, except for the control loop at the discharge of the recombiner coolers.

Since there is no safety related equipment in this loop, the entire AOGCCW System is classified as non seismic and non safety related. Design basis loads are presented in Table 9.2-5.

9.2.1.3.2 System Description

The AOGCCW System is shown in Drawing BR 2006, Sh. 8, major component data are presented in Table 9.2-6. The system is comprised of two pumps, two heat exchangers, a surge tank, a chemical feed tank, and associated valves and piping.

The AOGCCW pumps are located in the Offgas Building. Check valves are provided at the discharge of each pump, followed by manually operated butterfly valves. The two redundant pumps discharge to a common header which branches to supply cooling water to the Augmented Offgas (AOG) System equipment. Water flowing from the equipment joins into a return header, passes through the AOGCCW heat exchangers and then to the pump's suction. A six inch bypass around the heat exchangers is provided to maintain minimum temperature during periods of low seawater temperature. The system features 100 percent backup during normal operation, requiring only one pump and one heat exchanger for component cooling. The heat exchangers are located at the pump suction to ensure that AOGCCW System pressure is lower than NSW System pressure at their interface.

A chemical feed tank adds an inhibitor for corrosion protection. An elevated surge tank provides a surge volume for system expansion and contraction resulting from temperature changes. The surge tank overflows into the Offgas Building floor drain system and vents to the atmosphere. Water from the Demineralized Water Transfer System (described in Subsection 9.2.3.2) is provided for makeup of the surge tank for initial fill and to compensate for system leakage. Makeup to the tank is manually established. Pressure relief for all isolable equipment is provided, in accordance with code requirements, through safety relief valves. The flow rate in the recombiner cooler is adjusted by a control loop. A temperature regulated throttle valve (T16 008A-3) controls flow between 100 and 200 gpm, and a second valve controls flow between 20 and 100 gpm. Thus, offgas out of the cooler is maintained at the temperature required by the controller, which is normally 150°F. All other components cooling flow is adjusted by manually throttling globe valves located downstream of the component being cooled.

Since the NSW System, which constitutes the heat sink for the AOGCCW System, operates at a higher pressure than the shutoff head of the AOGCCW pumps, any system leakage will be into the AOGCCW System. This prevents any possible discharge of radioactive material to the environment, precluding the need to install radiation monitors.

9.2.1.3.3 Safety Evaluation

The AOGCCW System is neither required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related.

9.2.1.3.4 Testing and Inspection Requirements

No special tests and/or inspections are required for the AOGCCW system beyond normal checks. Periodic samples are taken from the cooling water stream at locations downstream of the recombiner and heat removal components to check for the presence of radioactivity and for seawater leakage into the AOGCCW System.

9.2.1.3.5 Instrumentation Requirements

The AOGCCW pumps are controlled by local manual switches. The loss of pump discharge header pressure is annunciated on the AOG System control cabinet, and at the Control Room via a common "Offgas Building Trouble" alarm. The same applies to the surge tank high/low level alarm. A sight glass, mounted on the surge tank, provides tank level readings.

Closed cooling water discharge temperature from each Offgas Building component being cooled is indicated locally. Table 9.2-7 lists instruments for the AOGCCW System.

9.2.1.4 New Radwaste Closed Cooling Water System

9.2.1.4.1 Design Bases

The New Radwaste Closed Cooling Water (NRWCCW) System provides inhibited demineralized water cooling to liquid radwaste treatment equipment and the sample coolers. This water is in turn cooled in the NRWCCW heat exchangers located in the Heat Exchanger Building by the NSW System.

The piping for this system was designed, fabricated, inspected and erected in accordance with ANSI B31.1. All piping components are fabricated from carbon steel. Valves for the system are manual, except for the evaporator condenser valves which are temperature regulated.

Since there are no safety related equipment in this loop, the entire NRWCCW System is classified as non seismic and non safety related. Design basis loads are presented in Table 9.2-8.

9.2.1.4.2 System Description

The NRWCCW System is shown in Drawing BR 2006, major component data are presented in Table 9.2-9. The system is comprised of two pumps, two heat exchangers, a surge tank, a chemical feed tank, and associated piping and valves.

The NRWCCW System has been in a stand-by mode since September 1999. The system is only returned to service for periodic sampling or whenever the radwaste evaporator is being used. With the evaporator out of service, the only remaining heat load is the High Purity Waste Collection Tank, HP-T-1A. Processing from this tank will be suspended if tank temperatures exceed the high temperature alarm point or the NRCCW System could be returned to service.

The NRWCCW pumps are located in the New Radwaste Building. Check valves are provided at the discharge of each pump, followed by manually operated butterfly valves. The pumps discharge to a common header which branches to supply cooling water to radwaste equipment. Water flowing from the equipment joins into a return header, passes through the NRWCCW heat exchangers (which are located in the Heat Exchanger Building adjacent to the New Radwaste Building) and goes to the pump suction. The heat exchangers are located at the pump suction to ensure that NRWCCW System pressure is lower than NSW System pressure at their interface. Only one pump and one heat exchanger are required to be in operation when one evaporator condenser is in service.

A chemical feed tank adds an inhibitor for corrosion protection. An elevated surge tank provides a surge volume for system expansion and contraction resulting from temperature changes. The surge tank overflows into the New Radwaste Building floor drain system and vents to the atmosphere. Water from the Demineralized Water Transfer System (described in Subsection 9.2.3.2) is provided for makeup of the surge tank for initial fill and to compensate for system leakage. Makeup to the tank is manually established.

Pressure relief is provided, in accordance with code requirements, through safety relief valves. The cooling water flow through the evaporator condensers is regulated by temperature adjusted flow control valves. All other component cooling flow is adjusted by manually throttling globe valves located downstream of the component being cooled.

Since the NSW System, which constitutes the heat sink for the NRWCCW System, operates at a higher pressure than the NRWCCW pumps, any system leakage will be into the NRWCCW System. This prevents any possible discharge of radioactivity to the environment.

9.2.1.4.3 Safety Evaluation

The NRWCCW System is neither required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related.

9.2.1.4.4 Testing and Inspection Requirement

No special tests and/or inspections are required for the NRWCCW System beyond normal checks. Periodic samples are taken from the cooling water flow at locations downstream of the Radwaste Concentrator skid and the High Purity Waste Tank cooler to check for the presence of radioactivity and for seawater leakage into the NRWCCW System.

9.2.1.4.5 Instrumentation Requirements

The NRWCCW pumps are controlled by the START-STOP switches located in the New Radwaste Building Control Cabinet. Pump discharge is monitored for low pressure and high temperature. The common "Radwaste Building Trouble" alarm will alert at the Control Room if either of these conditions exist.

An expansion tank-high/low-level alarm is provided to alert of improper tank water level. This condition is annunciated on the Radwaste Building Control Cabinet, and alarmed in the Control Room via the "Radwaste Building Trouble" window. A sight glass, mounted on the surge tank which is located on the New Radwaste Building metal deck at the 56 foot elevation, provides tank level readings.

Closed cooling water discharge temperature from each component being cooled is indicated locally. Table 9.2-10 lists instruments for the NRWCCW System.

9.2.1.5 Turbine Building Closed Cooling Water System

9.2.1.5.1 Design Basis

The Turbine Building Closed Cooling Water (TBCCW) System is designed to provide under normal conditions inhibited demineralized cooling water to Turbine Building equipment and to the Reactor Recirculation Pump MG sets that are not subject to radioactive contamination. When the Reactor

Building closed Cooling Water System is unavailable, and the plant is shutdown, the TBCCWS can provide a cooling water supply to the Augmented Fuel Pool Cooling (AFPC) system heat exchanger.

The system has a heat removal capacity of 45.0 x 10^6 Btu/hr; about 80 percent of this load is provided by the stator winding liquid cooler, the generator hydrogen coolers, and the turbine lube oil coolers. These loads are present only during power operation. A listing of components cooled by the system is presented in Table 9.2-11. The heat load that the TBCCW system can accept under design conditions from the AFPC system heat exchangers is approximately 11.5 x 10^6 Btu/hr. In order to achieve the required flow rate to the heat exchangers, all unsafety related flow loads except those needed for minimum required TBCCW system flow and those required during plant shutdown are isolated.

9.2.1.5.2 System Description

The TBCCW System is included in Drawing BR 2006. Major component data are presented in Table 9.2-12. The system is comprised of three half capacity pumps, two half capacity heat exchangers, a chemical treatment system, a surge tank, and associated piping and valves.

The TBCCW pumps and heat exchangers are located in the Turbine Building. Check valves are provided at the discharge of each pump, followed by manually operated butterfly valves. The pumps discharge through 14 inch lines to a 20 inch header which branches into the two heat exchangers via 14 inch lines. Water from the heat exchanger flows to a common header and is distributed to the components cooled by the TBCCW System. A 12 inch bypass line is routed from the pump discharge header to the heat exchanger discharge header to compensate for fluctuations in circulating water temperature. Cooling water from the equipment being cooled flows into a return header and is routed to the pump's suction.

The surge tank is located at the high point of the system and is sized to hold the expected maximum expansion of the TBCCW System. Makeup from the Demineralized Water Transfer System (described in Subsection 9.2.3.2) can be added through a diaphragm operated control valve which operates automatically on decreasing level of the tank.

The chemical treatment system is designed for intermittent injection of a chemical solution into the demineralized water contained within the system. The chemical serves to inhibit corrosion in the system. The equipment consists of a mixing tank and a chemical feed pump. Water is drawn from the discharge header of the TBCCW pumps and the solution is injected upstream of the pumps and downstream of the surge tank connection.

All system valving is strictly manual, except for the makeup supply from the Demineralized Water Transfer System to the Surge Tank and the Hydrogen Coolers TBCCW flow. The Hydrogen Coolers are fed via an air controlled valve, which may be operated in a temperature regulated automatic mode or simply manually. There are isolation valves for the three pumps, the two heat exchangers and each cooled component. Discharge valves from the cooled components are utilized for flow regulation. Since all cooled equipment is accessible during operations, valves are located adjacent to the equipment.

The Turbine Oil Coolers are located at the north end of the Turbine Building. The TBCCW pumps, heat exchangers, chemical feed equipment, and all cooled equipment except the Recirculation Pump MG sets, and the Control Room air conditioner are located in the Turbine Bldg. Basement. The Recirculation Pump MG Sets are located in a separate area between the office building and the Reactor Building at El. 23'-6". The Control Room air conditioner, unit 'A', is at El. 63', and the TBCCW surge tank is at El. 84'. The Augmented Fuel Pool Cooling Heat Exchanger is located on El. 75' of the Reactor Building. The connection from the TBCCW piping to the AFPC heat exchanger is adequately isolated to prevent TBCCW System contamination.

Each TBCCW pump can operate continuously or on standby, and can be started manually or automatically on low discharge header pressure. During all modes of operation, operators will select the proper combination of TBCCW pumps and heat exchangers to place in service, which will provide the necessary component cooling. Under normal conditions, circulating water is supplied to the heat exchangers for heat rejection. However, the capability exists to line-up service water to these heat exchangers, at the same time isolating circulating water. No special plant conditions are needed to change this alignment.

The largest heat loads on the system comes from the lube oil coolers, the stator winding liquid coolers, and the hydrogen coolers. When temperatures of the circulating water allow, TBCCW can be throttled through these components, or the circulating water can be throttled through the TBCCW heat exchangers thus adjusting temperature uniformly. Generally, it is more convenient for the system to be controlled using the discharge valves of the TBCCW heat exchangers to regulate the amount of circulating water, rather than each individual end user.

The TBCCW System normally cools components not subject to radioactive contamination and, therefore the piping materials are not expected to become contaminated. In the rare situation when TBCCW is used to cool the ASFC system heat exchanger, the heat exchanger will first be drained and flushed to minimize the potential for contaminating the system, and while in operation, the system will be sampled periodically for radioactivity.

9.2.1.5.3 Safety Evaluation

The TBCCW System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related.

The failure modes and effects analysis of the system is summarized in Table 9.2-13.

9.2.1.5.4 Testing and Inspection Requirements

No special tests and/or inspections are required for the TBCCW System beyond normal checks. Water samples are taken in the Turbine Building basement.

During TBCCW System operation for cooling of the Spent Fuel Pool, periodic sampling for radioactivity will be performed.

9.2.1.5.5 Instrumentation Requirements

Instrumentation for the system is listed in Table 9.2-14. The TBCCW pumps are controlled from momentary contact START-STOP switches (spring return to normal) on panel 13R in the Control Room. Each pump will run continuously when the switch is operated momentarily to START. After the switch is operated momentarily to STOP, the pump will start automatically in low discharge header pressure. The circuit includes a pressure sensor in the discharge header and a ten second time delay relay to prevent the standby pump from starting on momentary pressure surges. "TB CC WATER DISCH LOW-PRESS" annunciates on panel 7F on pressure drop to below the set point. Individual "TB CC WATER PUMP TRIP" alarms for each pump, as well as a common "TB CC WATER PUMP AUTO-START", are provided on the 7F alarm panel. A "TBCCW CHEM ADD TNK LVL LO" alarm is also provided.

Level controls and alarms are provided for the surge tank. High level and low level alarms annunciate "TB CC SURGE TANK HI-LO LEVEL" also on panel 7F. The chemical addition mixing tank is provided with a gage glass and a level switch with local high level alarm.

9.2.1.6 Stator Liquid Cooling System

9.2.1.6.1 Design Bases

The Stator Liquid Cooling System is designed to remove heat from the generator during operation. Without stator cooling plant output must be reduced. The system utilizes TBCCW System water as the heat sink.

9.2.1.6.2 System Description

The system is shown in Drawing GE234R166, major component data are presented in Table 9.2-15. This closed cooling loop provides circulating demineralized water directly through the generator stator windings. Two pumps are provided, with one on standby which is started when discharge pressure drops 10 psig. Cooling water flows from the pump into the heat exchangers. The shell sides of the heat exchangers are piped in series and water from the TBCCW System flow, also in series, through the tube side. A bypass around the cooler operates automatically to maintain inlet stator water at a constant temperature.

The water is filtered, and part of the flow is diverted for purification. Low electrical conductivity is maintained by continuous removal of impurities from the diverted flow by means of a mixed bed deionizer. If the water conductivity cannot be maintained at the recommended low level, the deionizer resin should be replaced. This can be accomplished without reducing load in the generator. The deionizer draws water from a point downstream of the full flow filter, after purification the water is returned to a storage tank. A filter makeup line is connected to the supply line of the deionizer.

Cooling water in the generator flows directly through the stationary armature windings, which are formed by a number of hollow insulated copper conductors arranged in the form of rectangular bars. The individual hollow conductors are manifolded together at each end of the bars to an annular manifold. Water leaving the generator flows to a storage tank through a debubbler.

The storage tank provides NPSH to the pumps and allows for system expansion and contraction. Two or three cubic feet per day of hydrogen permeates through the insulating connections in the generator into the water and are released at the debubbler within the storage tank. Condensation of moisture carried into the vent drains continuously via the sealing loop.

9.2.1.6.3 Safety Evaluation

The system is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related. Unit output must be reduced to about 25 percent of rated capacity if the stator cooling water outlet temperature exceeds the runback high temperature setpoint or if the stator cooling water flow is less than the runback low flow setpoint.

9.2.1.6.4 Testing and Inspection Requirements

No special tests and/or inspections are required for this system beyond normal checks.

9.2.1.6.5 Instrumentation Requirements

Instrumentation for this system is presented in Table 9.2-16. When the stator cooling temperature exceeds the runback high temperature setpoint, or the stator cooling water flow is less than the runback low flow setpoint, a generator runback signal is developed. If armature current is above the stator no-flow capability approximately 25 percent of generator rated output, a pulse signal is generated which causes the speed load changer to runback; at the same time a three minute timer is energized.

If armature current drops below the stator no-flow capability, then runback is terminated and the timer stops; but if the timer reaches the three-minute setpoint before armature current drops below the stator no-flow capability, the turbine is tripped.

9.2.1.7 Phase Duct Cooling System

9.2.1.7.1 Design Bases

The aluminum conductors within the generator housing carry the electrical output and are supported by insulators. Cooling of the isolated phase ducts is provided to remove the heat generated by the large currents.

9.2.1.7.2 System Description

The isolated phase ducts are cooled by forced, closed circuit air which is circulated by one of two redundant fans.

The fans are locally controlled at a push button station at the cooling unit. The air is cooled in a heat exchanger by the TBCCW System.

9.2.1.7.3 Safety Evaluation

The system is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents.

9.2.1.7.4 Testing and Inspection Requirements

No special tests and/or inspections are required beyond normal checks.

9.2.1.7.5 Instrumentation Requirements

The TBCCW System return line has a local temperature indicator. A "GENERATOR MAIN LEADS HIGH TEMPERATURE" alarm is annunciated in panel 8F/9F at the Control Room. An "ISOLATED PHASE DUCT FAN #1 (#2) TRIP" alarm is also located in panel 8F/9F which annunciates when the motor is off.

9.2.2 Cooling Systems for Reactor Auxiliaries

9.2.2.1 Emergency Service Water System

The system description is presented in Subsection 6.2.2

9.2.2.2 Reactor Building Closed Cooling Water System

9.2.2.2.1 Design Bases

The Reactor Building Closed Cooling Water (RBCCW) System is designed to perform the following functions:

a. Provide inhibited demineralized water to all of the system components at a temperature in the range of 70°F to 105°F.

b. Permit flow control through each component supplied.

c. Detect RBCCW System leakage by monitoring and recording surge tank makeup flow rate.

The system is designed to provide inhibited demineralized cooling water to Reactor and Radwaste Buildings auxiliary equipment that is subject to radioactive contamination. The RBCCW System also acts as a buffer between radioactively contaminated systems, which it cools, and the Service Water System, which is the heat sink for the RBCCW System. The SWS is described in Subsection 9.2.1.1.

The design of the RBCCW System permits cooling of vital equipment during emergency shutdown with minimum load on the Emergency Diesel Generator. The design heat removal capacity of the RBCCW System at a design flow of 3500 gpm per heat exchanger is 116×10^6 Btu/hr. When the Shutdown Cooling Water System is in operation, the full heat removal capacity of the RBCCW System is utilized. Estimated system loads are presented in Table 9.2-17.

9.2.2.2.2 System Description

The RBCCW System is included in Drawing BR 2006. Major component data are presented in Table 9.2-18. The system is comprised of two half capacity heat exchangers, two 50 percent capacity pumps, a chemical treatment system, a surge tank, and piping and valves to feed all cooled equipment in parallel.

The RBCCW pumps and heat exchangers are located on the east side of the Reactor Building at El. 51'. Check valves are provided at the discharge of each pump, followed by manually operated butterfly valves. Closed cooling water flows from the pumps into a common header which feeds the two parallel heat exchangers. A bypass line is provided for the heat exchangers. Flow and temperature control is achieved through manual manipulation of system valves as provided in the operating procedures.

The RBCCW System pipe penetrates the drywell at two points. The direction of flow is such that water enters the drywell through one motor operated and one check valve in series and exits the drywell through two motor operated valves in series. The RBCCW pumps are thus located outside primary containment, whereas the drywell cooling units, the Recirculation Pumps and motors, and the Drywell Equipment Drain Tank are located inside primary containment. A manual throttling valve is located in the RBCCW return line, downstream of the outboard containment isolation valve. This separates the throttling function from containment isolation.

The five drywell cooling units have common supply and return lines with individual manually operated isolation valves. Cooling coils for the Drywell Equipment Drain Tank and the Reactor Building Equipment Drain Tank have remote manual discharge solenoid valves for isolation. There are manual isolation valves for each RBCCW pump and heat exchanger and manual isolation valves for each of the other cooled units. Discharge valves from the cooled units are utilized for flow regulation. Manually operated valves control closed cooling water flow through the two original and one augmented Spent Fuel Pool Coolers.

The surge tank is located at the high point of the system (at the northeast corner of the Reactor Building at El. 95'), and is sized to hold the expected maximum expansion of the RBCCW System. Makeup from the Demineralized Water Transfer System (described in Subsection 9.2.3.7) can be added manually or by an automatic level control valve. Makeup rate is monitored and recorded. The surge tank discharge is to the RBCCW return header, upstream of the chemical injection point.

The chemical treatment system, located on the east side of the Reactor Building at El. 51', is designed for intermittent injection of a chemical solution into the demineralized water contained within the system. The chemical serves to inhibit corrosion. The equipment consists of a mixing tank and a chemical feed pump. Water is drawn from the discharge header of the RBCCW pumps and the solution is injected upstream of the pumps and downstream of the surge tank connection.

The equipment cooled by the RBCCW System are all located in potentially radioactive areas of the plant.

Normal operation under load, with service water at 87°F, requires two heat exchangers in service and two pumps running. With service water below approximately 75°F, full load operation is possible with one heat exchanger and one pump. During shutdown, when most of the cooling demand is from the shutdown heat exchangers, two pumps and two heat exchangers should be in service. As the rate of decay heat generation decreases, one pump and one heat exchanger can be shutdown. One pump and one heat exchanger remain in operation during the shutdown for refueling, and the isolation valves in the drywell supply and return headers can be closed when the recirculating water pumps are not operating and the drywell coolers are being supplied cooling water from the drywell chiller.

In satisfying compliance with the requirements of NUREG-0578, the control logic to the containment isolation valves provides isolation for reactor vessel low low level and drywell high pressure, or reactor vessel triple low water level. Deliberate operator action is required to reopen these isolation valves.

The control logic is generated within the Core Spray System (low low water level or high drywell pressure) and the Automatic Depressurization System (triple low reactor vessel water level). Since RBCCW System isolation shuts off all cooling to the recirculation pump seals, damage could result if RBCCW cooling is not restored within approximately sixty seconds. Thus, a time delay has been added to the triple low portion of the RBCCW isolation logic to prevent spurious RBCCW isolation. Thus, the RBCCW can only isolate if the triple low signals are sealed in for 3-5 seconds. The RBCCW isolation system is a Class 1E safety system.

Reactor Building Closed Cooling Water System safety-related motor-operated valves are included in the Generic Letter (GL) 89-10 Motor-Operated Valve (MOV) Program as noted in the OCNGS Program Description for NRC Generic Letter 89-10 Motor-Operated Valve Program. This program has reestablished the design basis for safety-related motor-operated valves. Critical design bases assumptions such as design bases differential pressure, safety function - open vs. close, minimum available AC/DC voltages, actuator gearing, torque switch control logic, valve factors, stem friction coefficients, and valve stroke times have been established in assessing GL 89-10 design bases capability. Plant changes or activities which can affect these design bases assumptions must consider the affect on the capability of GL 89-10 motor-operated valves to perform their safety function and on safety margins established for these valves.

9.2.2.2.3 Safety Evaluation

The RBCCW System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The closed cooling water is not subject to contamination by exposure to a radioactive environment, but it can become contaminated by equipment cooler leakage.

The equipment serviced by the RBCCW System within the Primary Containment is not required to mitigate the consequences of postulated accidents, and since the RBCCW System is not protected against missiles and pipe whip inside the drywell, the system must be isolated upon containment isolation initiation to provide assurance that the public will be protected from the consequences of postulated accidents. To insure that a loss of power (i.e., single failure) does not prevent RBCCW System isolation, the motor operated valves in series are fed from separate power supplies. If the motor operated supply isolation valve fails to close, the check valve in series would achieve the necessary isolation.

A safety injection signal trips the RBCCW and SW pumps. Then, during operation from the Emergency Diesel Generators, both RBCCW pumps start automatically after a 166 sec time delay and the SWS pumps start automatically after a 120 second time delay, unless a LOCA signal is present. Both heat exchangers remain in service, but the Reactor Water Cleanup System will trip, thus reducing heat load to the system. One, two or three shutdown cooling heat exchangers may be started up manually, depending on the total heat load to the system.

The RBCCW System provides cooling to the Reactor Building corner room spaces, which house Containment and Core Spray pump equipment. Loss of corner room cooling has been evaluated with respect to long term operation of the Containment Spray and Core Spray Systems. As a result of this analysis, the provision of Class I, seismic structures for the RBCCW System and SWS was not required. Seal cooling and gear box lube oil cooling for the Control Rod Drive hydraulic pumps is no longer provided by the RBCCW System, but from Control Rod Drive pump process water.

This conclusion makes it acceptable to trip the RBCCW pumps and SW pump during a LOCA. A safety injection signal trips the RBCCW pump instantaneously, while the SW pump trip is delayed for ten seconds (±15%) after a safety injection signal. The load shedding feature and long time delay (120 seconds) in restarting the SW pump ensures that the ten second time delay for tripping the SW pump after a safety injection signal will not cause the pump to be inadvertently connected to the Emergency Diesel Generators.

The failure modes and effects analysis of the system is summarized in Table 9.2-19.

Leaks in the RBCCW System which are larger than the capacity of a Demineralized Water Transfer pump would result eventually in inadequate cooling of the components serviced by the RBCCW System. For such leaks, the operator would be made cognizant of the loss of RBCCW cooling capability by not only the low surge tank level alarm, but then also by low RBCCW pump discharge pressure and, additionally, by high temperature alarms from various components serviced by the RBCCW System. These loss of cooling indications would be available to the operator within seconds after loss of RBCCW cooling capability in order to take corrective action.

If it is postulated that there is a leak in the RBCCW System, the surge tank level would drop and should annunciate an alarm in the Control Room. The Demineralized Water Transfer pumps could be manually placed on a diesel powered emergency bus to provide makeup to the RBCCW System. This makeup rate could be as large as 150 gpm. The system could continue to operate in this manner with no loss in cooling function for a considerable length of time depending upon the RBCCW leak rate and level of water in the Demineralized Water Storage Tank. If the tank were full and the RBCCW leak is at a rate of 50 gpm, the RBCCW System would continue to perform its cooling function for at least 10 hours before the makeup water supply was depleted. This allows considerable time to isolate and eliminate the RBCCW System leak through operation of appropriate remote manual or local manual valves, or to repair the system.

If the RBCCW System leak were in excess of 150 gpm, or completely failed, the Shutdown Cooling System would be inoperable. Cooling water would still be available for injection into the reactor by utilizing the Core Spray. Therefore, there is no concern about safe shutdown of the reactor regardless of the size of the RBCCW System break postulated, thus supporting the position that the system is not safety related.

9.2.2.2.4 Testing and Inspection Requirements

The system is continuously used and monitored during reactor operation and shutdown, and is subjected to regular inservice inspection testing and a preventive maintenance program. Maintenance of pumps, coolers, valves and other equipment is done in accordance with manufacturer's recommendations. During normal plant operation and shutdown, all components are accessible for maintenance. Surveillance of the RBCCW System during testing is accomplished with instrumentation which is accessible during normal plant operating conditions. Water samples from the outlet of each RBCCW heat exchanger are available at a local sampling sink. The inservice inspection of pumps and valves is performed in accordance with the requirements of the latest version of the Oyster Creek Inservice Inspection Program.

9.2.2.2.5 Instrumentation Requirements

The RBCCW System instrumentation is presented in Table 9.2-20. The RBCCW pumps are controlled from momentary contact START-STOP switches (spring return to normal) on panel 13R at the Control Room. The switches can be pulled out to lock the pump in STOP and extinguish the indicator lights. Each pump runs continuously when the switch is operated momentarily to START. When the switch is operated to STOP, the pump remains stopped and the green running light on panel 13R remains on.

The surge tank is provided with level controls and alarms on high and low level. It is desired to determine leakage in the RBCCW System in the range of 0.5 to 10 gpm. This is accomplished by metering makeup to the tank. This system is supplied from vital power sources.

The chemical injection tank is provided with a gage glass and a level switch with local low level alarm and CHEM-ADDITION TANK LOW LEVEL alarm on the 1F/2F alarm panel.

The system is monitored for radiation.

9.2.2.3 Shutdown Cooling System

The operation and description of the Shutdown Cooling System is presented in Subsection 5.4.7.

9.2.3 Makeup Demineralizer and Demineralized Water Transfer Systems

The domestic and makeup water supply systems are the source of all potable water, demineralized water and condensate for the station. Fresh raw water is drawn from a deep well and processed in the pretreatment system. After treatment, part of the water goes to the domestic water system and the rest is further treated in the Makeup Demineralizer System to be used as demineralized water and for makeup to the Condensate Storage and Transfer System. The Well and Domestic Water System is presented in Subsection 9.2.4. This subsection describes the demineralized water train from a point downstream of the pretreatment process. The Condensate Storage and Transfer System and the Condensate Cleanup System are discussed in Subsections 10.4.6 and 10.4.7.

9.2.3.1 Makeup Demineralizer System

9.2.3.1.1 Design Bases

The Makeup Demineralizer (MUD) System takes pretreated water from the Well and Domestic Water (WDW) System and processes it to meet the high purity standards of water for makeup purposes. The required quality of makeup water is as shown in Table 9.2-21.

9.2.3.1.2 System Description

The original Makeup Demineralizer System was replaced by a mobile demineralizer unit for purifying filtered well water before transfer to the demineralized water storage tank.

The MUD System outflow is pumped to the Demineralized Water Storage Tank (DWST) where it is stored until needed. The DWST is located outside the northwest corner of the Turbine Building, near the Torus Water Storage Tank. Demineralized water pressure at the outlet of the system should not be below 45 psig, and the maximum pressure drop in the system should not exceed 50 psi.

9.2.3.1.3 Safety Evaluation

The MUD System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. During failure of normal auxiliary power, the DWST has enough reserve for anticipated requirements.

9.2.3.1.4 Testing and Inspection Requirements

No special tests and/or inspections are required for the MUD System beyond normal checks. Sampling provisions include sample points at the system's effluent line and at the effluent lines for each filter and ion exchanger.

9.2.3.1.5 Instrumentation Requirements

The MUD System is controlled locally from a central control panel. Table 9.2-23 summarizes the instrumentation and control provisions.

9.2.3.2 Demineralized Water Transfer System

9.2.3.2.1 Design Bases

The Demineralized Water Transfer (WD) System provides the following:

a. Storage of 175,000 gallons of demineralized water in the DWST.

b. An adequate supply of demineralized water for the following plant uses:

1. Initial fill up and makeup to: the Condensate Storage Tank, the RBCCW System, the TBCCW System, the AOGCCW System, the NRWCCW System, the Heating Boiler Deaerator, the Solid Radwaste System in the New Radwaste Building.

2. Supply of demineralized water to the chemical laboratory and the Maintenance Building.

3. Supply of demineralized water to the New Radwaste Building's Chemical Addition Tank, and personnel emergency shower and eyewash.

4. Cleaning and flushing via hose stations in the Turbine Building, Reactor Building, New and Old Radwaste Buildings, and Offgas Building.
5. System rinsing for the Solid Radwaste System in the New Radwaste Building.

6. Decontamination of the sampling stations.

7. Makeup to the Isolation Condensers while in standby condition only.

8. Other miscellaneous uses.

The WD piping is seismically designed to withstand a horizontal force equal to 0.05 times the operating dead load of the piping. The vertical seismic load was considered zero. The governing code is ANSI B31.1, to a 100-F temperature and 175 psig pressure.

9.2.3.2.2 System Description

The WD System is shown in Drawing BR 2004, major component data are presented in Table 9.2-24. The system is comprised of a 187,700 gallon outdoor storage tank (DWST), two full capacity transfer pumps, and associated piping and valves. The normal high level in the DWST is 175,000 gallons (overflow at 187,000 gallons).

Demineralized water from the MUD System enters the WD System at the DWST. Water is drawn from the tank through the WD pumps and into the system supply header. The six inch pump suction line and the four inch return line to the DWST are provided with locked open manually operated gate type block valves. These valves can be closed to mitigate the effects of leaks in any connecting pipe. All flanges and penetrations which could contact dissimilar metals are insulated. The DWST is electrically grounded, and is provided with an overflow line which is routed to the Turbine Building basement.

The four inch demineralized water supply header runs below grade to the Turbine Building. There are system branches which feed the various plant buildings, as shown in Drawing BR 2004.

9.2.3.2.3 Safety Evaluation

The WD System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related. During the 15R refuel outage, the WD System became contaminated. The system was flushed as required by SE-000523-001. Analysis of samples taken after flushing indicate the WD system is no longer contaminated.

The WD System is normally kept in operation at all times. During loss of offsite power, either transfer pump may be started manually and operated from the Emergency Diesel Generators, if there is a demand on the system. There is no need to operate a transfer pump merely to fill the CST.

9.2.3.2.4 Testing and Inspection Requirements

No special tests and/or inspections are required for the WD System beyond normal checks.

9.2.3.2.5 Instrumentation Requirements

There are two wide range level transmitters, a local level indicator, and a temperature gage on the DWST. One level transmitter provides a common high/low annunciator on alarm panel 7F in the Control Room. The other level transmitter provides DWST Level Indication on panel 5F/6F and lo-lo level annunciator on alarm panel 7F in Control Room. Each transfer pump is operated from a START-AUTO-STOP switch on Control Room panel 13R. A pressure switch on the discharge header starts the standby pump automatically if discharge pressure drops to a preset value. The following annunciators are provided on alarm panel 7F:

a. Common DEM TRANS PUMPS TRIP alarm for both pumps

b. DEM TRANS PUMPS BOTH RUNNING

c. DEMIN WTR LVL LO-LO

Locally, there are pressure taps at the suction and discharge of each pump and a pressure gage on the discharge header.

9.2.4 Potable and Sanitary Water Systems

9.2.4.1 Well and Domestic Water System

9.2.4.1.1 Design Bases

The Well and Domestic Water (MD) System serves the following functions:

a. Provides all potable water used on site, including the Administration Office Building and the Maintenance Building demand.

b. Provides pretreated water to the MUD System (described in Subsection 9.2.3.1).

Typical raw water quality is presented in Table 9.2-25.

9.2.4.1.2 System Description

The MD System is shown in Drawing 3E-871-21-1000. The pretreatment system was replaced by a trailer mounted pretreatment system. The Pretreatment trailer provides filtered raw water and operates in conjunction with Deep Well Pumps. Major component data are listed in Table 9.2-26.

Fresh raw water is drawn from the 400 foot, 12 inch diameter deep well which contains two 100 gpm submersible pumps. One pump is located 50 feet below grade and the other 60 feet below grade. Pump selection is made manually at the well pad in the storage yard to the east of the

Emergency Diesel Generators. The selected pump operates automatically on demand and is controlled by a MANUAL-OFF-AUTO switch on the 13R panel in the Control Room. The State of New Jersey limits the amount of water removed from the well to 100,000 gallons per day.

The Deepwell Pumps are used to supply raw water to the pretreatment trailer and the fill the clearwell Tank. The pretreatment trailer filters the raw water supply by the deepwell pumps for subsequent storage in the clearwell tank. One of two deepwell pumps is manually selected at the pump pad and required to maintain a minimum reservoir capacity in the clearwell tank. The clearwell tank satisfies station demands for domestic water and makeup water. The carbon filter and the Demineralizer Trailer operate in conjunction with the filter water pumps to purify makeup water from the clearwell tank and store it in the Demineralized water storage tank. The filter water pumps are required to supply water to the domestic water and makeup demineralizer systems.

The clearwell receives the hypochlorinated, clarified and filtered water and has a volume of 9500 gallons. The clearwell tank maintains required retention and provides sufficient suction head pressure (NPSH) to support filtered Water Pump operation at the minimum clearwell tank operating level.

Three filtered water pumps remove the water from the clearwell. One pump operates as required to maintain the proper level in the Domestic Water Tank. The other two pumps are not automatic and operate in association with the MUD System. An interlock is installed for these three pumps to prevent lowering the level in the clearwell below the low level alarm. The clearwell level provides the necessary NPSH for the filtered water pumps. The hypochlorinator pump operates automatically only when the 1-3 filtered water pump is operating in the domestic position.

A soda ash injection system has beeen installed, which injects soda ash at the inlet to the domestic water tank (T-10-4). This system will neutralize the pH to reduce corrosion and satisfy potable water standards.

9.2.4.1.3 Safety Evaluation

The MD System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system's water does not come in contact with radioactive contamination.

During failure of normal auxiliary power, the deep well pumps and the filtered water pumps do not restart automatically, The domestic water tank has enough reserve capacity for anticipated requirements. Operating power is available from the emergency generators so that the system, or parts of it, may be placed in operation, if necessary, during prolonged power failure.

When one of two of the filter water pumps which service the MUD System are out of service, the third pump can be used for that purpose if demand for demineralized water is heavy. In this case, there will be no automatic pump start on low Domestic Water Tank level, although makeup water will be admitted normally as long as the pumps are operating. Local action is required to transfer a pump to domestic water service.

9.2.4.1.4 Testing and Inspection Requirements

No special tests and/or inspections are required for the WDW System beyond normal checks. Sampling provisions are incorporated in the raw water influent line.

9.2.4.1.5 Instrumentation Requirements

A WELL PUMP TRIP annunciator is provided at panel 7F in the Control Room. The deep well pumps mode of operation is controlled from a three position selector switch on Panel 13R in the Control Room. The positions are MANUAL-OFF-AUTO. The Deepwell pumps operate in an “ON-OFF” control mode activated by the clearwell low and high level switches, respectively.

All three Filtered Water Pumps are controlled from the MUD Panel in the Turbine Building basement. Pumps No. 1 and No. 2 can only be run in manual. Pump No. 3 can be run in manual or automatic; while in the automatic mode the pump will cycle on Domestic Water Tank level. The soda ash injection system also operates in conjunction with the No. 3 pump and domestic water tank level. Any of the three pumps will trip on low suction pressure, thus insuring that proper NPSH is maintained. When clearwell level is raised and pressure restored above the trip setpoints, the pumps selected to run will restart.

The Pretreatment Building sump sludge pumps are also controlled from the MUD Panel. The pumps are controlled by three position hand switches labeled HAND-OFF-AUTO. In AUTO, a float switch in the sump starts and stops the pumps to control sump level. Pump logic is set up so that the pumps alternate to equalize run time. This run time is shown on integrators located in the Pretreatment Building.

A HAND-OFF-AUTO switch in the MUD Panel controls the hypochlorination pump. In AUTO, the pump runs any time the well water pumps run.

A pneumatic controller monitors clearwell level and develops an "on" air signal to open and close the clearwell level control valve. This air signal also operates a pressure switch which starts and stops the deep well pumps and the hypochlorinator pump.

A common trouble alarm on the 7F alarm panel is activated for the following:

a. Domestic Water Tank low level

b. Deepwell pump failure to start on clearwell low level

c. Deepwell pump trip on overload

9.2.4.2 Domestic Water Distribution System

9.2.4.2.1 Design Bases

The Domestic Water Distribution (DWD) System distributes potable water throughout the facility.

9.2.4.2.2 System Description

The DWD System is shown in Drawings 3E-871-21-1000 & 15050-110-PID-050. The system includes a water storage tank in the Pretreatment Building and in the North Yard Domestic Water Facility. Electric water heaters in the Office Building, Plant Engineering Building, Site Emergency Building and the Machine Shop. Additionally, a booster subsystem at the Maintenance Building and the Site Emergency Building.

The original domestic water tank has a capacity of 5000 gallons. System pressure is maintained by pressurizing the tank to 50 psig by a separate oilless air compressor provided with an air regulation system. The North Yard domestic water tank has a capacity of 4,000 gallons. System pressure is maintained by pressurizing the tank to 65 psig by an air compressor equipped with a separate oil/water filter. Potable water is supplied to the plant for air washers, sump pump bearings, laundry, drinking fountains, showers, emergency showers and eyewash stations in addition to typical restroom uses.

A chemical feed subsystem treats the original domestic water prior to use. This system uses the differential pressure across the original Domestic Water Tank inlet isolation valve to provide the necessary driving force. The chemical feeder is filled with polyphosphate, a phosphate glass which dissolves slowly in water and serves to inhibit scale production, corrosion and red water formation in the domestic water piping. The North Yard Domestic Water facility has a water softener and adds soda ash to neutralize the ph to reduce corrosion and satisfy potable water standards. A Sodium Hypochlorite Injection System has been added to ensure that the North Yard Domestic Water System is bacteriologically sterile for human consumption and to oxidize and precipitate remaining dissolved iron and eliminate any traces of hydrogen sulfide which causes a "rotten egg" smell. To ensure that any precipitated iron is removed a particulate filter was installed prior to distribution to the Domestic Water System. The original Domestic Water System also has a soda ash injection system, similar to the North Yard.

Both tanks "float" on the domestic water distribution piping. Makeup water to the original tank is from the DWD System. Makeup water to the North Yard tank is from a deep well just north of the Domestic Water Facility. Water is automatically added as required to maintain levels in the tanks. The makeup lines include a check valve to prevent backflow. Shutoff valves are provided just after each tank.

The main four inch domestic water line for building services runs below grade from the pretreatment building to the turbine building basement. Branches serving the various buildings are provided with shutoff valves. The North Yard Domestic Water Facility has a six inch line that ties into the existing domestic water header north of the turbine building. Additionally a new six inch line was installed to directly supply the New Administration Building which also cross ties into the original Domestic Water System between the plant engineering and site emergency buildings.

The North Yard System will be the designated source of potable water for the New Administration Building, however, it can also be lined up to supply other parts of the original system through either its north or south site tie-in points. The valve line ups are controlled by Station Procedure 321, "Domestic Water Systems."

The system contains hot water heaters: a unit in the Machine Shop, a unit for the Office Building, a unit in the Site Emergency Building, and a unit for the Plant Engineering Building and also in the New Site Administration Building.

9.2.4.2.3 Safety Evaluation

The DWD System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents.

9.2.4.2.4 Testing and Inspection Requirements

No special tests and/or inspections are required for this system beyond normal checks.

9.2.4.2.5 Instrumentation Requirements

In the original domestic water system, Filtered Water Pump No. 3 of the DWD System is controlled by two level switches monitoring Domestic Water Tank level. The high level switch stops the pump when the tank is full, and the low level switch starts the pump when the tank is half full. A third, low-low level, switch alarms DOMESTIC WATER TANK LO-LEVEL at the 7F alarm panel in the Control Room when level drops below the setpoint.

A pneumatic controller monitors tank level and develops an air signal to open and close the tank's level control valve. Tank pressure is maintained by air loading at about 50 psig.

The deep well pump is automatically controlled by two level switches monitoring the New Domestic Water Tank level. The high level switch stops the deep well pump and the low level switch starts the deep well pump when the tank is one third full. A local alarm activated for the following conditions: High-high pressure (>90 psi), low-low level (<29 inches from bottom of the tank), deepwell pump motor temperature high trip or high current trip or low current trip.

9.2.4.3 Sanitary Waste System

9.2.4.3.1 Design Bases

The Sanitary Waste System is designed to collect all plant sanitary drains and direct them to a controlled collection point.

9.2.4.3.2 System Description

All sanitary drains in the Office Building and Turbine Building, including floor drains in the Office Building, are combined in a six inch line. There are separate four inch drain lines from the various plant buildings which join the main sanitary drain line. All piping is designed for a maximum temperature of 100°F and a maximum pressure of 35 psig and is heat traced where exposed. All piping, valves and supports are designed as nonseismic, and underground piping is backfilled to provide adequate support and protection. PVC sanitary waste line is supported in accordance with the Basic Plumbing Code.

Domestic waste water from all plant locations enters an 8'-6" diameter by 15' deep concrete equalizing tank, via the six-inch sanitary collection main. The equalizing tank is located under the parking lot near the main entrance to the plant. This tank discharges, through two self priming two inch diaphragm pumps, to the Lacey Municipal Utilities Authority Sewer System and subsequently to the Ocean County Utilities Authority regional collection system via an eight inch gravity line. Valves are provided to control flow.

A radiation monitoring system has been provided to continuously monitor radiation levels in the effluent at the transfer pumps. The system continuously indicates and records radiation levels. The radiation monitoring system consists of a scintillation detector, a photo multiplier tube and a preamplifier, all mounted inside a drywell located in the sewage lift pump station. The ratemeter, recorder, power supply and supporting relay logic are located in the RAGEMS Building. Power is derived from local lighting power. As a backup, manual samples may be taken from the sewage pit for laboratory analysis.

9.2.4.3.3 Safety Evaluation

The Sanitary Waste System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents.

9.2.4.3.4 Testing and Inspection Requirements

No special tests and/or inspections are required for this system beyond normal checks. The radiation detector requires annual calibration and a quarterly response check.

9.2.4.3.5 Instrumentation Requirements

The 480 volt, 2 hp, sewage transfer pumps are controlled by equalizing tank level normally in an automatic mode. The pumps can be operated individually or in parallel as per the volume of fluid in the tank. Manual operation of either pump can be selected. Audio and visual alarms for loss of power to either pump or tank high level are provided.

The continuous radiation monitor alarms below 50 percent of the 10CFR20, Appendix B, Table 1, Column 2, value for Co-60. If radiation is detected, an alarm is initiated in the Security Building. Procedures require that the Control Room be immediately notified and that the alarm be investigated. If levels continue to rise, the sewage lift pumps trip automatically below the 100 percent value of 10CFR20.

9.2.5 Ultimate Heat Sink

9.2.5.1 Design Bases

The ultimate heat sink is intended to dissipate waste heat from the plant during normal, shutdown and accident conditions.

9.2.5.2 ystem Description

During normal plant operations, heat is dissipated via the RBCCW System to the SWS and via the TBCCW system to the SWS or Circulating Water System also via the main condensers into the Circulating Water System and subsequently to the discharge canal. During a LOCA, heat is dissipated via the Emergency Service Water System to the discharge canal.

The Circulating Water System is described in Subsection 10.4.5, the Service Water System is described in Subsection 9.2.1, and the Emergency Service Water System in Section 6.2.

9.2.5.3 Safety Evaluation

The banks of the Circulating Water System canal have been analyzed under various conditions for conformance to AEC Safety Guide 27 (presently USNRC Regulatory Guide 1.27). The analysis included the following combination of natural phenomena:

a. The Probable Maximum Hurricane (PMH)

b. The resulting high water

c. An earthquake having a horizontal acceleration of 0.11g

The hurricane itself will have no appreciable effect on the canal banks. Using time/water level relationships presented in Section 2.4, it can be concluded: (1) that the rise in water will tend to stabilize the canal banks; (2) wave action will be minor in the critical areas of the canal, west of State Route 9, because of attenuation; and (3) erosion of sand banks along the seashore is over a long period of time, thus precluding damage or obstruction of the canal.

The maximum flood water will tend to saturate the canal banks, laterally during the rise cycle and vertically when flooding overflows the banks. Transient water levels, resulting from wave action will result in less than full saturation with some 20 percent of the voids filled with entrapped air.

Within the time span of the PMH, the banks will not be partially saturated to their full extent (80 percent of voids), and during the drawdown cycle drainage will be bidirectional, i.e., toward the canal and the unsaturated zone inland of the canal simultaneously. Therefore, assuming the worst possible failure mode, drawdown of the intake canal could block no more than 25 percent of the total intake canal volume.

The examination of the canal banks, assuming saturation and a 0.11 g earthquake, reveals that earthquake action on saturated soils will produce slump zones no greater than earthquake action on drained soils. The evaluation of the liquefaction potential for dry soils, considered in Section 2.5, is applicable to the case of simultaneous occurrence of PMH, flood and earthquake.

In considering the effects of combined phenomena on the stability of earth banks, it should be recognized that any alteration of bank configuration is in the direction of greater stability, and the effects are not additive. At some point, the bank configuration attains a degree of stability that permits it to withstand additional disruptive forces without further alteration.

Collapse mechanisms of the three bridges which cross the intake canal have been discussed in the Forked River PSAR (Docket No. 50-363), Supplement No. 2, page 12-1. The analysis precludes the possibility of complete blockage of the canal. Under the most adverse conditions analyzed, the least available flow in the canal was found to be 304,000 gpm at a mean low water level elevation of (-)1.3 feet, with a maximum velocity of 3 feet per second. The continuous flow of water required for emergency shutdown is about 14,000 gpm.

It can thus be concluded that there is an extremely low probability of losing the capability of the canal as the Ultimate Heat Sink.

9.2.5.4 Testing and Inspection Requirements

Refer to Subsection 10.4.1 and 10.4.5.

9.2.5.5 Instrumentation Requirements

Refer to Subsection 10.4.1 and 10.4.5.

9.2.6 Condensate Storage Facilities

The Condensate Storage facilities consist of a 525,000 gallon Condensate Storage Tank, which is described in conjunction with the Condensate Transfer System in Subsection 10.4.7.

TABLE 9.2-1
(Sheet 1 of 2)

MAJOR COMPONENTS OF THE SERVICE WATER SYSTEM

Service Water Pumps

Number of Pumps	2
Type	Two stage, vertical, turbine pump
Design TDH	130 ft
Design Capacity	6000 gpm
Bhp at Design Point	252
Shutoff Head	206 ft
Minimum Continuous Flow	3500 gpm
Materials	
Casing	Cast Iron
Impeller and Shaft	Stainless Steel
Bearings	Cutless rubber
Motor	
Horsepower	250
Speed	1200 rpm
Full load current	304 amp
Service Factor	1.15
Bearings	Thrust
Power Requirements	460 volt, 3 phase
Power Source	Unit Substation 1A3 for motor 1-1 Unit Substation 1B3 for motor 1-2

Reactor Building Closed Cooling Water Heat Exchangers

Number of Heat Exchangers	2
Capacity	58 x 10^6 Btu/hr
Shell Side Parameters	
Fluid	Inhibited, demineralized water
Design Flow	3500 gpm
Inlet Temperature	133°F
Outlet Temperature	100°F
Tube Side Parameters	
Fluid	Seawater
Design Flow	6000 gpm
Inlet Temperature	85°F
Outlet Temperature	104°F
Design Pressure	
Shell Side	150 psig
Tube Side	100 psig to full vacuum

TABLE 9.2-1
(Sheet 2 of 2)

MAJOR COMPONENTS OF THE SERVICE WATER SYSTEM

Reactor Building Closed Cooling Water Heat Exchangers (Continued)

Heat Transfer Rate (clean/dirty)	530/392 Btu/sq ft/°F
Number of Passes	
Shell Side	2
Tube Side	2
Pressure Drop	
Shell Side	10 psi
Tube Side	8 psi
LMTD	22.2°F
Cleanliness Factor	Used rate 22% of clean
Materials	
Shell	ASTM A285C
Tube	ASTM B111
Tubes	
Number	1212
Size and gauge	18 BWG, 7/8 inch OD, 288 inch long

Turbine Building Closed Cooling Water Heat Exchangers

Number of Heat Exchangers	2
Capacity	22.5 x 10^6 Btu/hr
Shell Side Parameters	
Fluid	Inhibited, demineralized water
Design Flow	5000 gpm
Inlet Temperature	109°F
Outlet Temperature	100°F
Tube Side Parameters	
Fluid	Seawater
Design Flow	5000 gpm
Inlet Temperature	85°F
Outlet Temperature	94°F
Design Pressure	
Shell Side	150 psig
Tube Side	100 psig to full vacuum

TABLE 9.2-2
(Sheet 1 of 1)

SERVICE WATER SYSTEM LINE INSTRUMENTATION AND ALARMS

Instruments

1. Pressure gage at pump 1-1 discharge
2. Pressure gage at pump 1-2 discharge
3. Pressure transmitter transmits service water pressure to indicator on panel 5F/6F
4. Differential pressure gage at tube side of the TBCCW heat exchanger 1-1.
5. Differential pressure gage at tube side of the TBCCW heat exchanger 1-2.

Alarms

1. Service Water Pump Trip - Panel 5F/6F
2. Liquid Process High Radiation - Panel 10F

TABLE 9.2-3
(Sheet 1 of 3)

MAJOR COMPONENTS OF THE NEW RADWASTE SERVICE WATER SYSTEM

New Radwaste Service Water Pumps

Number of Pumps	2
Type	Vertical wet pit
Design Flow	2000 gpm
Design TDH	180 feet
Maximum Design Temperature	150°F
Design Pressure	600 psig
Normal Operating Pressure	75 psig*

Augmented Offgas Closed Cooling Water Heat Exchangers

Number of Heat Exchangers	2 (CC-H-2A, CC-H-2B)
Type	Horizontal Mounting Shell and Tube
Capacity	2.06 x 10^6 Btu/hr
Shell Side Parameters	
Fluid	Inhibited, demineralized water
Design Flow	406.6 gpm
Inlet Temperature	105°F
Outlet Temperature	95°F
Tube Side Parameters	
Fluid	Seawater
Design Flow	250 gpm
Inlet Temperature	80°F
Outlet Temperature	97.2°F
Design Pressure and Temperature	
Shell Side	150 psig/150°F
Tube Side	75 psig/150°F
Heat Transfer Rate (clean/dirty)	548/345 Btu/sq ft/°F
Number of Passes	
Shell Side	2
Tube Side	4
Pressure Drop	
Shell Side	10 psi
Tube Side	6 psi

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* A discharge pressure of at least 60 psig must be maintained to prevent pump runout

TABLE 9.2-3
(Sheet 2 of 3)

MAJOR COMPONENTS OF THE NEW RADWASTE SERVICE WATER SYSTEM

Augmented Offgas Closed Cooling Water Heat Exchangers (Continued)

M.T.D. (corrected)	10.3
Fouling Resistance	0.00050
Materials	
Shell	Carbon Steel A-515-70
Tube	90/10 Cu-Ni B-111
Tubes	
Number	202
Size and gage	18 BWG, 3/4 inch OD, 14'-11" long
Shell Diameter	17-1/4" ID
Design Code	ASME VIII, Div. 1, TEMA Class R

New Radwaste Closed Cooling Water Heat Exchangers

Number of Heat Exchangers	2 (CC-H-1A, CC-H-1B)
Type	Horizontal Mounting Shell and Tube
Capacity	23.66×10^6 Btu/hr
Shell Side Parameters	
Fluid	Inhibited, demineralized water
Design Flow	1875 gpm
Inlet Temperature	126°F
Outlet Temperature	100°F
Tube Side Parameters	
Fluid	Seawater
Design Flow	1717 gpm
Inlet Temperature	80°F
Outlet Temperature	108.2°F
Design Pressure and Temperature	
Shell Side	150 psig/150°F
Tube Side	75 psig/150°F
Heat Transfer Rate (clean/dirty)	548/345 Btu/sq ft/°F
Number of Passes	
Shell Side	2
Tube Side	4
Pressure Drop	
Shell Side	10 psi
Tube Side	8 psi
M.T.D. (corrected)	17.2
Fouling Resistance	0.00050
Materials	
Shell	Carbon Steel A-515-70
Tube	90/10 Cu-Ni B-111

TABLE 9.2-3
(Sheet 3 of 3)

MAJOR COMPONENTS OF THE NEW RADWASTE SERVICE WATER SYSTEM

New Radwaste Closed Cooling Water Heat Exchangers

Tubes	
Number	1260
Size and gage	18 BWG, 3/4 inch OD, 16'-5" long
Shell Diameter	40" ID
Design Code	ASME VIII, Div. 1, TEMA Class R

TABLE 9.2-4
(Sheet 1 of 1)

NEW RADWASTE SERVICE WATER SYSTEM INSTRUMENTATION

Parameter	Indication
AOGCCW Heat Exchangers	
Service Water Inlet Pressure	Local
Service Water Inlet Temperature	Local
Service Water Differential Pressure	Local
Service Water Outlet Temperature	Local
NRWCCW Heat Exchangers	
Service Water Inlet Pressure	Local
Service Water Inlet Temperature	Local
Service Water Differential Pressure	Local
Service Water Outlet Temperature	Local

TABLE 9.2-5
(Sheet 1 of 1)

DESIGN BASIS LOADS FOR THE AUGMENTED OFFGAS CLOSED COOLING WATER SYSTEM

Component Cooled	Quantity	Normally Operating	AOGCCW Flow Rate (each component)
Cooler/Condenser	2	1	200 gpm
ater Removal Subsystem (Stage 1)	3	1	30 gpm
Refrigeration Unit Skid er Removal Subsystem (Stages 2 and 3)	3	1	10 gpm
frigeration Unit for Charcoal Vault Coolers	2	1	5 gpm
Total Normal Operating Flow			245 gpm

TABLE 9.2-6
(Sheet 1 of 1)

MAJOR COMPONENTS OF THE AUGMENTED OFFGAS CLOSED COOLING WATER SYSTEM

Augmented Offgas Closed Cooling Water Pumps

Number	2 (CC-P-2A, CC-P-2B)
Type	Horizontal AVS
Design Flow	500 gpm
Head	100 feet
Design Temperature	150°F
Design Pressure	75 psig
Motor Horsepower	25
Design Code	ANSI B123.1 AVS

Augmented Offgas Closed Cooling Water Heat Exchangers

See Table 9.2-3

Augmented Offgas Closed Cooling Water Surge Tank

Number	1 (CC-T-2)
Type	Horizontal
Material	Carbon Steel
Design Temperature	150°F
Design Pressure	Atmospheric
Tank Volume	50 gallons
Design Code	API 650, App. J

TABLE 9.2-7
(Sheet 1 of 2)

AUGMENTED OFFGAS CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
AOGCCW Heat Exchangers	
Component Cooling Water InletPressure (2)*	Local
Component Cooling Water Inlet Temperature (2)	Local
Component Cooling Water Outlet Pressure (2)	Local
Component Cooling Water Outlet Temperature (2)	Local
AOGCCW Surge Tank	
Water Level	Local
AOGCCW Pumps	
Inlet Pressure (2)	Local
Discharge Pressure (2)	Local
Discharge Header Temperature	Remote
Discharge Header Pressure	Remote
AOG System Water Removal Subsystem	
No. 1 - Component Cooling Water Outlet Temperature	Local
No. 2 - Component Cooling Water Outlet Temperature	Local
No. 3 - Component Cooling Water Outlet Temperature	Local
AOG System Refrigeration Units	
No. 1 - Component Cooling Water Outlet Temperature (2)	Local
No. 2 - Component Cooling Water Outlet Temperature (2)	Local
No. 3 - Component Cooling Water Temperature (2)	Local

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* One for each line

TABLE 9.2-7
(Sheet 2 of 2)

AUGMENTED OFFGAS CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
AOG System Charcoal Vault Refrigeration Units Component Cooling Water Outlet Temperature (2)*	Local
AOG System Recombiner Subsystems	
A – Component Cooling Water Outlet Temperature	Local
B – Component Cooling Water Outlet Temperature	Local

---

* One for each line

TABLE 9.2-8
(Sheet 1 of 1)

DESIGN BASIS LOADS FOR THE NEW RADWASTE CLOSED COOLING WATER SYSTEM

Component Cooled	Quantity	Normally Operating	NRWCCW Flow Rate (each component)
Evaporator Condenser(1)	2	1	1200 gpm
Condensate Cooler (1)	2	1	600 gpm
Vent Condenser (1)	2	1	56 gpm
High Purity Waste Tank Cooler	1	1	60 gpm
High Purity Waste Pump (2)	2	1	6.5 gpm
Chem Waste/Floor Drain Pump (2)	2	1	6.5 gpm
Concentrated Liquid Waste Pumps (2)	2	1	3.5 gpm
Total Normal Operating Flow			1940.5 gpm

Note (1)
One evaporator and its associated components are abandoned.

Note (2)
During D&D's Mechanical verification effort in 1986, these cooling sources were found to be abandoned. These components are now cooled by the Condensate Transfer System.

TABLE 9.2-9
(Sheet 1 of 1)

MAJOR COMPONENTS OF THE NEW RADWASTE CLOSED COOLING WATER SYSTEM

New Radwaste Closed Cooling Water Pumps

Number	2 (CC-P-1A, CC-P-1B)
Type	Horizontal Centrifugal AVS
Design Flow	1865 gpm
Design TDH	160 feet
Design Temperature	150°F
Design Pressure	75 psig
Motor Horsepower	100
Power Supply	CC-P-1A, MCC 1E11;CC-P-1B, MCC 1E12
Design Code	ANSI B123.1 AVS

New Radwaste Closed Cooling Water Heat Exchangers

See Table 9.2-3

New Radwaste Closed Cooling Water Surge Tank

Number	1 (CC-T-1)
Type	Horizontal
Material	Carbon Steel
Design Temperature	150°F
Design Pressure	Atmospheric
Tank Volume	500 gallons
Design Code	API 650, App. J

TABLE 9.2-10
(Sheet 1 of 2)

NEW RADWASTE CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
NRWCCW Heat Exchangers	
Component Cooling Water Inlet Pressure (2)[*]	Local
Component Cooling Water Inlet Temperature (2)	Local
Component Cooling Water Outlet Pressure (2)	Local
Component Cooling Water Outlet Temperature (2)	Local
NRWCCW Surge Tank	
Water Level	Local
NRWCCW Pumps	
Inlet Pressure (2)	Local
Discharge Pressure (2)	Local
Discharge Header Temperature	Remote
Discharge Header Pressure	Remote
Radwaste Building Evaporator Condensers	
A - Component Cooling Water Outlet Temperature	Local
B - Component Cooling Water Outlet Temperature	Local
Radwaste Building Distillate Coolers	
A - Component Cooling Water Outlet Temperature	Local
B - Component Cooling Water Outlet Temperature	Local

---

[*] One for each line

TABLE 9.2-10
(Sheet 2 of 2)

NEW RADWASTE CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
Radwaste Building Vent Condensers	
A - Component Cooling Water Outlet Temperature	Local
B - Component Cooling Water Outlet Temperature	Local
Radwaste Building High Purity Waste Tank Cooling Coil Component Cooling Water Outlet Temperature	Local

TABLE 9.2-11
(Sheet 1 of 1)

DESIGN BASIS LOADS FOR THE TURBINE BUILDING CLOSED COOLING WATER SYSTEM

Objective	Component	Quantity
Generator Cooling	Stator Winding Liquid Coolers	2
	Hydrogen Coolers	6
	Generator Bus Heat Exchanger	1
Turbine Lubrication	Turbine Lube Oil Coolers	2
Condenser Vacuum	Condenser Vacuum Pump Exhauster Cooler	1
Service and Instrument Air	Main Air Compressors	3
Condensate	Condensate Pump Motor Coolers	3
Feedwater	Reactor Feed Pump Lube Oil Coolers	3
HVAC	Control Room Air Conditioner	2
Recirculation Pump	Reactor Recirculation Pump MG Set Oil Coolers	5

TABLE 9.2-12
(Sheet 1 of 2)

MAJOR COMPONENTS OF THE TURBINE BUILDING CLOSED COOLING WATER SYSTEM

Turbine Building Closed Cooling Water Pumps

Number of Pumps	3
Type	single stage, double suction, horizontally split-volute centrifugal
Design TDH	165 feet
Design Capacity	5000 gpm
Design NPSH Required	25 Feet
Design Shutoff Head	204 ft
Motor	
Horsepower	250
Speed	1800 rpm
Full-Load Current	301 amp
Service Factor	1.15
Bearings	Ball
Power Requirements	460 volt, 3 phase
Power Supply	1-1: US 1A1 1-2: US 1A1 1-3: US 1B1

Turbine Building Closed Cooling Water Heat Exchangers

See Table 9.2-1

TABLE 9.2-12
(Sheet 2 of 2)

MAJOR COMPONENTS OF THE TURBINE BUILDING CLOSED COOLING WATER SYSTEM

Turbine Building Closed Cooling Water Chemical Feed

Mixing Tank	
Capacity	100 gallons
Type	Vertical, cylindrical, bottom dish head and removable top cover
Mixer Motor	TEFC, 1/3 hp, single phase
Solution Pump	
Pump Type	Simplex diaphragm, controlled volume
Capacity	Adjustable : 0 to 5 gph at 30 psig
Motor Horsepower	1/4

Turbine Building Closed Cooling Water Surge Tank

Capacity	Approximately 600 gallons
Dimensions	3 feet, 0 1/2 inch diameter, 8 feet long
Design Pressure	15 psig

TABLE 9.2-13
(Sheet 1 of 4)

TURBINE BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
TBCCW Heat Exchangers (2)	Internal leakage	Flow of demineralized water from the closed system detectable by a decrease in level in the surge tank
TBCCW Pumps (3)	Pump trip or malfunction	The capacity of one pump matches the flow requirements of one heat exchanger. Failure of one pump would cause automatic start of the standby pump.
	Loss of power supply	Two of the 250 hp pump motors are connected to one 460 volt ac bus and the third motor is connected to a separate bus. Either or both buses can be manually connected to the diesel generators in the event of normal auxiliary power failure.
TBCCW Surge Tank (1)	Tank Failure	This tank does not have a major role during normal system operation, however, it must operate to detect and compensate for leakage.

TABLE 9.2-13
(Sheet 2 of 4)

TURBINE BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
TBCCW Chemical Treatment Equipment	System Failure	Operation of this system is intermittent and not necessary for TBCCW System operation.
Stator Winding Liquid Cooler (2)	Internal Leakage	Flow of water into the TBCCW System. Partial loss of cooling will require reduction of generator load.
Hydrogen Coolers (6)	Internal Leakage	Flow of water from the TBCCW System into the coolers. The presence of water is detected by instrumentation and alarmed. The failed cooler would be valved out and generator load need to be reduced depending on cooling water temperature.
Generator Bus Heat Exchanger (1)	External Leakage	Water would flow from the system to the Turbine Building Drain Tank, requiring makeup to the TBCCW system.
	Complete loss of cooling	Requires reduction of bus loading to reduce heat load
Turbine Lube Oil Coolers (2)	Internal Leakage	Flow of cooling water into the oil would be detected through rising oil tank level. The leaking coil must be isolated to prevent water from entering the turbine bearings

TABLE 9.2-13
(Sheet 3 of 4)

TURBINE BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
Condenser Vacuum Pump Cooler (1)	Loss of Cooling	Failure during operation is not critical.
Service and Instrument Air Systems (3) - Jacket Intercoolers and After Coolers	Loss of Cooling	Requires shutdown of the affected compressor. Other compressors would provide instrument air requirements first.
Condensate Pump Motor Coolers (3)	Loss of cooling and internal Leakage	Instruments would alarm on high bearing temperature and the pump would shutdown. All three pumps are required for full power operation, thus limitation of reactor power would be required
Reactor Feed Pump Lube Oil Coolers (3)	Loss of Cooling	Instruments would alarm on high lube oil temperature and would require shutdown of the pump. All three pumps are required at full power. Outage of one pump would impose a limitation on reactor power.

TABLE 9.2-13
(Sheet 4 of 4)

TURBINE BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
Recirculation System Pump M-G Set Coolers (5)	Loss of Cooling	The M-G Set would be shutdown. Outage of one recirculation pump would reduce power output capability of the reactor.
Control Room Air Conditioner Cooled by TBCCW (1)	Loss of Cooling	There is a redundant ‘B’ HVAC system. If TBCCW fails, the redundant HVAC system will maintain temperature in the control room. If the redundant ‘B’ system fails also at the same time, outside air can be admitted to the Control Room as an alternate to air conditioning. In the case of an airborne radioactivity release the control room is aligned to partial recirculation mode. In one hour of complete LOOP, diesel power can be made available to only run the SF-1-15 fan on the ‘A’ HVAC system.

TABLE 9.2-14
(Sheet 1 of 3)

TURBINE BUILDING CLOSEDCOOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
TBCCW Heat Exchangers Header	
Discharge Header Pressure	Remote
Discharge Header Temperature	Remote
TBCCW Heat Exchangers	
Component Cooling Water Inlet Temperature (2)*	Local
Component Cooling Water Differential Pressure (2)*	Local
Component Cooling Water Outlet Temperature (2)	Local
TBCCW Surge Tank	
Water Level	Local
TBCCW Pumps	
Discharge Pressure (3)	Local
Discharge Header Temperature	Local
TBCCW Mixing Tank	
Level	Local**
Vacuum Priming Pump Coolers	
Component Cooling Water Inlet Temperature (2)	Local
Component Cooling Water Outlet Temperature (2)	Local
Stator Winding Liquid Coolers	
Component Cooling Water Inlet Pressure	Local
Component Cooling Water Outlet Pressure	Local

---

* One for each line
** With Local alarm on high level
Remote = Control Room

TABLE 9.2-14
(Sheet 2 of 3)

TURBINE BUILDING CLOSEDCOOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
Generator Hydrogen Coolers	
Component Cooling Water Inlet Temperature (6)*	Local
Component Cooling Water Inlet Pressure (6)	Local
Component Cooling Water Outlet Temperature (6)*	Local
Component Cooling Water Outlet Pressure (6)*	Local
Generator Bus Heat Exchanger	
Component Cooling Water Inlet Temperature	Local
Component Cooling Water Inlet Pressure	Local
Component Cooling Water Outlet Temperature	Local
Component Cooling Water Outlet Pressure	Local
Hydrogen Seal Oil Vacuum Pump Cooler	Abandoned
Service and Instrument Air Compressors	
Component Cooling Water Inter Cooler Outlet (1-3 Compressor only)	Local
Component Cooling Water Outlet Temperature (3)	Local
Reactor Feed Pump Lube Oil Coolers	
Component Cooling Water Outlet Temperature (3)	Local
Mechanical Vacuum Pump Coolers	
Outlet Pressure	Local
Outlet Temperature	Local

---

* One for each line

TABLE 9.2-14
(Sheet 3 of 3)

TURBINE BUILDING CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication
Reactor Recirculation System Pump M-G Set Component Cooling Water Outlet Temperature (5)*	Local
Turbine Lube Oil Coolers	
Component Cooling Water Inlet Pressure (2)*	Local
Component Cooling Water Outlet Temperature (2)	Local
Component Cooling Water Outlet Pressure (2)*	Local
Control Room Air Conditioner	
Component Cooling Water Inlet Temperature	Local
Component Cooling Water Outlet Temperature	Local

---

* One for each line

TABLE 9.2-15
(Sheet 1 of 1)

MAJOR COMPONENTS OF THE STATOR LIQUID COOLING SYSTEM

Stator Cooling Water Pumps	
Number of Pumps	2
Capacity	350 gpm
Motor Horsepower	50
Power Supplies	A from 1A11 B from 1B11
Stator Cooling Heat Exchangers	
Number of Heat Exchangers	2 (in series)
Type	Shell and Tube
Shell Side Parameters	
Fluid	Demineralized water
Design Flow	302 gpm – 317 gpm
Outlet Temperature	30-48°F
Tube Side Parameters	
Fluid	Demineralized Water (from TBCCW System)
Design Flow	1600 gpm
Full Flow Filter	
Type	Replaceable Cartridge
Filtering Size	14 micron
Maximum Differential Pressure	8 psi
De-Ionizer	
Type	Mixed Bed
Maximum Inlet Temperature	50°C
Maximum Differential Pressure	15 psi
Maximum Conductivity	0.5 micromhos/cm
Maximum/Normal Flow	45-55 gpm
Storage Tank	
Quantity	1

TABLE 9.2-16
(Sheet 1 of 1)

STATOR LIQUID COOLING SYSTEM INSTRUMENTATION

Parameter	Indication
Pump Discharge Pressure	On Panel[*]
Armature Inlet Pressure	On Panel
Armature Inlet Flow	On Panel
Armature Inlet Temperature	On Panel
Armature Outlet Temperature	On Panel
De-Ionizer Flow	Local
Conductivity	On Panel
Generator Inlet	
Deionizer Outlet	
Generator Outlet	
Filter Inlet Pressure	Local
Filter Outlet Pressure	Local
Generator Inlet Temperature	Local/Panel
Deionizer Inlet Pressure	Local
Surge Tank Pressure	Local
Surge Tank Sight Glass	Local
Surge Tank Level (Hi/Low)	On Panel
Reserve Pump Running	On Panel

---

[*] Stator cooling panel is located in the Turbine Building basement

TABLE 9.2-17
(Sheet 1 of 2)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM DESIGN BASIS LOADS

Objective	Component	Quantity	Heat Loads (10^6 Btu/hr) Normal	Shutdown (First Hour)	Shutdown (13 Hrs. After Scram)
Fuel Pool Cooling System	Fuel Pool Heat Exchangers*	3	5.0	5.0	5.0
Shutdown Cooling System	Shutdown Cooling Heat Exchangers*	3	-	88.0	31.0
	Shutdown Cooling Pumps	3	-	0.96	0.96
Reactor Water Cleanup	Non-regenerative Heat Exchanger (2	1	40.0	24.0	-
System	Shells)	2	NegligibleNegligible	-	-
	Cleanup Recirc. Pump Coolers	1	Negligible	-	-
	Cleanup Auxiliary Pump Cooler	1		-	-
	Pre-Coat Pump Cooler				

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[*] One refueling cycle load

TABLE 9.2-17
(Sheet 2 of 2)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM DESIGN BASIS LOADS

			Heat Loads (10^6 Btu/hr)		
Objective	Component	Quantity	Normal	Shutdown (First Hour)	Shutdown (13 Hrs. After Scram)
Heating and Ventilation	Tunnel Recirc. Fans	2	0.14	-	-
	Corner Room Coolers				
	Core Spray Pumps	2	-	0.5	0.5
	Containment Spray Pumps	2	-	0.4	0.4
Radioactive Drains Cooling	Reactor Building Equipment Drain Tank	1	0.06	0.06	0.06
Drywell Cooling	Recirc. Pump and Motor Coolers	5	1.5	0.9	-
	Drywell Cooling Units	5	3.0	3.0	3.0
	Drywell Equipment Drain Tank	1	0.25	0.25	0.25

TABLE 9.2-18
(Sheet 1 of 2)

MAJOR COMPONENTS OF THE REACTOR BUILDING CLOSED COOLING WATER SYSTEM

Reactor Building Closed Cooling Water Pumps

Number of Pumps	2
Type	Single stage, double suction, horizontally split-volute centrifugal
Design TDH	175 feet
Design Capacity	3500 gpm
Bhp at Design Point	176
NPSH	50 feet
Shutoff Head	226 ft
Minimum Flow	30 gpm
Materials	
Casing	Cast iron
Impeller	Bronze
Shaft	Steel SAE 1035
Wear rings, casing and impeller	Bronze
Bearings Type	Ball
Motor	
Horsepower	200
Speed	1800 rpm
Full-Load Current	237 amp
Service Factor	1.15
Bearings Type	Ball
Power Requirements	460 volt, 3 phase
Power Supply	1-1 : US 1A2 1-2 : US 1B2
Shaft Coupling	Fast, gear type

Reactor Building Closed Cooling Water Heat Exchanger

See Table 9.2-1

TABLE 9.2-18
(Sheet 2 of 2)

MAJOR COMPONENTS OF THE REACTOR BUILDING CLOSED COOLING WATER SYSTEM

Reactor Building Closed Cooling Chemical Feed

Mixing Tank	
Capacity	100 gallons
Type	Vertical, cylindrical, bottom dish head and removable top cover
Mixer	Portable Type with GE Motor ¼ - 1-60-115/230-1725 TEC
Solution Pump	
Pump Type	Simplex diaphragm, controlled volume
Capacity	Adjustable : 0 to 5 gph at 30 psig
Check Valves	Ohio Injector Co., Body C.S. with stellite; Disc SS
Rupture Disk	Safety Systems - Aluminum
Coupling	Direct Drive
Motor Type	TEFC, 1750 rpm
Motor Horsepower	1/4

Reactor Building Closed Cooling Water Surge Tank

Capacity	Approximately 500 gallons
Dimensions	3 ½ feet diameter 8 feet long
Material	Carbon Steel Plate, 3/8 inch thick
Design Pressure	15 psig

TABLE 9.2-19
(Sheet 1 of 5)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
RBCCW Heat Exchangers (2)[*]	Emergency shutdown	High temperature at the non-regenerative heat exchanger discharge trips the cleanup system. Shutdown cooling is regulated to limit temperature rise in the RBCCW System. No damage to the reactor occurs.
	Internal Leakage	Loss of demineralized water into the SWS, detectable by surge tank level and makeup rate.
RBCCW Pumps (2)[*] Shutdown.	Pump trip or malfunction	Same as for heat exchanger
	Loss of power supply	The 200 hp pump motors are fed from two separate 460 volts AC buses that are automatically connected to the diesel generators in the event of normal auxiliary power failure.

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[*] Loss of RBCCW during plant operation causes loss of drywell cooling. Entry to plant Emergency Operating Procedures may result.

Note: Internal and external leakage also gets detected by the radiation levels indicated by the RBCCW and/or Service Water process radiation monitors.

TABLE 9.2-19
(Sheet 2 of 5)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
RBCCW Surge Tank (1)[*]	Tank Failure	This tank does not have a major role during normal system operation, however, it must operate to detect and compensate for leakage.
RBCCW Chemical Treatment Equipment	System Failure	Operation of this system is intermittent and not necessary for RBCCW System operation.
Fuel Pool Coolers (3)	Internal Leakage	Flow of fuel pool water into the RBCCW System until detection by high surge tank level and isolation of leaking cooler. Higher than normal fuel pool temperature might result while the failed cooler is isolated.
Shutdown Cooling Heat Exchangers (3)	Internal Leakage	Flow of reactor water into the RBCCW System until detected by high surge tank level. Isolation of the failed heat exchanger would extend the reactor cooldown period.

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[*] Loss of RBCCW during plant operation causes loss of drywell cooling. Entry to plant Emergency Operating Procedures may result.

Note: Internal and external leakage also gets detected by the radiation levels indicated by the RBCCW and/or Service Water process radiation monitors.

TABLE 9.2-19
(Sheet 3 of 5)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
Shutdown Pump Coolers (3)	Loss of Cooling	Reactor cooldown period will be extended.
Reactor Water Cleanup System[*]		
Non-regenerative heat exchanger	Internal Leakage	Flow of reactor water into the RBCCW System until detected by surge tank level. Results in isolation and loss of the RWCU System.
Recirculation Pump Coolers	Loss of Cooling	Reduced cleanup capacity of 50% of design value.
Auxiliary Pump Cooler	Loss of Cooling	The pump would be shutdown (if in use), at low reactor pressure the cleanup system would not be available.
Precoat Pump Cooler	Internal Leakage	Flow of filter aid into the RBCCW System. Significant degradation of heat removal capacity could lead to pump cavitation after prolonged operation.

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[*] Depending on the failure, the reactor may be operated from 12 hours to seven days without RWCU System before shutdown is required.

Note: Internal and external leakage also gets detected by the radiation levels indicated by the RBCCW and/or Service Water process radiation monitors.

TABLE 9.2-19
(Sheet 4 of 5)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
Tunnel Recirculation Fans	External Leakage	Flow of RBCCW System water into the pipe tunnel resulting in higher than desired ambient temperatures in the tunnel during operations.
Core Spray Pump Compartment Coolers (2)	External Leakage	Flow of RBCCW System water into the Reactor Building, prompting cooler isolation and increase in ambient temperatures.
Containment Spray Pump Compartment Coolers (2)	External Leakage	Same as above.
Reactor Building Equipment Drain Tank (1)	External Leakage	Flow of RBCCW System water into the tank, causing excessive cycling of the drain pump and/or high tank level alarms.
Reactor Water Recirculation Pump Coolers (5)	Loss of Cooling	Temperature instrumentation would alarm. Pump would be shutdown and reactor power level reduced.
	External Leakage	Flow of RBCCW System water into the motor lube oil causing thrust bearing failure.

Note: Internal and external leakage also gets detected by the radiation levels indicated by the RBCCW and/or Service Water process radiation monitors.

TABLE 9.2-19
(Sheet 5 of 5)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM FAILURE MODES AND EFFECTS ANALYSIS

Component	Failure Mode	Consequences
	Internal Leakage	Flow of reactor water into the RBCCW System through pump seals and bearings.
Drywell Heating and Ventilation Coolers (5)	Loss of Cooling to two or more units	Higher than normal drywell temperatures
	External Leakage	Flow of RBCCW System water into drywell.
Drywell Equipment Drain Tank	External Leakage	Flow of RBCCW System water into the tank, causing excessive cycling of the drain pump and/or high tank level alarms. Or, flow of RBCCW System water into drywell sump and higher than normal tank temperature.

Note: Internal and external leakage also gets detected by the radiation levels indicated by the RBCCW and/or Service Water process radiation monitors.

TABLE 9.2-20
(Sheet 1 of 3)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication	Instrument
RBCCW Heat Exchangers		
CCW Inlet Temperature (2)	Local	TI-43, TI-44
CCW Inlet Pressure(2)	Local	PX-71, PX-72
CCW Outlet Temperature(2)	Local/Recorder	TX-45, TX-46
CCW Outlet Pressure (2)	Local	PX-57, PX-58
CCW Discharge Header Temperature	Control Room	TE-43
RBCCW Surge Tank		
Water Level	Local	LI-36
Makeup Water Flow	Local/Recorder	FT-12-287
RBCCW PUMPS		
Suction Pressure	Local	PI-52
Suction Temperature (2)	Local	TI-541-9, T1-541-10
Discharge Pressure (2)	Local	PI-50, PI-51
Discharge Flow (2)	Local	FE-5-1, FE-5-2
Pump Trip	Remote	HS-5

TABLE 9.2-20
(Sheet 2 of 3)

REACTOR BUILDING CLOSED COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication	Instrument
RBCCW Chemical Treatment		
Tank Level	Local	LI-35 (Sight Glasss) LS-507 (Low Level)
Shutdown Cooling Heat Exchangers		
CCW Combined Outlet Temperature	Control Room	TE-45
Flow Control Valve Position	Control Room	RV-17
CCW Differential Pressure (3)	Local	dPI-57 dPI-58 dPI-541-2
Spent Fuel Pool Coolers		
CCW Outlet Temperature (3)	Local	TI-541-6 TI-541-8 TI-5-268
CCW Differential Pressure (2)	Local	dPI-541-4 dPI-541-3
Reactor Water Cleanup System Equipment		
Non-regenerative Heat Exchangers-CCW Outlet Temperature	Local	TE-188
Non-regenerative Heat Exchanger-CCW Flow	Local	dPI-506

TABLE 9.2-20
(Sheet 3 of 3)

REACTOR BUILDING CLOSED
COOLING WATER SYSTEM INSTRUMENTATION

Parameter	Indication	Instrument
RBCCW In-Line Filter		
Inlet Pressure	Local	PI-12
Outlet Pressure	Local	PI-11
Drywell Equipment		
CCW Inlet Temperature	Control Room	TE-108
Recirculation Pump Seal Cooler-CCW Outlet Flow Switches (5)	Local	FS-210-32A FS-210-32B FS-210-32C FS-210-32D FS-210-32E
Recirculation Pump Motor-CCW Outlet Temperature (5)	Control Room	TE-210-33A TE-210-33C TE-210-33E TE-210-33G TE-210-33J
Recirculation Pump Seal Cooler-CCW Outlet Temperature (5)	Control Room	TE-210-33B TE-210-33D TE-210-33F TE-210-33H TE-210-33K
Drywell CCW Outlet Temperature	Local	TE-56
Drywell Combined Differential Pressure Used as Flow Indication	Local	DPI-541-1130
RBCCW System Isolation (V-5-147, V-5-166, V-5-167)	Control Room	N/A

TABLE 9.2-21
(Sheet 1 of 1)

MAKEUP WATER QUALITY REQUIREMENTS

Parameter	Quality
pH @ 250C	5.6 - 7.5
Specific Conductance	Less than 1.0 micromho/cm at 250C
Silica	Less than 20 ppb as SiO_2
Chloride	Less than 20 ppb as C1
Total Organic Carbon	Less than 400 ppb

TABLE 9.2-23
(Sheet 1 of 1)

MOBILE MAKEUP DEMINERALIZER SYSTEM INSTRUMENTATION

Instrumentation/Controls	Indication/Objective
Conductivity Meter	Conductivity measured at effluent line from mixed bed demineralizer tank. Effluent line conductivity is alarmed locally.
Motor Controls	ON-OFF switches on local panel.
Influent Flow Indicator	Permits setting of manual rate control valve. Low flow is alarmed locally.
Flow Totalizer	One for the system. Alarms at preset total flow to indicate need for regeneration.
Differential Pressure	One across makeup demineralizer trailer. Indicator Alarm at 60 psid to indicate need for regeneration.
Cycle Controls	Normal cycle is cation - anion-anion-mixed bed. Effluent is diverted to inlet on high conductivity. Effluent valves fail closed to prevent excessive impurities in effluent.
Sampling Provisions	Sample cocks at plant effluent line.
Remote Alarm	Common MAKEUP DEMIN TROUBLE alarm on 7F alarm panel.
Makeup Panel Alarms	a. High Level in Storage Tank b. Low Level in Storage Tank

TABLE 9.2-24
(Sheet 1 of 1)

MAJOR COMPONENTS OF THE DEMINERALIZED WATER TRANSFER SYSTEM

Demineralized Water Storage Tank

Type	Vertical, dome roof
Normal Capacity	187,700 gallons
Diameter	30 feet-0 inch
Height (cylindrical portion)	35 feet-9 inch
Material	Stainless Steel
Vent	Atmospheric roof vent with filter rated 99.98% efficient at 0.3 micons, sized for 200 cfm air flow.

Demineralized Water Transfer Pumps

Number of Pumps	2
Type	Single stage, open impeller, end suction, foot mounted, vertically split case, back pull out horizontal centrifugal
Design TDH	260 feet
Design Capacity	250 gpm
NPSH Required	9.1 feet
Shutoff Head	345 feet
Motor	
Horsepower	50
Speed	3500 rpm
Power Requirements	460 volts, 3 phase; 120 volts, single phase
Power Source	MCC 1B32

TABLE 9.2-25
(Sheet 1 of 1)

TYPICAL RAW WATER QUALITY

Raw Water Constituents, ppm	
Calcium	--
Magnesium	--
Total Hardness	17.7
um and Potassium	--
Total Cations	--
ride	10
hate	7
te	0.05
rbonate	10
Total Anions	--
carbon dioxide	20
rogenion concentration	50 – 60
bidity	10 – 60
pended matter	--
anic and/or volatile solids	0.8 - 10.0
Total Solids	20 – 110
ductivity	45 – 60
nolphthalein alkalinity	0
nomethyl - Methyl orange alkalinity	8.6 - 6.0
Soluble silica anion	6 – 8
Iron (ferric)	1.5 - 2.0
Nitrates	0.05

TABLE 9.2-26
(Sheet 1 of 1)

MAJOR COMPONENTS OF THE WELL AND DOMESTIC WATER SYSTEM

Deep Well

Depth	400 feet
Casing Diameter	12 inches
Casing Material	Standard full weight carbon steel pipe, 3/8 inch wall thickness, ASTM A-53, welded.
Discharge Line Material	6 inch carbon steel pipe, full random lengths, threaded and coupled joints per USAS1 B31.1 100,000 gallons per day (limited by the state of New Jersey)

Deep Well Pumps

Number of Pumps	2
Capacity	100 gpm
Power Source	MCC 1A11

Filtered Water Pumps

Number of Pumps	3
Capacity	140 gpm
Power Supply	MCC 1A13

Pretreatment Building Sump

Type	Three Section, two are seal wells, one an overflow drain
Sludge Pumps	
Number of Pumps	2
Type	Vertical centrifugal, float actuated
Pit Depth	6 feet
Motor horsepower	1 ½

TABLE 9.2-27
(Sheet 1 of 1)

MAJOR COMPONENTS OF THE DOMESTIC WATER DISTRIBUTION SYSTEM

Domestic Water Storage Tank

Type	Horizontal, hydropneumatic with oilless compressor
Capacity	5000 gallons
Dimensions	6 feet diameter by 24 feet- 7 inches long
Design Pressure	100 psig
Operating Pressure	50-55 psig
Relief Valve Setting	55 psig

Machine Shop Hot Water Heater

Capacity in Tank	30 gallons
Number of Heaters	Two 1500 watt heating coils
Working Pressure	125 psig
Water Temperature	140°F

Office Building Hot Water Heater

Capacity in Tank	500 gallons
Supply Capacity	400 gpm minimum from 40°F to 140°F
Power Source	MCC 1A21

Maintenance Building Pressure Booster Subsystem

Tank Capacity	1500 gallons
Pump Capacity	100 gpm
Pump Discharge Pressure	40-50 psig

9.3 PROCESS AUXILIARIES

9.3.1 Service and Instrument Air System

9.3.1.1 Design Bases

The Service and Instrument Air (SIA) System has been designed to provide an air supply as follows:

a. For air operated valves and pneumatic control devices, throughout the plant.

b. For resin mixing and transport in the Condensate Demineralizer and Reactor Cleanup Demineralizer Systems.

c. For mixing of water and sodium pentaborate decahydrate in the Standby Liquid Control System (Liquid Poison System) tank.

d. For motive force in the transfer of resins from the High Purity Waste Demineralizers, Concentrator Distillate Demineralizers and the Spent Resin Tanks; and to dry the High Purity and Chemical Waste Filters.

e. For cleaning the Condensate Pre-Filters and to provide a motive force for draining these vessels.

Instrument air, called control air because of its function, must be oil free and have a low moisture content. Control air is thus filtered and dried to a dewpoint of -40°F at 100 psig. Service air is oil free, and dried.

The piping associated with this system was designed, fabricated, inspected and installed to ANSI B31.1. Aftercoolers, moisture separators and air receivers were fabricated in conformance to the requirements of ASME VIII.

9.3.1.2 System Description

The SIA System is shown in Drawing BR 2013. Major component data are listed in Table 9.3-1. The system consists of three main plant air compressors with intercoolers, three aftercoolers, three air receivers, and two duplex drying towers with prefilters and post filters for the control air line. All of this equipment is located in the Turbine Building basement.

A fourth air compressor and one aftercooler are located at the Heat Exchanger Building to supply service air to the New Radwaste Building. Two additional control air receivers are provided; one at the New Radwaste Building and the other at the Offgas Building, except the refrigerated air dyers, which are on El. 23'-6".

A fifth air compressor supplies air to the NRW Building (service air for tools only) when that portion of the air distribution network is isolated because of radioactive contamination.

Finally, a sixth air compressor provides an air supply for maintaining pressure and the hydropneumatic Domestic Water Tank. This compressor is not part of the SIA System and is not connected to it.

Service air is provided in the New Radwaste (NRW) Building as motive force in resin transfer from the High Purity Waste Demineralizers, Concentrator Distillate Demineralizers and the Spent Resin Tanks. Service air is also used in this building to dry the High Purity Waste Filters and Chemical Waste Filters. Because the service air demand in the plant may on occasion exceed the capacity of the main plant compressors, when NRW Building demand is high, a separate compressor, aftercooler and receiver have been provided to supply service air to the Radwaste Building when air supply from the main plant air compressors is reduced or insufficient.

The drywell instrument nitrogen system receives backup from instrument air. The nitrogen/air line penetrates the drywell to serve drywell equipment. The line has been designed to include containment isolation and leakage rate testing provisions, and the necessary instrumentation.

An air receiver with a capacity of 15 cubic feet is provided in the Offgas Building for instrument air. The receiver is required to reduce the effects of load demands at other plant locations. Each air operated instrument has its own pressure regulator and filter set located on local instrument racks. A similar receiver is provided for the New Radwaste Building.

Control air is used to hold the control rod scram valves in the closed position. Should air header pressure drop below a setpoint, the scram valves will open, thereby inserting the control rods and shutting down the reactor. Other station air operated valves and pneumatic control devices are also designed to fail in the position which provides greater safety. Some essential valves are provided with accumulators.

The air receivers normally have enough reserve to supply both service and instrument air while the standby compressor starts and loads. If not, the service air supply shuts down automatically upon pressure drop to 75 psig.

9.3.1.3 Safety Evaluation

The SIA System is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. The system is not safety related except for those portions associated with operation of certain valves (MSIV's, secondary containment isolation and Reactor Building to Torus Vacuum Breakers). The safety related portion of the air piping extends from the actuator of these valves to the associated isolation check valve including the piping to the air accumulator for each valve.

Three full capacity air compressors are provided, thus providing enough redundancy in the event of failure of one compressor, even when one of the three has been shutdown for maintenance. Power is supplied to air compressor No. 1-1 from Unit Substation 1A1, and power for compressors Nos. 1-2 and 1-3 is from Unit Substation 1B1, providing the system with two sources of electrical power supply. On loss of power USS 1A1 and USS 1B1 trip on undervoltage, but can be returned to service after the diesel generator units start. If diesel loads permit, the operator may start one air compressor after a loss of normal offsite and onsite power. All station air operated valves and pneumatic devices fail in the position that provides greatest safety or are supplied with a limited volume of air to permit their continued operation. This emergency supply is stored in an air accumulator. Upon low air pressure, the service air system is automatically isolated.

9.3.1.4 Testing and Inspection Requirements

No special tests and/or inspections are required for this system beyond normal checks, with the exception of those safety related portions associated with operation of certain safety related valves (MSIVs, Secondary Containment isolation and Reactor Building to Torus Vacuum Breakers). A preventive maintenance and surveillance test program has been implemented in response to NRC Generic Letter No. 80-14.. All system components are accessible so that testing operations may be performed.

9.3.1.5 Instrumentation Requirements

Instrumentation and alarms for the system are listed in Table 9.3-2.

9.3.2 Process Sampling System

9.3.2.1 Design Bases

Water quality and process sampling is provided to monitor the operation of equipment, and to supply information for making operating decisions where these are influenced by water chemistry.

The sampling system is designed to satisfy the following criteria:

a. Permit a representative sample to be taken in a form which can be used in the laboratory and which safeguards against change in the constituents to be examined.

b. Minimize the contamination and radiation at the sample point.

c. Reduce decay and sample line plateout as much as possible.

9.3.2.2 System Description

Provisions have been made to collect steam, gaseous and liquid samples throughout the facility. Table 9.3-3 lists the plant's sampling stations.

Sample tubing is 1/4 inch diameter x 0.049 inch wall thickness and 3/8 inch diameter x 0.065 inch wall thickness. Sample stream flow rates are selected to maintain turbulent flow for more accurate sampling. All liquid sample lines are provided with means for regulating sample flow and are as short and direct as possible. Piping and sample lines are routed as to avoid crud traps, dead legs and low points. The sample line takeoffs are connected at the side of the process pipe rather than the bottom.

Liquid samples are routed to sample sinks or to the Water Chemistry Monitoring System. The Water Chemistry Monitoring System includes the Reactor Water Sample Station (RWSS) and the Final Feedwater Facility (FFW). The RWSS provides sample and analysis capabilities as listed in Table 9.3-3 for Reactor Water and the Reactor Water Cleanup System. The FFW provides sample and analysis capabilities as listed in table 9.3-3 for the final Feedwater. Whenever necessary, sample coolers and valves for manual pressure reduction are provided. The RWSS, located on Reactor Building El. 75'-3", consists of a wet and a dry section to accommodate both grab sampling and in-line analysis instrumentation respectively. It is equipped with a splash guard sash and an exhaust fume hood. The FFW, located in the

Feedwater Pump Room, consists of in-line sample and analysis equipment. Grab sampling is done at both the Feedwater and Condensate Sample Sinks.

Nozzles for liquid sampling are inserted into the process stream to about one fourth of the process pipe diameter for all pipes two inches and larger in diameter. This is to avoid sampling the relatively low velocity fluid near the wall of the pipe. Pipes smaller than two inches are sampled by reducing tees or flush welded tubing.

A reactor water sample sink with a laboratory type hood and a demineralized water supply is provided for a continuous flowing reactor water cleanup filter inlet sample. The grab sample line is as short as possible. Flow meter and conductivity elements are located downstream of the grab sample since they act as crud traps, and are located away from the hood, but do not require shielding.

The liquid poison sampler has only a short nipple after the sample valve that can be easily removed and cleaned. This serves to prevent contaminating the sample with crystallization from previous samples or valve leakage.

Each primary pipe has a representation type sampling nozzle to yield samples for gas analysis, steam quality and carryover. The steam samplers are designed in accordance with ASTM D-1066-59T. "Tentative Method of Sampling Steam," and their design characteristics are as follows:

a. The samplers are located in a vertical pipe run (just before entering the turbine), with ten pipe diameters of straight pipe prior to sample location.

b. The sample condenser is located as near the sample point as practical. Downstream of the condenser, sample pipe is constructed of stainless steel.

Composite samples of condenser cooling water are taken at the plant's intake and outfall. The outfall sampler is located at such a point that good mixing is ensured for the outflow. Monitoring of the Circulating Water System is discussed in detail in Section 10.4.

A short sample line is provided at the resin transfer pipe from the resin mixing tank. In the condensate demineralizer regeneration train, the sampler is located at an elbow so that the resins do not change direction of flow when sampled.

The Process Sampling System locations for the Offgas Building are as follows:

a. Upstream of each Offgas Recombiner

b. Downstream of each Offgas Cooler/Condenser

c. Upstream of first charcoal bed in the Offgas System

d. Downstream of the first and second charcoal beds in the Offgas System

e. Downstream of the fourth (last) charcoal beds in the Offgas System

f. Downstream of the Offgas HEPA filter station

g. In the closed cooling water system downstream of each recombiner subsystem

h. In the closed cooling water system downstream of each water removal subsystem

Both tubing and valving are arranged to allow receipt of fresh, representative samples of the Augmented Offgas System. Tubing conforms to ANSI B31.1 and their materials have been selected as per ASTM A269 Type 316 SS.

A sample pump, located on the return header, provides the motive force for sampling and purging of the Augmented Offgas System sample lines. Cooling water samples are transported to the sample station by AOGCCW System pressure.

This sample station consists of a sink and hood. The sink drains into the Offgas Building floor drain sump. Gas released at the sampling station is contained by the hood and discharged into the Offgas Building ventilation system by an exhaust fan.

The offgas sample lines are equipped with valved quick disconnect fittings and manual shutoff valves. Such an arrangement prevents inadvertent releases of potentially radioactive samples, should the sample bottle be disconnected while the associated valve is left open.

In the New Radwaste Building, the following sample locations are provided:

a. Downstream of the High Purity Waste Tank drain pump

b. Downstream of the High Purity Waste Filter System

c. Downstream of each High Purity Waste Demineralizer

d. Downstream of each Chemical Waste/Floor Drain Collection Tank Drain Pump

e. Downstream of the Chemical Waste/Dewatering Filter System

f. Downstream of each Radwaste Concentrator (Concentrate)

g. Downstream of each Radwaste Concentrator (Distillate)

h. Downstream of each Concentrated Liquid Waste Tank drain pump

i. Downstream of each Concentrator Distillate Demineralizer

j. In the NRWCCW System downstream on each Concentrator Subsystem

k. In the NRWCCW System downstream of the High Purity Waste Cooling Coil

l. In the heating and process steam lines downstream of the Concentrator Drain Collection Tank

In addition, the following samples from the New Radwaste Building equipment are routed to the sample station in the Old Radwaste Building.

a. Downstream of the High Purity Waste Sample Pump

b. Downstream of the Chemical Waste Distillate Sample Pump

Samples taken in the Old Radwaste Building downstream of the High Purity Waste Pump are routed to the New Radwaste Building.

Materials have been selected in accordance with ANSI B31.1, and tubing conforms to ASTM A213 or A269, Type 316 SS and ASTM B468 (Alloy 20).

A root valve is provided for isolation at the point from which the samples are drawn. If required, the Radwaste Concentrators and Concentrated Liquid Waste Tanks may be sampled at local sample points. All other samples terminate in sample valves above a sink, and are less than 120°F in temperature. Before collecting the sample, the isolation valve is kept open for sufficient time, and the contained fluid from the sample tubing is run down, to ensure that the collected sample adequately represents the source process fluid.

A sample station consists of a stainless steel sink and a fume hood with sash, maintained under negative pressure via an exhaust fan which discharges into the New Radwaste Building ventilation system.

Purge streams of sample lines, and contents of the sample station sink, are discharged to the New Radwaste Building floor drains. Local sample collection points identified earlier are provided for infrequently sampled points in lieu of routing to the sampling station.

The Post Accident Sampling System is described in Section 11.5.

9.3.2.3 Safety Evaluation

The Process Sampling System is not required for the safe shutdown of the reactor. The reactor liquid sampling line which is routed outside containment is provided with isolation valves which are part of the Reactor Coolant Pressure Boundary (RCPB). These valves are required to operate in order to mitigate the consequences of an accident. The remainder of the system is not safety related and all tubing is nonseismic.

9.3.2.4 Testing and Inspection Requirements

The reactor liquid sampling line is tested as part of the RCPB during the primary containment leak rate tests.

No special tests and/or inspections are required for the remainder of the system beyond normal checks.

9.3.2.5 Instrumentation Requirements

Instrumentation associated with sampling equipment is discussed in Section 11.5. For the Offgas Building, switches are provided locally for the sample pump and the sample hood exhaust fan, and compound pressure/vacuum gages are provided to allow estimates of sample sizes on sample lines. For the New Radwaste Building, a switch operates the sample hood exhaust fan, and bimetallic temperature indicators are provided to measure sample temperature upstream of the collection cylinders.

9.3.3 Equipment and Floor Drainage Systems

9.3.3.1 Design Bases

Floor drains, equipment drains, roof drains and sanitary drains are provided to collect normal plant liquid effluents and route the collected water either to radwaste treatment, sewage treatment or discharge. The Equipment and Floor Drainage System has been designed to handle large volumes of fluids resulting from spills, maintenance activities, system flushing, rinsing operations and occasional decontamination work.

The sumps and drain tanks and their pumps are adequately sized to accommodate expected volumes of water in order to minimize the potential for flooding.

9.3.3.2 System Description

The Equipment and Floor Drainage System (EFDS) is shown in Drawings 3D-151-07-001, 3D-153-07-001, 3D-154-07-001, 3D-155-07-001, ED-576-07-001 and Figure 9.3-11. Major component data are presented in Table 9.3-4. The system collects water from floor drains and equipment drains from plant buildings, structures and components. The Chemical Waste System referred to in this subsection is described in Section 11.2.

9.3.3.2.1 Turbine Building Floor and Equipment Drains

Floor and equipment drains are collected in five sumps in the Turbine Building basement; then pumped to the New Radwaste Building Chemical Waste System or to the discharge canal, depending upon origin. Wastes from the regeneration systems are collected in a two compartment regeneration system waste tank. High conductivity waste is pumped to the New Radwaste Building Floor Drain Collector tank; low conductivity waste is pumped to the High Purity Waste Collector Tank.

Sump drainage is used for all floors in the Turbine Building to simplify the piping and permit positive control over discharge to the environment. Since the basement floor is at mean sea level, all drains from this floor must be pumped. Drains from controlled areas are pumped to the New Radwaste Building for treatment.

Potentially contaminated overflow lines and drains from the Condensate and Demineralized Water Storage Tanks are run below grade through a 12 inch line terminating 36 inches above the basement floor in the main condenser area. A three way valve in the valve pit next to the Condensate Storage Tank can be operated to route the floor drains from the two valve pits and the outdoor pump pad to the Turbine Building basement, if they become contaminated (normal route). The high level of the storage tanks is set well below the overflow pipe so that overflow is not expected during normal operation. If the tanks must be drained, the drain valves are partially opened so that discharge does not exceed sump pump capacity.

All drains from controlled areas and from the regeneration waste tank low conductivity compartment, are pumped to the High Purity Waste Collector Tank in the New Radwaste Building. The regeneration waste tank high conductivity compartment is processed and directed to the Floor Drain Collector Tank.

All sump pumps and waste transfer pumps are duplex, 100 percent capacity, and arranged for intermittent, alternate operation, except for the sump 1-1 pumps which are controlled manually.

9.3.3.2.2 Reactor Building Floor and Equipment Drains

Reactor Building floor drains and equipment drains are separated. Floor drains are directed into the Torus room, and then into one of two sumps in the Reactor Building basement. Check valves are located in the floor drains in the NW and SW corner rooms which allow flow from the corner rooms into the Torus room. These check valves will prevent flooding of the corner rooms from the Torus room. The penetration sleeves of Core Spray and Containment Spray pipe are adequately sealed to prevent leakage from entering the corner rooms. Air operated isolation valves are located in the 1-6 and 1-7 sumps, which close on high-high sump level. These valves isolate the sumps from the Torus room, which prevent flooding the NE and SE corner rooms. Sump 1-6 drains by gravity to sump 1-7, and duplex, 100 percent capacity sump pumps drain sump 1-7 to the New Radwaste Building Chemical Waste System. Equipment drains are collected by a ring header beneath the first floor of the Reactor Building and drained to the Reactor Building Equipment Drain Tank (RBEDT) in the southwest corner of the building, located at El. (-)6'-5". One horizontal centrifugal pump discharges the drain to the high purity waste collector tank.

The Reactor Building Equipment Drain Tank also collects water from the scram discharge headers after a scram is reset. It is vented to the stack through ventilation ducts. Floor drains from the Liquid Poison System area at El. 95'-3" are piped to the floor below and collected in drums to reduce the load on the waste demineralizer. The floor drain from the cask decontamination area at El. 119'-3" empties into the laundry drain tank.

The drain tank, drain pump, and sump pumps are part of the liquid radwaste treatment system, and are controlled from the radwaste control panel.

Each level of the Reactor Building, with the exception of El. 119' is equipped with a floor drain network capable of passing the maximum credible flow rate from an actuation of the Fire Protection System or a pipe break. Their drain headers are routed at El. 12' to the drain area within the torus compartment (outside the torus) which is isolated from the corner rooms on high sump level.

9.3.3.2.3 Drywell Floor and Equipment Drains

Floor and equipment drains are also segregated in the drywell with the floor drains collected in a sump and the equipment drains collected in the Drywell Equipment Drain Tank (DWEDT). Duplex pumps are used for the tank and two submersible pumps are used for the sump to transfer the contents to the New Radwaste Building. The tank is provided with overflow and vent lines to the sump.

Each discharge has dual isolation valves that are closed by the Reactor Protection System on high drywell pressure or low-low reactor water level. Flow through each drain line is monitored and recorded as a check on leakage. If both pumps are required to empty the sump (from a large leak) an alarm annunciates in the Control Room. Pumps are controlled from switches on the radwaste control panel and interlocked to shut down on closure of the isolation valves.

The DWEDT is cooled by an external heat exchanger located at the discharge of the drain transfer pumps. The heat exchanger is cooled by the RBCCW System. A thermal relief valve in the RBCCW System outlet line prevents overpressurization of the cooling water side of the heat exchanger when the RBCCW flow is inadvertently isolated.

9.3.3.2.4 Offgas Building Floor and Equipment Drains

Recombiner condenser condensate, moisture removal equipment condensate and floor drain waste are collected in the Offgas Building sump. A set of redundant duplex pumps are provided to transfer the contents of the Offgas Building sump to a floor drain sump at the base of the plant stack. The contents of the plant stack sump are transferred to one of the Chemical Waste/Floor Drain collector tanks.

The pipe chase in the Offgas Building is provided with a sump to collect moisture condensate from the offgas lines. A sump pump transfers the sump contents to the Offgas Building sump.

9.3.3.2.5 New Radwaste Building Floor and Equipment Drains

Maintenance drains from process components containing radioactive or potentially radioactive wastes are permanently piped to funnel type drains to prevent contamination of floor areas. Where "hard" piping is not feasible, permanent hose connections are provided, and contaminated drains are directed to a local floor drain or funnel through a drain hose.

Floor drains in tank cubicles, except SL-T-1A and SL-T-1B (the concentrated liquid waste tanks), are valved normally closed to prevent flooding a sump and surrounding floor area in the unlikely event of a catastrophic tank failure.

The entrances to valve galleries, pipe galleries and pump cubicles are curbed to prevent the spread of contamination due to inadvertent spills or leaks. Such areas are provided with floor drains to direct spills or leaks to a local sump.

9.3.3.2.6 Laundry and Laboratory Drains

Drains from the contaminated change area are drained to the laundry drain tank in the Reactor Building basement and vented to a roof stack in the Office Building. Drains from the laboratory are drained to a laboratory drain tank next to the laundry drain tank and also vented to a roof stack. The drain tanks are considered part of the radwaste system. All controls and alarms are located on the radwaste control panel.

9.3.3.2.7 Sanitary Drains and Sewage Disposal System

All sanitary drains in the Office Building and Turbine Building, and floor drains in the Office Building, are combined into a six inch line which is routed to the sewage collection tank. There is a separate four inch sanitary drain from the machine shop. The Sanitary Waste System is discussed in Subsection 9.2.4.3.

9.3.3.2.8 Torus Water Drain Piping and Storage

Draining of the torus is periodically required to facilitate maintenance, repair and modification activities. To allow the transfer of torus water to the Torus Water Storage Tank (TWST), a piping interconnection has been provided. Water is removed from the torus through a torus drain line and then directed to the TWST. The TWST has a storage capacity of approximately 750,000 gallons. The TWST contents are used to refill the torus.

9.3.3.2.9 Roof Drains and Overboard Discharge

Roof drains are collected by a series of drain pipes run beneath the roof and connected to a six inch riser serving the Reactor Building and a ten inch riser serving the Turbine Building, Office Building and Machine Shop. The risers are run inside the building line and connected below grade to the 30 inch, spiral corrugated overboard drain line to the discharge canal. The Turbine Building roof at El. 46'-6" is drained by scupper type drains and downspouts to a buried drain, which joins the main overboard drain east of the pretreatment area. The drains from the Condensate Storage tank valve pits and the Condensate Transfer pump house are routed to the Turbine Building condenser bay. The discharge of the Pretreatment building sump is routed to a pit south of the Diesel Generator building.

The main overboard discharge line starts at the seal well outside the east wall of the Reactor Building and runs below grade to the discharge canal. It also carries service water discharged from the Reactor Building Closed Cooling Water heat exchangers, emergency service water from the Containment Spray System heat exchangers, and radwaste overboard discharges.

9.3.3.3 Safety Evaluation

The EFDS is not required for the safe shutdown of the reactor nor to mitigate the consequences of postulated accidents. Reactor Building drains are sized to accommodate the maximum flow resulting from pipe rupture and/or Fire Protection system actuation. The corner rooms are isolated from each other by the use of isolation valves and check valves.

9.3.3.4 Testing and Inspection Requirements

Readings from the logic integrators are taken on each shift by operators and recorded on their tour sheets. At least once each shift, the Control Room Operator calculates the identified and unidentified leakage in the primary containment to insure that Technical Specification limits are not violated. The DWEDT and drywell sump isolation valves are tested periodically and are required to operate in order to achieve containment isolation in the event of an accident.

9.3.3.5 Instrumentation Requirements

In the Turbine and Reactor Building, the control and instrumentation scheme is identical for all sump and waste transfer pumps, except for the DWEDT and the drywell sump pumps (see Subsection 9.3.3.2.3) which include interlocks with the isolation valves and the sump 1-1 pumps which are controlled manually. Each pump of a duplex pair is controlled from a local switch so that one pump can be operated manually when the other is out of service. In the automatic mode the pumps operate alternately to assure approximately equal duty. Pumps are started and stopped by float level switches and a pressure- diaphragm high-high level switch cuts in the second pump and alarms this condition in the Control Room. Each pump has an elapsed time meter for maintenance scheduling.

As previously noted, the isolation valves for sumps 1-6 and 1-7 close on high-high level to prevent flooding of the corner rooms.

The logic integrators which provide pump running times are located in:

a. The Turbine Building basement for sumps 1-1 through 1-5.

b. The 480 volt Switchgear Room for the RBEDT, the DWEDT, Reactor Building Sump 1-7, and Drywell Sump 1-8.

In the drain systems of the Offgas and New Radwaste Buildings pumps are controlled by a four position switch. The START position runs a pump regardless of water level in the sump. The AUTO position runs a pump when sump water level exceeds the high level setpoint. The STANDBY position runs the standby pump when water level exceeds a high-high level setpoint. The STOP position stops a pump from running.

In the Offgas Building, sump high-high level is alarmed on the AOG System control cabinet. This alarm is connected to a common alarm in the Control Room.

In the New Radwaste Building, high-high level in any sump is alarmed on the building's control cabinet. This alarm is connected to a common alarm in the Control Room.

Instruments required for normal operation of the drainage system in the New Radwaste Building are listed in Table 9.3-5. All instruments are local.

9.3.4 Chemical and Volume Control System

Not Applicable to BWRs.

9.3.5 Standby Liquid Control System (Liquid Poison System)

9.3.5.1 Design Bases

The Standby Liquid Control (or Liquid Poison) System (SLCS) is designed to bring the reactor to a shutdown condition at any time in core life independent of control rod capabilities. The most severe requirement for which the system is designed is shutdown from a full power operating condition assuming complete failure of the Control Rod Drive System to respond to a scram signal.

The rate of reactivity compensation provided by the SLCS is designed to exceed the rate of reactivity gain associated with reactor cooldown from the full power condition. The system is not provided as a backup for reactor trip functions, since most transient conditions that require reactor trip occur too rapidly to be controlled by the SLCS.

The Standby Liquid Control System meets the following safety design bases:

a. Backup capability for reactivity control is provided, independent of normal reactivity control provisions in the reactor, to be able to shut down the reactor if the normal control system ever becomes inoperative.

b. Sufficient 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, thereby ensuring complete shutdown capability from the most reactive condition, at any time in core life.

c. The time required for actuation and effectiveness of this backup control is consistent with the reactivity rate of change predicted between rated operating and cold shutdown conditions. A fast scram of the reactor or operational control or fast reactivity transients is not specified to be accomplished by this system.

d. Means are 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 systems.

e. The neutron absorber is dispersed within the reactor core in sufficient quantity to provide a reasonable margin for leakage or imperfect mixing.

f. The system is reliable to a degree consistent with its safety function; the possibility of unintentional or accidental shutdown of the reactor by this system is minimized by design.

The system is actuated only by remote manual action from the Control Room. All portions of the system were designed for earthquake loads of 0.3g horizontal and 0.1g vertical (see Section 3.7).

9.3.5.2 System Description

The SLCS is presented in Drawing GE148F723, major component data are listed in Table 9.3-6. The system consists of an atmospheric pressure tank for low temperature sodium pentaborate solution storage, two full capacity high pressure positive displacement pumps, two accumulators, two explosive actuated shear plug valves, a test tank, a poison sparger ring (in the reactor pressure vessel), and associated piping and valves. All components outside of the drywell are located on El. 95' of the Reactor Building.

The liquid poison tank is an atmospheric pressure storage tank with a nominal storage capacity of 4100 gallons. This capacity does not consider the air space above the liquid, nor the dead storage below the suction line. The solution is a combination of water and dry sodium pentaborate decahydrate. The solution is nominally at 16% boron by weight, with a 36% B-10 atom %. Since these materials dissolve slowly and can crystallize out of solution at low temperatures, there are tank heaters and pipe heaters to maintain the solution at temperatures between the low temperature limits contained in plant Technical Specifications and the suction piping and tank design temperature of 150°F. The tank is complete with a top cover, vent and drain. The pump suction line is arranged and constructed to minimize entry of particulate material which might settle to the tank's bottom.

The sodium pentaborate solution is delivered to the reactor by one of two full capacity 30 gpm, 1500 psig, positive displacement stainless steel pumps. The suction lines are heat traced from the tank to the pump casing, as are all branches to the first isolation valve, to prevent crystallization of the boron solution.

Accumulators are installed in each pump discharge line to absorb pressure pulsations from the positive displacement pumps. These are nitrogen bladder type accumulators with approximately 2 1/2 gallon capacity.

A relief valve at the discharge side of each relieves overpressure conditions back to the storage tank. Each valve is sized to relieve 30 gpm at 1400 psig with a maximum backpressure of 30 psig at the valve.

Each of the two explosive valves (see Figure 9.3-13) is a double-squib-actuated shear plug. When either squib is fired a shear plug is forced across a welded cap allowing flow through the valve. The shear plug insert is replaceable and removable spool pieces are installed upstream of each valve body to facilitate servicing. Each valve is designed for the full 30 gpm flow.

Two firing squibs are installed in each valve for redundancy. A low current is passed through each one of these primers to indicate firing readiness by checking electrical circuit continuity. The approximate firing current is 2 amperes, and valve operating time is two milliseconds.

Each explosive valve is closed by a plug in the inlet chamber. The plug is circumscribed with a deep groove so the end readily shears 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 that it does 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 is either circuit opens. Indicator lights show which primary circuit opened.

There is additional piping and valving to provide for testing of this system. A test tank is provided to functionally test the SLCS pumps for their readiness. There are provisions for recirculating the poison solution to assure the readiness of the poison tank and pump suction. The test tank, filled with demineralized water, provides a means to test the poison injection valves and the reactor vessel poison injection sparger without injection of the boron solution.

The piping for the system is sloped to permit poison solutions to be drained to removable drums, and demineralized water connections are provided. The poison solution will not normally be in any portion of the system, except in the storage tank and its immediate piping, thus precluding the need for heating the pumps and discharge lines.

One three position switch is located in the Control Room for actuation of the liquid poison system. The center position is "off." Turning the switch either to the left or the right will fire one explosive valve and start the corresponding pump.

The SLCS is manually initiated from the Control Room to pump the boron neutron absorber solution into the reactor, if shutdown cannot be accomplished or sustained using the control rods. The system is required only to shutdown the reactor at a steady rate within the capacity of the Shutdown Cooling System and to keep the reactor from going critical again as it cools.

Actuation of the system is by means of a keylock switch in the Control Room. This ensures that switching on the system is a deliberate act.

Switching to either side starts an injection pump, and opens one explosive valve. A flow sensor in the injection line will then trip the Reactor Water Cleanup System demineralizers to prevent loss or dilution of the boron.

A red light in the Control Room indicates that power is available to the pump motor contactor and that this contactor is closed (pump running).

An alarm through the keylock switch indicates that liquid is flowing. If the pump lights or explosive valve light indicate that the liquid may not be flowing, the operator can immediately turn the switch to the other side, which actuates the alternate pump. Cross piping and check valves ensure a flow path through either pump and either explosive valve. The chosen pump starts even though its local switch at the pump is in the stop position for test or maintenance. Flow from each pump is at 30 gpm. 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 ensure opening when needed and ensure that boron does not leak into the reactor when the pumps are being tested.

The liquid is piped through stainless steel piping into the reactor vessel and discharged near the bottom of the core shroud so that it mixes with the cooling water rising through the core. The boron absorbs thermal neutrons, and thereby terminates the nuclear fission chain reaction in the fuel.

The specified neutron absorber solution is boron-10 enriched sodium pentaborate. It is prepared by dissolving dry sodium pentaborate decahydrate in demineralized water. An air sparger is provided in the boron solution tank for mixing. To prevent system plugging, the suction piping nozzle for the pumps is approximately four inches above the bottom of the tank.

The reactor vessel poison injection sparger ring has ten equally spaced 1/4 inch diameter holes to provide for distribution of the solution. With this design, and the precautions taken to maintain a clean liquid system, the sparger inside the reactor pressure vessel will not clog.

Normally, uniform dispersion of the boron in the reactor water is dependent upon forced recirculation. Therefore, at least one of the Reactor Recirculation pumps or one of the Shutdown Cooling System pumps should be in operation as the liquid poison is injected. There will be flow of the boron up into the reactor, even without pumps, due to the natural circulation resulting from generated heat in the reactor.

If the Liquid Poison System is actuated during refueling, when the refueling pool is flooded, the reactivity worth of the system is reduced due to the greater water volume. However, assuming that the gate between the refueling pool immediately above the reactor vessel and the spent fuel storage pool is closed before any significant amount of poison has diffused into the storage pool, there will still be adequate shutdown capability. The SLCS is not intended to be used as a reactivity control device for the spent fuel storage pool.

Modes of Operation

a. The normal status of the system is on standby service, where the valves are unfired and the pumps are off with the poison solution in the storage tank only.

b. When the system is actuated by the Control Room switch, a pump should have a running indication, its corresponding valves should have a fired indication, and there should be a flow indication annunciator signal. The Reactor Water Cleanup System automatically isolates at this time. The poison system can continue running until the entire solution from the storage tank has been injected. No low level pump shutoff is provided because the pump can be operated for some time at no flow without damage to the pump.

c. Poison solution can be recycled from the poison tank through the pump and back to the poison tank. This operation will test the poison pump operation and poison flow within the poison loop.

d. Demineralized water can be cycled from the test tank through the pumps and piping and back to the test tank. This operation can be utilized to check pump operation. This cycle should also be initiated to clear the poison solution precipitate from the piping, if necessary. The test tank can then be drained to removable drums for disposal. Pump testing should be performed on a routine basis.

e. The poison injection system can be tested during plant outages by isolating the poison storage tank and actuating the system to inject demineralized water from the test tank into the reactor vessel.

9.3.5.3 Safety Evaluation

The SLCS is a highly reliable system which is not used for normal unit operation.

In the remote event of a scram system failure, sufficient liquid poison must be injected into the reactor coolant to reduce power from rated to cold shutdown level. To bring the reactor from full power to cold shutdown, sufficient liquid control must be inserted to give a negative reactivity worth equal to the combined effects of rated coolant voids, fuel Doppler, xenon, samarium and temperature change plus shutdown margin. To ensure shutdown margin requirements are met, a design margin of 1.0% $\Delta k_{\text{effective}}$ is included to account for uncertainties in the design calculation. This requires a minimum 35 atomic % Boron-10 concentration of 110 ppm in the reactor and with a 25% safety margin results in an average Boron-10 concentration in the reactor of 138 ppm. The SLCS injection rate is limited to ensure that the boron concentration will always be increasing during the injection phase to prevent power oscillations. This is applicable only during the period when the SLCS is being used to bring the reactor to hot shutdown from steady state operating conditions. With the original design basis, this requirement is fulfilled by limiting the solution concentration and injection time such that the amount of boron required to achieve cold shutdown plus the 25% margin is injected in no less than 60 minutes and not more than 120 minutes. A lower solution concentration can be used if injection of the B-10 solution is within 120 minutes. For an injection interval of 120 minutes, shutdown of the reactor can be fulfilled by the injection of 3600 gallons pf 5 wt% solution of a minimum 35 atomic % B-10.

However, based on General Electric Company's (GE) reanalysis, the limiting condition for this requirement is redefined as injecting 20% of the total boron solution required to reach hot shutdown conditions in the time required for one complete pass through the core and recirculation system (recirculation transient time) of a slug of water at natural circulation operating conditions. GE defines the hot shutdown concentration as 355 ppm natural boron (65.1 ppm Boron-10) and the recirculation transient time as 72 seconds. This results in a maximum injection rate of 59.2 ppm natural boron/minute (10.85 Boron-10/minute).

The system is capable of satisfying the requirements of the SLCS generic design basis as well as the requirement for the reduction of risks from an anticipated transient without scram (ATWS) as specified in 10CFR50.62 (C)(4). The ATWS rule requires that the SLCS' minimum flow capacity and boron content be equivalent in control capacity to 86 gallons per minute (gpm) of 13 weight percent (wt.%) sodium pentaborate solution. The ATWS rule is applicable only until the reactor is brought to hot shutdown. To comply with the required equivalent control capacity, the new solution has a minimum of 15 wt.% sodium pentaborate and maximum of 19.6% with a minimum of 35 atom % Boron-10. A minimum of 776 gallons of the above 19.6 wt.% solution are required to achieve the cold shutdown concentration of 138 ppm B-10. At a 30 gpm pump flow rate, the B-10 injection rate is 7.7 ppm B-10 per minute and the injection time is 26 minutes. Similarly at 15 wt.% solution concentration, 1035 gallons are required resulting in an injection rate of 5.8 ppm B-10/minute and an injection time of 35 minutes. This does not exceed the design basis maximum injection rate of 10.85 ppm B-10 per minute. Therefore, the current acceptable injection interval to meet the original SLCS design basis and the ATWS rule is between 26 and 120 minutes. To meet both the ATWS rule hot shutdown requirement and the original design basis for achieving cold shutdown, a maximum concentration of 19.6 wt% B-10 or minimum concentration of 15 wt% B-10 is required.

The solution volume during normal operation is expected to be a minimum of 1308 gallons. The tank volume requirements include consideration for 137 gallons of solution which is contained below the point where the pump takes suction from the tank, and therefore, cannot be inserted into the reactor.

Cooldown of the Reactor Coolant System requires a minimum of several hours to remove the thermal energy stored in the reactor, and to remove the radioactive decay heat. The controlled limit for the reactor vessel cooldown is 100°F per hr; normal operating temperature is approximately 550°F. Usually, using the main condenser and various cooling systems to shut down the plant requires 10 to 24 hrs before the reactor vessel is opened and much longer to reach room temperature (70°F); this is the condition of maximum reactivity and, therefore, the condition that requires the maximum concentration of boron.

In order to prevent the precipitation of the solute while in storage, the solution is maintained at least 5°F above the saturation temperature. To compensate for evaporation, which could lead to precipitation, the tank is oversized, thus allowing excess water to be added to the solution as a safety margin against evaporation losses.

The system must be operable in all operating modes, except shutdown, as established in the Technical Specification.

The quantity of sodium pentaborate solution at the minimum storage tank level, and at the solution saturation temperature, has a 25 percent margin over the required minimum amount. Tank level and temperature annunciators alert the operator of abnormal conditions. The tank heater is controlled, protected, and annunciated. Routine analyses of boron concentration are performed.

The system material selection, and the pressure and temperature design bases for equipment provide abundant margins for reliability. The tank outlet- strainer and the line flushing arrangements prevent clogging of the system flow. Positive displacement pumps and the very reliable explosive injection valves assure flow in the proper quantity. The pumps are protected from overpressure by relief valves and their accumulators prevent system damage from reciprocating pulsations. A flow switch gives a positive indication of liquid poison flow to the reactor.

The test tank provides a routine means to functionally test the system pumps for their readiness. There are provisions for recirculating the poison solution to assure the readiness of the poison tank and the pump suction. The test tank, with demineralized water, provides a means to functionally test the poison injection valves and the reactor vessel sparger without injecting boron solution.

The Liquid Poison System has redundancy in two full capacity poison pumps and in two full capacity poison injection valves, with common piping connections between the pumps and valves so that either valve may be used with either pump. The valve firing squibs have redundancy in two squibs per valve, either of which will open the valve. All squibs have a continuous monitoring system with annunciation to assure circuit continuity. There are no motor operated valves in the system. Manually operated valves in the system are locked in their proper position during reactor operation, and the valve located in the drywell is provided with position indication for surveillance.

The pump motors are drip-proof with built-in heaters to prevent condensation shorting. The pumps loads are distributed on two station auxiliary buses, either of which may be connected to the Emergency Diesel Generators. The pump motors are designed for starting and operating with reduced voltage and abnormal line frequency without damage.

The injection valves and squib monitoring circuits are energized from the highly reliable dc power system.

9.3.5.4 Testing and Inspection Requirements

The system has been designed to permit periodic testing, maintenance and operation of the injection pumps and appropriate valves. The pumps and valves are tested periodically to assure operability. The explosive valves (squibs) are purchased in lots with samples tested prior to installation. The lots are purchased such that the valve's primer and trigger mechanism 5-year service shelf life can accommodate a 24-month testing interval. All valves are replaced following testing with no valve left in service for a period exceeding five years including shelf-life.

Overall system performance is determined by isolating the poison tank, and draining, flushing and testing the system using demineralized water. Concentration by weight of the solution is determined monthly by chemical analysis. The contents of the SLC tank shall be analyzed for B-10 concentration at the beginning of each operating cycle. The quantity and temperature of the solution is monitored and annunciated in the Control Room, readings are taken on a daily basis. Pump operation is tested in accordance with the Inservice Testing Program.

The sodium pentaborate solution shall be sampled for B-10 isotopic analysis once per operating cycle. A 30 day time period is allowed for receiving the test results back which determine the B-10 enrichment of the sodium pentaborate. Once the enrichment is determined, an evaluation shall be made to assure that both the original design requirement and the ATWS requirement are met. If the original design requirement is not met (inadequate total amount of B-10 to achieve cold shutdown), proceed to the existing Technical Specification operability requirement. If the ATWS Rule is not met, a period of 7 days is allowed to bring the Boron enrichment into compliance. If at the end of the 7 day period compliance cannot be assured, then within 7 days, the NRC shall be notified and plans to bring the material into compliance with the ATWS Rule shall be submitted to the NRC.

The inspection of the reactor vessel poison injection sparger is by remote visual inspection of selected sections on a 10 year cycle. The continuity of the squib primers is constantly monitored.

9.3.5.5 Instrumentation Requirements

One three position rotary switch is provided on the console in the Control Room for SLCS actuation. This switch has center position OFF; counterclockwise position SYSTEM I and clockwise position SYSTEM II. Rotating this switch fires one explosive valve and starts one pump. Returning the switch to the OFF position stops the pump, but the valve remains open. Rotating the switch in the opposite direction fires the other explosive valve and starts the other pump. There are local switches at the pumps for test starting the pumps.

The pump motor starters are interlocked to prevent simultaneous operation of both pumps. This prevents too rapid an injection rate.

The flow switch at the injection valve discharge is a positive indication of poison solution flow to the reactor. This flow switch interlocks to the Reactor Water Cleanup System by closing the motor operated valves and tripping the pumps; thus boron cleanup is interrupted.

Several alarms monitor this system and provide the Control Room with information concerning its status. High and low temperature alarms are provided on the tank as well as high and low level alarms. A direct indication flow meter is provided in the liquid poison pump test circuit. Instrumentation, controls and alarms are presented in Table 9.3-7.

TABLE 9.3-1
(Sheet 1 of 2)

MAJOR COMPONENTS OF THE SERVICE AND INSTRUMENT AIR SYSTEM

Main Plant Air Compressors

Quantity	3
Type	1 - Two stage, double acting, heavy duty, water cooled, non lubricated 2 – Two Stage Rotary Screw
Intake Pressure	Atmospheric
Intake Temperature	Ambient
Discharge Pressure	115 psig
Actual Delivery referred to intake conditions	771 cfm Compressor 1-3 690 cfm Compressors 1-1 & 1-2
Motor Horsepower	150
Power Requirements	460 volts, 3 phase; 120 volts, single phase
Power Source	1-1: USS 1A1;1-2 and 1-3: USS 1B1

Air Receivers

Quantity	3
Maximum Working Pressure	115 psig

TABLE 9.3-1
(Sheet 2 of 2)

MAJOR COMPONENTS OF THE SERVICE AND INSTRUMENT AIR SYSTEM

Air Dryer A/B and C/D

Type	Duplex drying towers with electrical regeneration
Capacity	800 scfm
Design Temperature	100 degree F
Design Pressure	150 psig
Operating Cycle	8 hours minimum, otherwise on demand
Purge Flow to Off Service Dryer	17.5 scfm

TABLE 9.3-2
(Sheet 1 of 2)

SERVICE AND INSTRUMENT AIR SYSTEM INSTRUMENTATION

	Compressor Tag Number		
A. Compressor	1-1	1-2	1-3
1. Air Outlet Temperature Indication	X	X	X
2. High Outlet Temperature Sensor Alarm @300°F			X
3. High Outlet Temperature Sensor Shutoff @320°F			X
4. Air Outlet Pressure Indication	X	X	
5. Low Oil Pressure Sensor Alarm			X
6. Low Oil Pressure Sensor Shutoff	X	X	X
B. Compressors 1-1 & 1-2			
Alarms & Trips inlet air filter change, oil filter change, sensor failure, inlet restriction, high inter stage pressure, high second stage pressure, high line air pressure, low bearing oil pressure, high first stage temperature, high intercooler temperature, high second stage temperature, high bearing oil temperature, starter fault, main and fan motor overload and emergency stop.			
C. Air Receiver Pressure			
7. Air Pressure Indication	X	X	X
8. Low Pressure Sensor Alarm	X	X	X
9. Low Pressure Sensor Auto Start as Backup Unit at 90 psig			X
10. Pressure Sensor for Operating Compressor Loads @ 101-psig and Unloads @115 psig			X
11. Pressure Sensor for Backup Compressor Loads @ 85 psig and Unloads @ 105 psig			X
D. Aftercooler/Moisture Separator Outlet Air Temperature	X	X	X

TABLE 9.3-2
(Sheet 2 of 2)

SERVICE AND INSTRUMENT AIR SYSTEM INSTRUMENTATION

Instruments	Alarms On
Air Manifold	
Air Manifold Pressure	
Pressure Transmitter	-
Pressure Sensor (isolates Service Air Branch)	Low Pressure
Air Dryer Assembly	
Temperature Indicator (one each for towers A,B,C,D)	-
Pressure Gage (one each for towers A,B,C,D)	-
Valve Off Position Indicator	Dryer Failure
Dew Point Monitor (Local Indication)	-
CRD Hydraulic System	
Air Pressure Gage	-
Air Low Pressure Alarm Sensor	Low Pressure
Liquid Poison Tank	
Air Pressure Gage	-
Drywell Control Air Header	
Isolation Valve Position Indicator	Not Open
Isolation Valve Logic Indicator	Bypassed

TABLE 9.3-3
(Sheet 1 of 5)

SAMPLING STATIONS

Sample	Location	Purpose	Notes*
Reactor Water	Recirculation Pipe (Loop A and B)	Monitor reactor water. Loop A is sampled when cleanup Loop B is isolated	Loop A sample line penetrates containment, S.C., RWSS, Cont C.E. and D.O., Grab, metals
REACTOR WATER CLEANUP SYSTEM			
Filter influent	Filter inlet pipe	Monitor reactor water quality	
Filter effluent	Filter outlet pipe	Filter efficiency	
Demineralizer effluent	Pump discharge pipe	Demineralizer efficiency	
WSSS			
Core spray system sample	Carbon steel piping section	Water quality	
Steam samples	Primary steamline	1) Carryover 2) Steam quality 3) H_2 & O_2	
Pressure suppression pool	Containment spray line	Monitor corrosion and activity	
Liquid poison tank	Access cover – top of Poison Storage Tank	Borate concentration	

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* See Sheet 5 of 5

TABLE 9.3-3
(Sheet 2 of 5)

SAMPLING STATIONS

Sample	Location	Purpose	Notes*
CONDENSATE SYSTEM			
Condensate demineralizer influent	Condensate pump discharge	Condensate quality and condenser tube leaks	Grab, metals
Condensate demineralizer effluent	Demineralizer outlet pipe	Treated condensate quality	Grab, metals
Condensate Pre-Filter influent	Common Condensate Pre-Filter Inlet pipe	Monitor Pre-Filter Performance	Grab
Condensate Pre-Filter effluent	Outlet of each Condensate Pre-Filter	Monitor Pre-Filter Performance	Grab
FEEDWATER SYSTEM			
Feedwater heater	Heater outlet pipe at point of material change	Corrosion studies	Grab, S.C.
Feedwater	After last heater	Corrosion studies	S.C., FFW, Cont C.E. and D.O., Grab, metals
Extraction	Drain pump discharge	Corrosion studies	Grab
CLOSED COOLING WATER SYSTEMS			
Closed cooling water system	Outlet of each major heat exchanger	Determine location of heat exchanger leaks	

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* See Sheet 5 of 5

TABLE 9.3-3
(Sheet 3 of 5)

SAMPLING STATIONS

Sample	Location	Purpose	Notes*
Cooling water sample	Pump discharge	Check corrosion inhibitor concentration	
CIRCULATING WATER			
Influent	Inlet to closed cooling water heat exchanger	Determine background	Composite sample
Effluent	Discharge structure	Monitor plant activity release	Composite sample
WASTE DISPOSAL SYSTEM - LIQUID			
Waste surge tank	**	**	**
Waste collector tank	Pump discharge	Process data	Grab
Floor drain collector tank	Pump discharge	Process data	Grab
Waste neutralizer	Pump discharge	Process data	Grab
Waste sample tank	Pump discharge	Discharge suitability	Grab
Floor drain sample tank	Pump discharge	Discharge suitability	Grab
Fuel pool filter influent	Inlet pipe	Fuel pool quality	Grab

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* See Sheet 5 of 5

** Waste Surge Tank has been removed from Service

TABLE 9.3-3
(Sheet 4 of 5)

SAMPLING STATIONS

Sample	Location	Purpose	Notes*
Fuel pool filter effluent	Outlet pipes	Filter efficiency	Grab
Radwaste filters effluent	Outlet pipes	Filter efficiency	Grab
Waste demineralizer	Outlet pipe	Demineralizer efficiency	Grab
Concentrator heating steam	Condensate pipe	Determine tube leaks	Grab
OFF-GAS SYSTEM			
Air ejector sample	After air ejectors	1) Activity release 2) H_2O_2 and air leakage	Coat, RE, Grab Grab
Offgas filter samples	Inlet and outlet	Determine filter efficiency	Grab
tack sample	Stack	Particulate and iodine release	Cont, RE Particulate and iodine filter
MAKEUP SYSTEM			
Cation effluent	Outlet pipe	Demineralizer efficiency	Grab

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* See Sheet 5 of 5

TABLE 9.3-3
(Sheet 5 of 5)

SAMPLING STATIONS

Sample	Location	Purpose	Notes*
Degassifier Outlet	Outlet Pipe	Process Data	Grab
Anion effluent	Outlet pipe	Demineralizer efficiency	Grab
Mixed bed effluent	Outlet pipe	Demineralizer efficiency	Grab
Demineralized water storage tank	Pump discharge	Water quality	Grab
Condensate storage tank	Pump discharge	Water quality	Grab
SPECIAL SAMPLES			
Laundry drain tank	Pump discharge	Discharge suitability	Grab
Concentrator liquor	Outlet pipe	Test concentrator	Grab
Resin sample	Resin transfer line	Test resin mixing	Grab
Ventilation	Fan discharge	Activity release	Grab

*C.E. = Sample line conductivity element
RE = Radiation element on sample line
Cont = Continuous flowing sample
Grab = Grab sample
S.C. = Sample cooler
RWSS = Samples and analyses at Reactor Water Sample Station (RB EL.75'-3")
D.O. = In-line dissolved oxygen analysis
metals = metals grab sampler
FFW = Samples and analyses at Final Feedwater Facility (TB EL. 3'-6")

TABLE 9.3-4
(Sheet 1 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Turbine Building Sump No. 1-1

Location	NW corner of Turbine Building - El. 0'-0"
Capacity	200 gallons
Areas Drained	Turbine Oil Purification Equipment Area - El. 0'-0"
	Corridor, Northwest Section of Building - El. 27'-0"
Alarm	Turbine Building Sump 1-1 High Level

Turbine Building Sump No. 1-2

Location	NE corner of drain tank pit at condenser bay - El. (-)8'-0"
Capacity	200 gallons
Area Drained	Drain Tank Pit in Condenser Bay - El. (-) 8'-0"
Alarm	Turbine Building sump 1-2 High Level;Bubbler Panel, Loss of Instrument Air

Turbine Building Sump No. 1-3

Location	NW corner of condensate pump pit - El. 0'-0"
Capacity	1500 gallons
Areas Drained	Condenser Bay - El. 0'-0"
	Heater Bay at El. 23'-6"
	Feedwater and Condensate Pump Area at El. 3'-6" and 0'-0" Respectively
	Demineralizer and Condensate Storage Tanks
	Drains from Turbine Building Sump No.1-1.
Alarm	Turbine Building Sump 1-3 High Level

TABLE 9.3-4
(Sheet 2 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Turbine Building Sump No. 1-4

Location	SW corner of regeneration waste transfer pump room - El. 0'-0"
Capacity	800 gallons
Areas Drained	Mechanical Vacuum Pump Room at El. 3'-6" SJAE and Steam Packing Exhauster Room at El. 3'-6" Regeneration Waste Transfer Pump Room at El. 0'-0" Demineralizer Tanks Room at El. 23'-6" Demineralizer Control Panel and Regeneration Tank Rooms at El. 23'-6"

Turbine Building Sump No. 1-5

Location	SW corner of Turbine Building - El 3'-6"
Capacity	430 gallons
Areas Drained	Floor drains – Turbine Building basement
Alarm	Turbine Building Sump 1-5 High Level

High Conductivity Tank

Location	South side of the regeneration waste transfer pump room
Capacity	900 gallons
Areas Drained	Demineralizer Control Panel and Regeneration Tank Rooms at El. 23'-6"
Alarm	High Conductivity Tank High Level

Low Conductivity Tank

Location	South side of the regeneration waste transfer pump room
Capacity	900 gallons

TABLE 9.3-4
(Sheet 3 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Low Conductivity Tank (Continued)

Areas Drained	Regeneration tanks - if conductivity is 50 micromhos
Alarms	Low Conductivity Tank High Level;Low Conductivity Tank Valve Closed

Sump No. 1-1 Pumps

Quantity	2
Type	Vertical sump pump
Power Sources	MCC 1A12, MCC 1B12 (460 volts, 3 phase)
Controls	Local at sump
Discharge	To 1-3 sump

Sump No. 1-2 Pumps

Quantity	2
Type	Submersible sump pump
Power Sources	MCC 1A12, MCC 1B12 (460 volts, 3 phase)
Controls	Located in Feedpump Room
Discharge	To Chemical Waste System

Sump No. 1-3 Pumps

Quantity	2
Type	Submersible sump pump
Power Sources	MCC 1A11, MCC 1B11 (460 volts, 3-phase)
Controls	Local sump
Discharge	To Chemical Waste System

TABLE 9.3-4
(Sheet 4 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Sump No. 1-4 Pumps

Quantity	2
Type	Submersible sump pump
Power Sources	MCC 1A11, MCC 1B11 (460 volts, 3-phase)
Controls	Local at sump
Discharge	To Chemical Waste System

Sump No. 1-5 Pumps

Quantity	2
Type	Vertical Sump Pump
Power Sources	MCC 1A11, MCC 1B11, (460 volts, 3 phase)
Controls	Local at sump
Discharge	High Conductivity Tank, sampled for radioactivity prior to overboard discharge.

Low Conductivity Tank Waste Transfer Pumps

Quantity	2
Type	End suction, center line discharge, open impeller, centrifugal
Power Sources	MCC 1A11, MCC 1B11 (460 volts, 3 phase)
Controls	Local at tank
Discharge	To High Purity Waste System

TABLE 9.3-4
(Sheet 5 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

High Conductivity Tank Waste Transfer Pumps

Quantity	2
Type	End suction, center line discharge, open impeller, centrifugal
Power Source	MCC 1A11, MCC 1B11 (460 volts, 3 phase)
Controls	Local at tank
Discharge	To High Purity Waste System

Reactor Building Sump No. 1-7*

Location	SE corner of Reactor Building - El. (-)19'-6"
Capacity	700 gallons
Areas Drained	Control Rod Drive Module Area at El. 23'-6" Shutdown Heat Exchanger and Pump Rooms at El. 51'-3" and El. 38'-0" Core Spray Booster Pump Area & Adjacent Corridor at El. 51'-3" CRD Repair and Storage Room at El. 51'-3" North End of Reactor Building at El. 75'-3" North End of Reactor Building at El. 95'-3"

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* This sump receives the discharge from sump 1-6. It therefore receives all the floor drains in the Reactor Building and all equipment drains not directed to the Reactor Building Equipment Drain Tank. Areas draining to this sump are labeled with the letter A or B. Those areas with the letter "A" drain to sump 1-6 before draining by gravity to sump 1-7. Those areas with the letter "B" go directly to the sump 1-7.

TABLE 9.3-4
(Sheet 6 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Reactor Building Sump No. 1-7 (Continued)

	Control Rod Drive Module Area - South Area of El. 23'-6"
	Clean-Up System Area at El. 51-3"
	Equipment Hatch and Closed Cooling Water Heat Exchanger Area at El. 51'-3"
	Cleanup Filters, Demineralizers, and Precoat Mixing Area at El. 75'-3"
	Floor Near Equipment Hatch and Contaminated Machine Shop at El. 75'-3"
	South Section of Reactor Building at El. 95'-3"
Alarms	Sump high level
Pumps	Local control, supplied from MCC 1A21, MCC 1B21 (480 volt), discharging to the NRW Floor Drain Header Vertical, 100 gpm @ 95 feet TDH Submersible, 100 gpm @ 105 feet TDH
Instrumentation	High-high level, isolates to prevent flooding of corner rooms

Reactor Building Equipment Drain Tank

Location	SW corner of Reactor Building - El. (-)6'-5"
Capacity	5000 gallons

TABLE 9.3-4
(Sheet 7 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Reactor Building Equipment Drain Tank (Continued)

Areas Drained	(1) Reactor Building El. 23'-6" (2) Reactor Building El. 51'-3" (3) Reactor Building El. 75'-3" (4) Reactor Building El. 95'-3" (5) Reactor Building El. 119'-3"
Alarm	Tank high level
Pump	Local controls, supplied from MC-1B21 (480 volt), discharging to High Purity System in NRW

Drywell Equipment Drain Tank

Location	East side of drywell, between Recirc. Pumps A and E at El. 10'-3"
Capacity	374 gallons
Areas Drained	1. Recirc. Pump Seals 2. Head Vent (when shutdown) 3. Recirc. Suction and discharge valve stem leakoff 4. Refueling bellows seal assembly 5. Main Steam drain line 6. Recirculation Pump Casing drain lines 7. RPV Flange seal drain line 8. DWEDT Heat Exchanger Relief Valve, V-5-463, drain line 9. Spent Fuel Pool Cooling drain line (V-18-44)
Alarms	(1) "Drywell Equipment Drain Tank Hi Level." (2) "Drywell Equipment Drain Tank High Temperature." (3) "Drywell Equipment Drain Tank Both Pumps Running."

TABLE 9.3-4
(Sheet 8 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Drywell Equipment Drain Tank (Continued)

Pumps Control	Local alternator	
Power Supply	MCC 1A21, 1B21, 480V Swgr Room	
Discharge	to High Purity Radwaste System	
Tank Vent	to Drywell Atmosphere	
DWEDT Heat Exchanger		
Side	Hot/Process Side	Cold/Cooling Water Side
Flow	25,000 lb/hr	35,000 lb/hr
Inlet Temperature	170°F	100°F
Outlet Temperature	140°F	121°F
Fluid	Water	RBCCW
Allowable Pressure Drop	60 psi	8.4 psi
Design Heat Duty	750,000 Btu/hr	750,000 Btu/hr
Overall Cleanliness Factor	80 percent (25 percent excess surface)	
Materials	Plates - Type 304 SS, Covers - Carbon Steel	
Design Pressure	150 psig 150 psig	
Design Temperature	300°F 300°F	
Code	ASME VIII	

Drywell Sump No. 1-8

Location	Inside the drywell - El. 10'-3"
Capacity	380 gallons
Areas Drained	Various equipment leakage (unidentified) LPRM - Seal Tubes (when shutdown)

TABLE 9.3-4
(Sheet 9 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

Drywell Sump No. 1-8 (Continued)

Alarms	"Drywell Floor Drain Sump Hi Level" "Drywell Floor Drain Sump Pumps Low Level" "Drywell Floor Drain Sump Pumps Both Running" "Drywell Sump Hi Leak Rate/System Failure" After sump is pumped down, a timer will start if the sump pump starts prior to the timer running out, then the Hi Leak rate alarm will sound.
Alarm Operation	After sump is pumped down, a timer will start, if the sump pump starts prior to the timer running out, then the Hi Leak Rate Alarm will sound.
Pumps	Control – Local Power Supply – MCC 1A21 - 1B21 (480V Swgr Room) Discharge - Floor drain header in NRW Inst - Integrator (located in NRW) monitors total water pumped from sump to header

Stack Floor and Equipment Drains Sump No. 1-12

Location	Beneath Stack
Capacity	390 gallons
Pumps	Locally controlled duplex submersible

TABLE 9.3-4
(Sheet 10 of 10)

EQUIPMENT AND FLOOR DRAINAGE SYSTEM COMPONENTS

New Radwaste Building Sumps

Number	3
Location	New Radwaste Building
Capacity	500 gallons
Pumps	Locally controlled, submersible

Augmented Offgas Building Sumps

Number of Sumps	2
Location	Offgas building and offgas building pipe chase
Capacity	50 gallons/100 gallons
Pumps	Locally controlled, duplex, centrifugal

Old Radwaste Building Sumps

Number of Sumps	3 (2 floor drains, 1 equipment drain)
Location	Old Radwaste Building
Capacity	1000 & 450 gallons (2), 450 gallons (1)
Pumps	Locally controlled, submersible

Turbine Building Sump 1-13 Sump

Purpose	To drain the Sandbed Area
Location	Feedwater Pump Room (The Conduit Pit)
Capacity	46 gallons
Pumps	One Submersible Pump

Turbine Building Alcove Sump

Purpose	To drain the Sandbed Area
Location	Alcove, Turbine Building 3'-6" El.
Capacity	46 gallons
Pumps	One Submersible Pump

TABLE 9.3-5
(Sheet 1 of 1)

NEW RADWASTE BUILDING DRAIN SUMP INSTRUMENTATION

Instrumentation

Floor Drain Sump No. 1

Level Interlocks
- LS-0073
- LS-0074
- LS-0075

High Level Alarm
- LS-0076

Floor Drain Sump No. 2

Level Interlocks
- LS-063A
- LS-063B
- LS-064A
- LS-064B

High Level Alarm
- LS-065

Floor Drain Sump No. 3

Level Interlocks
- LS-066A
- LS-066B
- LS-067A
- LS-067B

High Level Alarm
- LS-068

Floor Drain Sump Pumps

DS-P-3A, B Discharge (Sump No. 1)
- PI-069A
- PI-069B

DS-P-4A, B Discharge (Sump No. 2)
- PI-070A
- PI-070B

DS-P-5A, B Discharge (Sump No. 3)
- PI-071A
- PI-071B

TABLE 9.3-6
(Sheet 1 of 1)

STANDBY LIQUID CONTROL SYSTEM COMPONENTS

Storage Tank

Nominal Capacity	4100 gallons
Material	Type 304 stainless steel
Heater	50 kW, 440 volts, immersion type,supplied from MCC 1A21 (controlled by tank level)
Sparger	Oil free instrument air sparger with holes directed towards bottom of tank

Test Tank

Capacity	120 gallons
Material	Type 304 stainless steel
Height	3.5 ft
Diameter	30 inch

Poison Injection Pumps

Quantity	2
Type	Reciprocating
Flow	30 gpm
Discharge Pressure	1500 psig
NPSH	25 ft
Motor	30 hp, 350 rpm, 440 volt gear motor with 120 volt space heater
Controls	Keylock switch in Control Room
Power Source	MCC 1A21, MCC 1B21 (heat tracing from MP-1E)

Accumulators

Quantity	2
Type	Bladder
Capacity	2 1/2 gallons

TABLE 9.3-7
(Sheet 1 of 1)

STANDBY LIQUID CONTROL SYSTEM INSTRUMENTATION

Sensing Instrument or Switch	Objective
Level Measuring System	Annunciate high/low liquid poison tank level. Provide indication of poison tank level in the Control Room. Provide low-tank-level cutoff of heaters when they are on thermostatic control.
Flow Switch	Annunciate liquid poison flow in the Control Room. Close ac and dc isolation valves on the Reactor Water Cleanup System and trip the cleanup pumps to prevent poison injection into cleanup loop.
Temperature Controller	Provide thermostatic temperature control of storage tank heater.
Temperature Switch	Annunciate high/low poison tank temperature in Control Room.
Local Pump Test Switches	Each switch actuates its respective pump for test.
Manual Liquid Poison Keylock Switch	Turning switch to either system I or II starts one injection pump and opens one injection valve. Returning the switch to OFF stops the pump but the valve remains open. Provides pump on indication in the Control Room (System I or II).
Continuity Meter Relays 14MR1/14MR2	Annunciate open liquid poison squib in the Control Room. Provide squib valve open indication in the Control Room (Panel 4F) for System I & II. Provide indication of control circuit continuity (located behind Panel 4F)
Pump Discharge Pressure Instrumentation	Provide pump discharge pressure indication locally and in the Control Room.
Valve Position Switches	Provides open and closed valve position indication for V-19-19 on Control Room Panel 4F.

9.4 HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS

9.4.1 Control Room And Old Cable Spreading Room Area HVAC System

9.4.1.1 Design Bases

The Control Room HVAC System has been designed to maintain a comfortable temperature, and a slightly higher than atmospheric pressure. The system serves the Control Room area and the adjacent old Cable Spreading Room.

An emergency mode is provided with 100 percent outside air to avoid recirculation, and to clear the area of smoke and fumes in the event of fire. The system has been modified to prevent smoke from other areas from entering the Control Room.

A modification allows the Control Room operators to override the thermostatic control of the exhaust air, return air and outside air dampers in order to allow recirculation mode operation with or without the minimum outside air damper being closed. This capability is provided to reduce the potential for intrusion of toxic and/or radioactive gases into the Control Room atmosphere.

9.4.1.2 System Description

The Control Room HVAC System flow diagram is shown in Drawing BR 2010. The HVAC component design parameters are listed on Table 6.4-1. The outside air intake is located approximately 350 ft from the stack. The system utilizes independent trains, train A and train B. Train A consists of one supply fan with a rated capacity of 14,000 CFM, and comprises steam coils for heating and a refrigeration unit for cooling. Train B consists of one supply fan with a rated capacity of 14,000 CFM, electric heating coil for heating and a four stage refrigeration unit for cooling.

HVAC System A is designated as the backup or LAG system; the HVAC System B is designated as the primary or LEAD system. Changes from LEAD to LAG will be accomplished through operator action. The ability of the system to recirculate air is provided with recirculation ranging from 0 to 100 percent of rated flow.

The system is normally operated to maintain Control Room air temperature at 75±5°F and slightly higher than atmospheric pressure. The old Cable Spreading Room temperature will be 84±5°F. When the Turbine Generator unit is in service the system must always operate in the cooling mode. During winter, when the Turbine Generator is not in service the system is utilized in the heating mode to maintain 70°F inside temperature conditions.

9.4.1.3 Safety Evaluation

The safety evaluation for this system is presented under Section 6.4, Habitability Systems.

9.4.1.4 Testing and Inspection

Surveillance requirements for the system are identified in the Technical Specifications. All equipment and components can be visually inspected to insure the equipment and components are functioning satisfactorily. Filters are routinely replaced when required.

9.4.2 Reactor Building Heating and Ventilating

The Reactor Building completely encloses the reactor and its Primary Containment. The structure provides secondary containment when the Primary Containment is in service, and functions as the primary containment during periods when the Primary Containment is open, as during refueling. The building houses the refueling and reactor servicing equipment, new and spent fuel storage facilities, and other reactor auxiliary, emergency, and service equipment. The primary objective of the secondary containment is to minimize ground level release of airborne radioactive materials, and to provide for controlled, elevated release of the building atmosphere under accident conditions.

a. The Reactor Building enclosure contains the following ventilation subsystems:

b. The normal Reactor Building Heating and Ventilating System.

c. The drywell cooling system.

d. The corner room and steam tunnel air recirculating systems.

e. The stack exhaust system.

Each of these subsystems is described in Subsection 9.4.2.2 (also see Table 9.4-1), except for the Standby Gas Treatment System (SGTS), which is described in Subsection 6.5.1. The SGTS is provided to process radioactive gases following a Design Basis Accident.

9.4.2.1 Design Bases

The plant heating, ventilating and air conditioning (HVAC) systems have two design objectives:

a. To provide a controlled environment so that the maximum allowable ambient temperature for standard rated electrical equipment (104ºF) is not exceeded.

b. To regulate the static pressure within certain areas of the plant, so as to minimize the spread of airborne radioactive contamination from controlled to uncontrolled areas and to provide safe disposal of airborne contaminants.

Temperatures at the plant site range from a high of 105°F to a low of (-)13°F. Since these extreme temperatures are reached only for brief periods, the HVAC systems were only designed to cope with a high temperature expected to be exceeded 2.5 percent of the time in summer, and a low temperature expected to be exceeded only 2.5 percent of the time in winter. These conditions correspond to a maximum design dry bulb temperature of 89°F (77°F wet bulb) and a minimum dry bulb temperature of 10°F.

9.4.2.2 Systems Description

9.4.2.2.1 Reactor Building Heating and Ventilating System

The flow diagram for the Reactor Building Heating and Ventilating (RBHV) System is presented in Drawing BR 2011. These figures include normal flow distributions within the system. The RBHV System consists of one air washer, three 50 percent capacity supply fans and one steam heating coil bank. There is one dedicated exhaust fan and an alternate exhaust fan. The alternate fan can be used by either the RBHV or Turbine Building Heating and Ventilating System. Butterfly valves are used in the RBHV ducts as isolation dampers.

Air entering the system is cooled by an air washer or heated by the heating coils as required prior to reaching the supply fans. The three supply fans feed into a common header. Each fan is sized for half capacity to permit maintenance of one fan while system demand is met by the other two. Two main supply ducts connect to the common header. Each main supply duct directs air to the various areas of the Reactor Building. Each general building area/elevation receives air from both main supply ducts. This permits proper air flow even if one of the supply ducts is isolated for maintenance.

A pair of isolation valves, installed in series, is located on each area supply duct within the Reactor Building. These valves are interlocked with the supply fans to open when one fan is running. Since these valves are relied upon to maintain secondary containment integrity, they close on receipt of an automatic or manual isolation signal.

The RBHV System is also used during inerting and deinerting of primary containment. A duct from one of the main supply headers penetrates the drywell. This duct contains two pair of isolation valves each installed in series. The one pair is used to provide drywell isolation and the other pair for secondary containment isolation. Separate exhaust ducts are provided from the torus and drywell. These exhaust ducts each contain a pair of isolation valves installed in series. All ducts which penetrate primary containment are carbon steel pipe up to the second isolation valve to ensure the integrity of the primary containment pressure boundary.

Ducts in the concrete forming the rim of the steam separator and dryer storage pool, the spent fuel storage pool, and the drywell cavity, draw air across the surface of the water to remove radioactivity released and exhaust it directly to the stack. A duct in the concrete below the reactor vessel top closing slabs maintains a negative pressure beneath the slabs to prevent the volume of air from expanding and contracting during temperature changes and reduces the accumulation of dust.

The RBHV System normally exhausts to the stack through a single exhaust duct which runs from the building to the exhaust fans. A pair of isolation valves installed in series in this duct permits isolation of the Reactor Building. These valves are controlled from the Control Room. They close upon receipt of an automatic or manual isolation signal. Air from the exhaust fan is direct to and released through the stack. An alternate path to the stack is provided via the SGTS. The exhaust path chosen is dependent on plant conditions and the amount of radioactive material in the exhaust flow.

The RBHV System will be automatically shutdown and isolated by any one of the following signals:

a. Refueling floor high radiation

b. Reactor Building exhaust duct high radiation

c. High drywell pressure

d. Low-low reactor water level

e. Reactor Bldg. pressure going positive (supply side isolation only. Exhaust valvesV-28-21 and V-28-22 are not automatically isolated).

f. Manual signal from the Control Room

g. High temperature in the RBHC System ductwork (Supply side isolation only,Exhaust Valves V-28-21 and V-28-22 are not automatically isolated.)

h. V-28-21 or V-28-22 not full open (Supply side isolation only.)

The drywell air inlet purge valves (V-28-42 and V-28-43) are part of the secondary containment boundary and, as such, must be able to serve as the primary containment during periods when the primary containment is open. These valves are normally closed during plant operations, and are opened during plant shutdown conditions or drywell deinerting. Closure of the purge valves will automatically occur on loss of Reactor Building ventilation supply fans, fuel pool area or equipment hatch high radiation, high drywell pressure or reactor water level Lo-Lo signal, thus isolating the secondary containment. The air inlet purge valves are closed automatically upon manual initiation of the Standby Gas Treatment System. The valves are closed automatically if Reactor Building pressure is greater than 1” WG, high ductwork temperature is detected, or valves V-28-21 or –22 are not full open. The isolation signal interlock to the drywell air inlet purge valves will cause the valves to close or be prevented from opening, which will minimize a ground level release in the event of an abnormal plant condition.

9.4.2.2.2 Drywell Cooling

The drywell and torus gas spaces are inerted with nitrogen during power operation. The drywell is isolated from the RBHV System (Drawing BR 2011) and is cooled by five recirculating fans and coolers. The reactor cavity space between the drywell head and the floor shielding is ventilated by the RBHV System.

Five recirculating fans and associated cooling coils provide internal cooling for the atmosphere within the drywell. Cooled nitrogen from the fans is fed to a ring header at El. 54' and delivered to the air space within the drywell. Most of the flow is directed downward toward the lower part of the drywell. Return nitrogen is collected by a second ring header at El. 91'-7" which receives nitrogen through five downward directed openings and through three ducts which exhaust the area above the reactor cap. Five return ducts deliver the nitrogen to the fan inlets which also receive a small amount of nitrogen from a return duct in the lower part of the drywell. The ducts at the fan inlet are provided with dampers that are interlocked with the fan control circuit. These dampers are closed when the fan is not operating.

Fans are controlled individually from the Control Room. In normal operation, four fans are sufficient for cooling; the fifth fan is a standby for any of the others.

Three of the fans start automatically following loss of auxiliary and startup power provided that drywell pressure is below the high level alarm point and the reactor water level is above the low-low alarm point. The other two fans can be started manually after emergency power is available.

To provide access to the drywell, and before removing the drywell head for a refueling outage, the nitrogen gas is purged and replaced with air as described in Section 6.2.

9.4.2.2.3 Reactor Building Recirculating Fans

In each corner of the Reactor Building basement at El.(-) 19'-6" there is a recirculating fan and an associated cooling coil. These fans provide cooling for the four Core Spray pumps, the four Containment Spray pumps, the Control Rod Drive feed pumps and associated equipment.

Fans can be arranged for automatic or manual operation. In automatic operation, two of the fans start and stop automatically with the Core Spray pumps, and the other two fans start and stop automatically with the Containment Spray pumps. Any fan can be operated from local switches. The fans operate whenever there is at least one of the associated pumps in operation.

Cooling water for the cooling coils is supplied from the Reactor Building Closed Cooling Water System (RBCCW).

Two additional recirculating fans are provided for the main steam tunnel. These fans are controlled individually from the Control Room, and their Cooling Coils also receive cooling water from the RBCCW System.

9.4.2.2.4 Stack Exhaust System

The Stack Exhaust System has three fans which receive and exhaust the streams from the Reactor Building and Turbine Building through the stack. One unit serves the Reactor Building and a second serves the Turbine Building. The third fan is a standby which is manually started when an operating fan stops and the appropriate dampers are repositioned to divert the airflow from the failed fan to the standby unit.

The stack is a concrete structure with a smooth internal surface to minimize particle accretion. Potential sources of gaseous waste are discharged from the top at a velocity of a minimum of 3000 fpm during normal power operation. Water collecting in a sump at the base of the stack is pumped to the New Radwaste Building by two sump pumps. (Section 9.3).

Radioactivity of the plume is carefully monitored to meet the standards on radioactivity release. Refer to Section 11.5.

9.4.2.3 Safety Evaluation

The RBHV System is normally operated with two supply fans running and one in reserve. The supply fans trip and lock out, and the isolation valves close on any of the signals listed in Subsection 9.4.2.2.1. The emergency exhaust system starts automatically and the supply fans cannot be restarted until the emergency situation is corrected . The Reactor Building, which has a potential for release of radioactivity, is a sealed structure with the interior maintained slightly below atmospheric pressure by the RBHV System so that any leakage will be in rather than out.

Negative pressure is created by the exhaust fans in the air ducts to the stack. The inlet and vortex dampers of these fans are manually opened to ensure that a negative pressure will be maintained.

The SGTS also maintains a negative pressure in the Reactor Building during an emergency condition. (Section 6.5)

9.4.2.4 Inspection and Testing Requirements

Testing of the shutdown and isolation capability of the RBHV System is conducted in accordance with plant technical specifications to ensure secondary containment integrity can be maintained following a design basis accident. (Refer to Section 6.2.3.4).

There are no special inspection and testing requirements for the Reactor Building Ventilation System, with the exception of secondary containment isolation valves and their associated accumulations. A preventive maintenance and surveillance test program has been implemented in response to NRC Generic Letter No. 88-14. The system is normally operating and any failure is easily detected.

9.4.3 Turbine Building Heating and Ventilation

9.4.3.1 Design Bases

The Heating and Ventilating (H&V) systems in the Turbine Building have two objectives:

a. To protect equipment and personnel from temperature extremes

b. To regulate the static pressure within certain areas of the plant so as to minimize the spread of airborne radioactive contamination and to provide safe disposal of airborne contaminants.

These HVAC systems are designed to meet the requirements of specific areas:

a. Areas normally not contaminated, but which can become so through system malfunction or equipment breakdown. Ventilation for most of these areas is once-through.

b. Areas which will probably contain radioactive contaminants at all times during plant operation. Such areas use once-through ventilation with all air exhausted to the main plant stack.

At the site, outside ambient temperatures as high as 105°F and as low as (-)13°F have been experienced. Since these temperatures are seldom reached, and then only for brief periods, the H&V systems were only designed to cope with a high temperature expected to be exceeded 2.5 percent of the time in summer, and a low temperature expected to be exceeded 2.5 percent of the time in winter. These conditions correspond to a maximum design dry bulb temperature of 89°F (77°F wet bulb) and a minimum design dry bulb temperature of 10°F.

9.4.3.2 System Description

The Turbine Building H&V systems are included in Drawing BR 2009 (also see Table 9.4-2). The figure includes normal flows for the systems. The building is served by five sets of fans: three sets are provided with air washers and heating coils, these distribute flow through most areas of the building; one set serves the feedwater and condensate pump area, and is dedicated to that area. Another system, serving the reheater ventilation, system, is a specialized system also shown in Drawing BR 2009.

The south end of the Turbine Building is served by two supply fans. This supply system is typical of the evaporative cooling systems used in the building. It consists of an air washer and steam fed heating coil and two full capacity supply fans in parallel. Air flow is directed from normally clean areas to contaminated areas and then to the stack. The static pressure in the Hi/Low Conductivity, Demineralizer, Regeneration, Steam Jet Air Ejector and Mechanical Vacuum Pump Rooms are to be maintained at a negative pressure relative to outside atmospheric conditions. Normally only one supply fan is operating and the dampers on the other are closed to prevent diversion of air. Steam is admitted to the heating coils from the auxiliary boiler as required to maintain a minimum air temperature of 50°F during cold weather when the turbine generator is shut down. The sump is drained automatically to prevent freezing. The spray pump in the air washer turns on automatically to provide evaporative cooling.

The ‘C’ Battery Room and the ‘C’ and ‘D’ 4160 V Switchgear Vaults are also provided with ventilation systems.

The ‘C’ Battery Room ventilation system consists of two exhaust fans. The ‘C’ Battery Room ventilation system is designed to maintain temperature of the batteries within preferred environmental conditions, and prevent the buildup of hydrogen. One exhaust fan is normally operating when the batteries are in service and the other fan is placed in standby. During the summer period, outside air is drawn through a louver and filter. During the winter period, a minimum amount of outside air is drawn in and mixed with air from the 4160V Switchgear Room. The air is exhausted to the outside atmosphere. An electric heater is also provided to maintain minimum temperature in the area during the winter months.

The 4160 V switchgear area located in the mezzanine south end receives air from the South End supply fans. The ‘C’ and ‘D’ 4160 V Switchgear are located in separate vaults. Each vault is ventilated by one roof ventilator fan. Each fan continuously circulates air drawn from the mezzanine south end area and discharges the air back to this area.

The operating floor is served by one air washer with two full capacity supply fans. The Turbine Building operating floor atmosphere is exhausted through four roof openings that are connected by an exhaust duct that runs on the building roof and down to the exhaust fan located on the west mezzanine roof. The inlet damper on the exhaust fan is controlled by a differential pressure controller to maintain a negative pressure in the operating floor space with respect to outdoor air pressure when this fan is running.

The effluent from the Turbine Building operating floor as well as the exhaust from reheater protection, miscellaneous equipment and lube oil equipment areas are monitored for radiation at the common exhaust duct enroute to the atmospheric discharge through a stack located on the west mezzanine roof. This stack is monitored for radiation. The operating floor exhaust fan is only required to be operated when the temperature just below the roof of the Turbine Building is above 130°F. The exhaust fan is operated in unison and interlocked with the supply fans to assure that the pressure within the operating floor is maintained at atmospheric pressure or below. If the radiation level is above a preset level, the supply and exhaust fans can be shut down manually. Automatic inlet louvers on the operating supply fan open only when the high level exhaust fan is operating.

The operating floor receives an inflow of air from the south-end mezzanine through the open equipment hatches as well as the supply ducts on the west wall of the operating floor. The operating floor also receives a portion of air from the reheater area ventilation system supply fans, and a small amount of flow from the Contaminated Instrument Shop. Supply air for the condenser area and heater bay comes from the operating floor. The condenser and heater bay areas are maintained at a negative pressure relative to outside atmospheric conditions.

The Contaminated Instrument Shop is provided with a recirculation fan. The recirculated air is filtered to remove potential contamination. A small amount of flow is diverted to the operating floor. The air flow diverted from the Contaminated Instrument Shop maintains the area at a slightly negative pressure.

The highly contaminated areas that are required to be maintained at a negative differential pressure relative to outside atmospheric conditions collectively are identified as the <u>Turbine Building Ventilation Envelope</u>. The Turbine Building Ventilation Envelope is defined as the walls, floors, and ceilings of the Condenser/Heater Bay, Hi/Low Conductivity Room, Steam Air Ejector Room, Mechanical Vacuum Pump Room, Demineralizer Room, and Regeneration Room. The physical integrity of this ventilation envelope is maintained to ensure a negative differential pressure in the envelope.

The reheater area ventilation system also serves the north end of the basement and mezzanine floors. It consists of an air washer, two full capacity supply fans, and one exhaust fan in the north end of the mezzanine floor. Air flow is divided between the reheater area and the north-end basement and mezzanine. The reheater area shares a common exhaust with the condenser area and the heater bay. The exhaust fan operates in unison with either supply fan and has a manual damper in the exhaust duct to regulate the flow of exhaust air.

The feedwater and condensate pump area is ventilated by a push-pull system consisting of one supply fan and one exhaust fan. The system is designed to control the temperature in the area using outside air for cooling and recirculated air for maintaining temperature when the turbine generator is operating. The maximum expected temperature is 114°F for 89°F outside air. The system uses 100 percent fresh air when the room exhaust air temperature is about 70°F or higher. Below 70°F room exhaust air temperature, the exhaust air is recirculated.

A provision for automatic damper lineup allows effective ventilation when either the supply or the exhaust fan is disabled. In normal operation, the dampers adjust automatically to hold the prescribed temperature and maintain a nominal flow of 68,000 cfm.

An additional exhaust system has been installed to remove excess heat from Reactor Feedwater Pump motors for pumps P-2-002A and P-2-002B. This system consists of hoods installed over each motor, ductwork which connects these hoods to the inlet of the feedwater and condensate pump area exhaust duct, and an inline fan located in this ductwork.

Reheater ventilation system exhaust fans circulate air, after shutdown, through the shell side and tube side of both reheater stages. The reheater ventilation system consists an exhaust fan and filter for each pair of reheaters. The supply side of the Reheater Ventilation System was isolated from the Reheater System and abandoned in place under BA 403061. Drawing BR 2009 includes a simplified flow diagram of the system.

The Turbine Building RAGEMS enclosure is provided with a separate heating and ventilation system to maintain acceptable environmental conditions for the RAGEM equipment.

Low differential pressure across exhaust fan EF 1-7 is alarmed in the Control Room. Turbine Building differential pressure on the operating floor, Heater Bay area and High/Low Conductivity room are measured locally. Vortex dampers at the exhaust fan are manually operated to prevent pressure buildup in the building.

The air washer systems are operated with only one supply fan running and one in reserve. There are no trip annunciators for these fans; however, the air washer low differential pressure annunciator alerts operators to a fan problem in these systems.

9.4.3.3 Safety Evaluation

Uncontrolled airflow (potentially contaminated) from the Turbine Building to the surrounding atmosphere is prevented. The Turbine Building has within it areas of high contamination. These areas collectively are identified as the Turbine Building Ventilation Envelope. To ensure that airflow patterns within the Turbine Building move air from areas of low potential contamination to areas of high contamination the Turbine Building Ventilation Envelope is maintained at a negative pressure relative to outside atmospheric conditions. This results in air leakage being in rather than out for the Turbine Building. Negative pressure is created by the exhaust fans. The inlet and vortex dampers of these fans are manually opened to ensure that a negative pressure will be maintained.

9.4.3.4 Inspection and Testing Requirements

No special equipment tests are required for these systems. Operating and standby components are alternated periodically to verify their operability. Routine visual inspection of the system components and instrumentation is adequate to verify system operability.

9.4.4 Radwaste Areas Heating and Ventilation

The radwaste areas of the plant include the Old Radwaste (ORW) Building, the New Radwaste (NRW) Building, the Offgas (OG) Building, and the Hot Machine Shop in the New Maintenance Building.

9.4.4.1 Design Bases

The heating and ventilation systems of the radwaste areas have been designed to meet the following requirements:

a. Provide fresh, tempered air to the various areas of the Radwaste Building in sufficient quantity to limit the temperature to a maximum of 104°F in areas where electrical equipment is located and where personnel access is not limited. In other areas the maximum temperature limit is 120°F. The design basis for building ventilation is 89°F dry bulb and 79°F wet bulb.

b. Provide air distribution within the building for controlled air movement from areas of low radioactive contamination potential to areas of high radioactive contamination potential.

c. Provide a means for filtering the exhaust air before discharging to atmosphere.

d. Heat the supply air as required to maintain a minimum of 50°F supply temperature during the winter season with a design basis of 10°F minimum outdoor dry bulb temperature. Zone booster heating coils increase the supply air temperature to 60°F before entering the respective zones.

e. Maintain automatically a negative pressure within the building with respect to atmospheric pressure in order to minimize the uncontrolled release of radioactivity.

f. Maintain airborne radioactivity below 10CFR20 and 10CFR50 Appendix I limits.

In addition, the design for the ORW Building and NRW Building meets the following requirements.

g. Provide a means for detecting and alarming automatically the ventilation system on low air flow and/or loss of air flow.

h. Provide ventilation to the building from a manually operated supply system and separate exhaust system. *

i. Automatically shut down the ventilation system following a preheat steam coil failure to protect against coil freeze up. *

j. Automatically alarm the ventilation systems filter media replacement.

k. Service, by means of a bypass arrangement, unit and equipment without shutting down the exhaust ventilation system. *

l. Maintain, by means of redundant exhaust fans, operation of the exhaust system following the failure of the normal operating fan.

All of the radwaste areas ductwork is designed, fabricated and constructed in accordance with Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMAGNA) standards, and is classified as non seismic.

* This section is not applicable to the Old Radwaste (ORW) Building.

9.4.4.2 System Description

9.4.4.2.1 Old Radwaste (ORW) Building

Drawing BR 2012 shows a simplified flow diagram of the ORW Building ventilating system (also see Table 9.4-3).

The system has two exhaust fans and discharges to the stack. The supply fans and air washer have been removed from service and abandoned in place.

The two exhaust fans are controlled individually by pushbutton stations at the local Control Panel in the ORW Building Control Room. In normal operation one exhaust fan will be on. The alternate fan will be off and its respective outlet or inlet damper will be closed. An interlock is provided for the exhaust fans so that if the operating fan stops the other will start automatically. The exhaust fans have inlet vanes which are locked in an open position to hold the static pressure in the building at a negative 0.25 inches WG or greater. A common alarm for overload of either of the two exhaust fans is provided.

Heating is supplied by means of electric heating units throughout the building.

All exhaust air is filtered before release. Absolute filters remove all particles (0.3 microns or larger), and roughing filters upstream of the absolute filters remove large particles. The filters are arranged in two parallel banks, each with an air operated, manually controlled valve in the outlet. Both filter banks are normally in service.

9.4.4.2.2 New Radwaste (NRW) Building

The ventilation system for the NRW Building (Drawing BR M611 and Table 9.4-3) is designed to provide adequate ventilation and maintain a negative pressure within the building of 0.125 inches water. The negative pressure is maintained to assure that no radioactive material escapes the building without being monitored by the Stack RAGEMS ventilation radiation monitors.

The supply system consists of one axial fan, associated ductwork, controls, heating coils and filters. The supply fan is sized to handle 100 percent fresh air with no recirculation and is filtered by fully automatic roll-up type filters and intermediate filters and then steam preheated by 50°F (during winter operation only) before delivery to the building. Booster heaters provide zone heating throughout the building, as required. Both preheat and booster heating coils are freeze protected low pressure steam coils.

The exhaust system consists of two axial fans in the building, two axial fans on the roof, associated ductwork and a filter train. The exhaust fans are each redundant and are sized to handle 100 percent of the exhaust air with no recirculation.

The exhaust filter train is sized to handle 100 percent exhaust air and consists of a roughing filter and a HEPA filter located directly upstream of the exhaust fans. After the air is filtered, monitored, and discharged from the building, the exhaust booster fans transfer the air to the stack, where it is monitored again and exhausted. A bypass ductwork arrangement is designed into the exhaust unit (filter train) to allow constant exhaust air flow during maintenance or replacement of filters. A two position, single blade butterfly type "zero" leakage damper is located in the bypass ductwork. The damper construction consists of a body and disc of carbon steel, and a seat of natural gum rubber strip liner, trim of stainless steel, and bearings of Grafoil (outboard self lubricating type). The damper actuator is a pneumatic type operating on 100 psig air pressure. In the bypass mode, the "zero leakage" damper opens, allowing the exhaust air to bypass the filters.

An automatically operated "bubble tight" isolation damper, located downstream of the two "booster" exhaust fans up on the roof, completely isolates the exhaust system from the outside environment during shutdown conditions, thus preventing backflow to the NRW Building from the plant stack.

The NRW Building Control Room, which is normally occupied, is air conditioned, using a minimum fresh air design. This room is sealed from adjacent areas and maintained at a positive pressure with respect to the adjacent building areas, which are under a slightly negative pressure. This design will allow only air leakage from the local Control Room to the adjacent areas at all times.

The NRW Building Control Room air conditioning system consists of a floor mounted package unit, located in the change room, and its associated ductwork extended to the single zone Control Room. The package unit is provided with an economizer cycle for year round comfort, and with low pressure steam coils for winter heating. The unit switches over from cooling to the economizer cycle at 55°F. The unit will respond to a room thermostat to maintain room temperatures at a nominal 75°F for comfort year round.

The Heat Exchanger Building is adjacent to the NRW Building. Temperatures and ventilation levels for this building are maintained by once-through outside air ventilation via a wall exhaust fan, which operates from a wall thermostat, and a "low pressure" steam unit heater.

9.4.4.2.3 Offgas Building

The Offgas Building Heating and Ventilation System (Drawing BR M611) is a push-pull heating and ventilation system providing once-through air flow with no recirculation. It consists of a supply air system and an exhaust air system, which discharges through a louver in the north wall of the building.

The supply air system consists of one full capacity (8,600 cfm) centrifugal fan in a cabinet together with an electric heating coil and prefilter. The prefilter is the renewable roll type and is automatically advanced to maintain a uniform pressure drop. The heating unit is a staged electric heater.

Sheet metal ducts are arranged to take outside air and deliver it to the various spaces within the building in proportion to the ventilation air in accordance with space requirements. An additional electric booster heating coil is provided in each of the three branches of the supply air system. This allows different temperatures to be selected for each zone.

The exhaust air system includes one full capacity air mover assembly, consisting of a cabinet containing a centrifugal fan together with a prefilter and final filter (HEPA). The prefilter is of the renewable roll type and is automatically advanced to maintain uniform pressure drop. The final filter is a replaceable high efficiency (99.97 percent) unit arranged in a filter bank three high by three long. The centrifugal fan is rated at 8,600 cfm.

9.4.4.3 Safety Evaluation

In order to prevent the release of airborne radioactivity, radwaste areas are maintained at a negative pressure with respect to atmospheric pressure, thus maintaining an infiltrated condition into the building. The consequences of the failure of automatic controls can be mitigated by manually adjusting the air operated dampers located in the exhaust systems. Redundant exhaust fans have been provided for the new Radwaste System only. The failure of the supply fan has no safety related significance.

In order to isolate and remove airborne radioactivity which may be released due to equipment failure or malfunction, air distribution within the buildings is designed for controlled air movement from areas of low radioactive contamination potential to areas of high radioactive contamination potential. An upset condition ("blowback" of air from a potentially high radioactive area to a low radioactive area) can occur when the exhaust fan stops, on an unscheduled basis, or during a component failure which reduces substantially or stops the exhaust air flow. At low exhaust ventilation air flow the condition is alarmed.

Radioactivity monitoring is described in Section 11.5.

9.4.4.4 Inspection and Testing Requirements

The performance of the heating and ventilating system components can be verified while the system is in operation. Pressure and temperature instrumentation and flow connections are provided for determining performance of the system and its components. The ductwork system and components are subjected to leak tests after erection. Filters and filter housings are subjected to manufacturers performance and production tests, as well as to a field DOP test.

In addition, the complete heating and ventilating system undergoes preperational testing at design conditions.

9.4.5 Office Building

9.4.5.1 Design Bases

Most of the Office Building atmosphere normally exhausts directly to the environs without filtration or radioactivity control.

The HVAC systems in the building are designed to meet the requirements of specific areas where personnel can enter and leave freely. Ventilation systems serving these areas use recirculation whenever possible.

Plant areas that are normally occupied by office workers or which contain sensitive electrical or electronic equipment are temperature controlled throughout the year. Relative humidity is not regulated.

Temperatures at the plant site have ranged from a high of 105°F to a low of (-)13°F. Since these extremes are seldom reached, and then only for brief periods, the HVAC systems were only designed to cope with a high temperature expected to be exceeded 2.5 percent of the time in summer and a low temperature expected to be exceeded only 2.5 percent of the time in winter.

These conditions correspond to a maximum design dry bulb temperature of 89°F (77°F wet bulb) and a minimum dry bulb temperature of 10°F.

9.4.5.2 System Description

The Office Building has six essentially independent ventilation systems (Drawing BR 2010 and Table 9.4-4) and all, except for the North-End HVAC system, serve uncontrolled areas. All systems exhaust directly to the atmosphere. The North-End HVAC system serves areas which are subject to minor contamination. Radioactivity is tracked into the area by personnel entering from contaminated areas. Most of the radioactive particles will adhere to clothing or the floor with little of it becoming airborne. The area is at a slightly negative pressure, with natural incoming airflow from adjacent uncontaminated areas. The Reactor Building is entered through air locks so that backflow into the Office Building is impossible under any circumstances. The North-End HVAC System exhausts to the atmosphere through a bank of roughing and absolute filters with no recirculation.

Parts of the building are heated by an electric baseboard heating system. Ventilated areas are served by electric duct heaters and all conditioned areas are heated by steam coils. Other buildings are heated primarily by steam heating coils associated with the ventilating system with additional heating by local unit heaters. Heating steam is obtained from a separate oil fired boiler. Some areas have electric booster coils to counteract roof transmission losses.

Acoustic lining is used in selected parts of the ducts serving the Office Building and Control Room (Subsection 9.4.1). Ducts supplying cool air are insulated to minimize heat losses and to prevent sweating. Exposed cooling ducts are also insulated where they pass through ventilated areas. Removable inspection panels are provided in various parts of the duct.

All outside air inlets have coarse screens which serve to remove large particles followed by further filtration or washing for removal of particles. Systems not using air washers have replaceable filters consisting of of a wire screen coated with a viscous material.

Exhaust filters are used in that portion of the Office Building HVAC System serving the hot chemical laboratory, the laundry, and the contaminated change area. Absolute filters of glass asbestos remove all particles 0.3 microns or larger, and roughing filters upstream of the absolute filters remove large particles.

9.4.5.2.1 North-End HVAC

Two once-through systems serve this area. One provides heating and ventilation for the monitoring and change room, the electrical tray room, and the laundry area. The other provides heating, ventilating, and cooling for the health-physics room, instrument shop, hot chemical laboratory and counting room. Each system has one supply fan and both systems share two exhaust fans and an exhaust filter bank.

The system which serves the monitoring and change room, the electrical tray room and the laundry area has one steam fed heating coil at the inlet of its supply fan, and is normally operated to maintain approximately 70°F in all areas (controlled by a thermostat in the monitoring and change room). A direct expansion air conditioning unit provides cooling to these areas.

The other system has a steam fed heating coil and a direct expansion type cooling coil at the supply fan inlet. Cooling is regulated by the outdoor ambient conditions to maintain the PASS Room at 76 ± 6°F. Both the hot chemical laboratory and the counting room are provided with a terminal electric duct heat which, together with the cooling capability, maintain room temperature at 72 ± 2°F all year round.

The two full capacity exhaust fans are provided with a roughing filter and an absolute filter in their common inlet duct. Normally, both supply fans and one exhaust fan are on.

The Postaccident Sampling System room has an independent exhaust system (Section 11.5).

9.4.5.2.2 South-End Heating and Ventilation System

This system provides heating and ventilation for the shower rooms, locker rooms, toilets, rest rooms, and machinery spaces of the Office Building south end. The system has one supply fan and two exhaust fans. It is partially recirculating system and has a minimum fresh air inlet. The system also contains one electric heating coil in the supply fan inlet duct, and booster heating coils in the ducts to showers, locker rooms, and similar areas. When the main heating coil is in service, temperature controllers operate the coil and the dampers to hold a temperature of approximately 70°F at the supply fan outlet. The booster coils are operated by local thermostats.

In normal operation, both exhaust fans are operating. One fan provides recirculation and partial exhaust to the atmosphere. The second fan provides a fixed flow of exhaust air to the atmosphere for this system and for those areas in the south end that receive supply air from the South-End HVAC System. Static pressure is not controlled.

9.4.5.2.3 South-End Offices HVAC

The existing South End HVAC System will be abandon-in-place to the maximum extent possible. The replacement system is a new commercial grade, 30 Ton rated cooling capacity, single-zone, rooftop mounted package air conditioning unit with Variable Air Volume (VAV) supply air temperature controls. The air conditioning unit consists of a refrigeration system (compressors, evaporator coil, condenser coil, condenser and fans/motors) and an air handling system (supply fan/motor, modulating economizer, barometric relief dampers, and air temperature controls). For heating, the System is provided with electric heaters in the VAV units and baseboard heaters within each zone. The System has been designed to maintain temperatures of 68°F (heating) and 72°F (cooling). The supply fan provides a total inlet airflow of 12,000 CFM. Exhaust airflow is accomplished mostly by natural leakage, however, approximately 5% of the total inlet airflow is discharged via the South End H&V System Exhaust Fan EF-1-19. The System is of the recirculating type with the ratio of outside air to inside air maintained by the 0-100% capacity modulating economizer (return and outside air dampers). The System consists of eleven (11) zones with the temperature in each zone regulated by a local room thermostat. Each thermostat regulates the VAV controls and baseboard heating units to maintain a 68°F/72°F working environment within the MOB.

9.4.5.2.4 Machine Shop and Storage Building

The Machine Shop and Storage Building is served by one supply fan, with a filter and steam coil, four gravity roof ventilators, and a small toilet room exhaust fan. The system is recirculating during winter operation. The air delivered by the supply fan is held at approximately 70°F by a temperature controller which positions the fresh air and recirculation dampers and the four exhaust dampers associated with the roof ventilators. The temperature controller also modulates steam to the heating coil. Minimum intake through the fresh air damper is 1500 cfm.

The two fans are controlled individually by local pushbutton stations. Both fans normally operate continuously and the temperature controller is in control when the supply is on. When this fan is stopped, the fresh air and exhaust dampers are driven closed. Static pressure in the area is slightly positive and is not controlled.

9.4.5.2.5 Battery and M-G Room Ventilation

This system supplies ventilation only to the Battery Room and M-G Room using one supply fan, and one exhaust fan. The system uses purge and air recirculation to maintain the temperature between 104°F and 60°F for the Battery Room, which is the area with the most limiting temperature requirements for operability. Outside ambient temperatures as high as 105°F and as low as (-)13°F have been experienced. Because these temperatures are seldom reached, and then only for brief periods, the ventilation system was only designed to cope with a high temperature expected to be exceeded 2.5 percent of the time in summer, and a low temperature expected to be exceeded 2.5 percent of the time in winter. This condition corresponds to an outside maximum design dry bulb temperature 89°F (77°F wet bulb) and an outside minimum design dry bulb temperature of 10°F. The system operating procedure is also used to maintain the Battery Room temperature, between 104°F and 60°F, for battery operability, especially for those brief periods when design temperatures are exceeded.

As a supplement to the ventilation of the M-G Sets, an air conditioner has been provided. Cooled air is directed to the area close to the cooling inlets for each motor. This system is actuated when motor temperature either approaches or exceeds a set motor temperature. This cooling system does not replace the ventilation system nor does it adversely affect ventilation of the Battery Room.

9.4.5.2.6 480V Switchgear Room Ventilation

The system supplies ventilation only for each of the two 480 V Switchgear Rooms and uses purge and air recirculation to maintain the Switchgear Room temperature at or below 104°F, with maximum room temperature of 120°F for switchgear operability. Outside ambient temperatures as high as 105°F and as low as (-)13°F have been experienced. Because these temperatures are seldom reached, and then only for brief periods, the ventilation system was only designed to cope with a high temperature expected to be exceeded 2.5 percent of the time in summer, and a low temperature expected to be exceeded 2.5 percent of the time in winter.

This condition corresponds to an outside maximum design dry bulb temperature of 89°F (77°F wet bulb) and an outside minimum design dry bulb temperature of 10°F. The ventilation system for the "A" Switchgear Room utilizes two 10 hp fans which are connected to the "A" EDG. The ventilation system for the "B" Switchgear Room utilizes two fans which are connected to the "B" EDG. In addition, permanently installed backup ventilation system consisting of one exhaust fan and intake damper is provided in the "A" Switchgear Room for use when the "A" Switchgear Room ventilation system is not functional. This backup system is connected to the "B" EDG and operates concurrently with the "B" Switchgear Room ventilation system.

The system operating procedure is also used to maintain the 480 V Switchgear room temperature, at or below 104°F, especially for those brief periods when design temperatures are exceeded.

Any single equipment or component failure will not result in the total loss of ventilation to both switchgear rooms. Failure of the "B" ventilation system will not affect "A" Switchgear Room operation or impair the plant's ability to achieve shutdown. Similarly, loss of the "A" ventilation system will not impair the plant's ability to achieve shutdown, due to operation of the "B" ventilation system and the "A" room backup ventilation system.

The removal of one fan (supply or exhaust) from service while the other fan (supply or exhaust) continues to run is an acceptable system configuration for performing maintenance. One fan operation ensures continued ventilation to the area to maintain proper room temperatures. Additional limitations and compensatory measures will be imposed during any maintenance period.

The "A" Switchgear Room Ventilation System is designed for an air flow of 9800 cfm. The backup system also provides 9800 cfm. The "B" Switchgear Room Ventilation System is designed for an air flow of 7200 cfm. Both the "A" and "B" rooms ventilations systems are capable of operation with up to 100% recirculation. The backup system for the "A" switchgear room utilizes 100% outside air with no provisions for recirculation.

9.4.5.2.7 Electric Baseboard Heating

Certain areas of the Office Building are subject to perimeter heat losses. Supplemental heat for these areas is furnished by 25 electric baseboard heaters and one surface mounted cabinet convector. The heaters operate in groups of one to five units controlled by local thermostats. Each heater operates on 277 volt, single phase power from the nearest or most convenient 480 volt distribution panel.

9.4.5.2.8 Deleted

9.4.5.3 Safety Evaluation

The Office Building heating and ventilating systems are designed so that malfunction of a system component will not affect the operation of any safety related system or component. However, loss of a heating and ventilating system component could cause temporary conditions of high or low temperature and/or humidity in certain areas. The resulting inconvenience is acceptable and does not pose a safety hazard.

9.4.5.4 Inspection and Testing Requirements

All equipment and components are visually inspected on a periodic basis to insure that they are not damaged and that all components are operating properly.

Filters are routinely replaced when required in accordance with the manufacturer's recommendation.

TABLE 9.4-1
(Sheet 1 of 2)

REACTOR BUILDING HEATING AND VENTILATION SYSTEM

System	Equipment	Function
Reactor Building Heating and Ventilation System	AW-1-4, SF-1-12; 13; 14	Provide heating, cooling and ventilation to Reactor Building Areas
Drywell Cooling System	RF-1-1; 2; 3; 4; 5	Cool reactor external surface and equipment inside the drywell.
Reactor Building Recirculating Fans:		
Steam Tunnel	RF-1-6; 7	Provide recirculation and cooling for pipes and equipment inside the steam tunnel.
Corner Rooms	RF-1-8; 9; 10; 11	Cool the Core Spray and Containment Spray Systems pumps, the Control Rod Drive feed pumps and associated equipment.
Stack Exhaust System	EF-1-5; 6; 7	Maintain Reactor Building at a negative 0.25 inches WG during normal operation.

TABLE 9.4-1
(Sheet 2 of 2)

REACTOR BUILDING HEATING AND VENTILATION SYSTEM

System	Equipment	Function
		Maintain the following Turbine Building areas. Condenser Bay, Heater Bay, Hi/Lo Conductivity Room, SJAE and Steam Seal area, Vacuum Pump Room, Demineralizer Room and Regeneration Room at a negative pressure relative to outside atmospheric conditions during normal plant operation.
Standby Gas Treatmemt System	EF-1-8; 9	Mitigate the consequences of an accident by maintaining a negative pressure of -0.25" WG in the Reactor Building.

TABLE 9.4-2
(Sheet 1 of 1)

TURBINE BUILDING HEATING AND VENTILATION SYSTEM

Equipment	Areas Served
AW-1-1 and SF-1-1; 2	South End
AW-1-2; SF-1-3; 4, and EF-1-33	Operating Floor
AW-1-3, SF-1-5; 6, and EF-1-4	Reheater Area
SF-1-7 and EF-1-1	Feedwater and Condensate Pump Area
SF-1-22 and EF-1-23	Machine Shop and Storage Areas
EF-1-2; -3	Reheater Ventilation System

TABLE 9.4-3
(Sheet 1 of 1)

RADWASTE AREA VENTILATION

Equipment	Areas Served
HV-S-052 (supply fan); HV-S-053A, And B (exhaust fans); HV-S-054A And B (exhaust booster fans)	New Radwaste Building

TABLE 9.4-4
(Sheet 1 of 1)

OFFICE BUILDING HEATING AND VENTILATING SYSTEM

Equipment	Areas Served
SF-1-16 and EF-1-26; 27	North-End
FN-826-008A (System A) FN-826-008B (System B) SF-1-24	Control Room and old Cable Spreading Room
SF-1-19 and EF-1-18; 19	South-End
SF-1-20 and EF-1-20	Battery Room and M-G Room
SF-1-21 and EF-1-21	'B' 480V Switchgear Room Supply and Exhaust Fans
FN-56-004	'A' 480 V Switchgear Room Supply Fan
FN-56-007	'A' 480 V Switchgear Room Exhaust Fan
FN-56-008	'A' 480 V Switchear Room Alternate Exhaust Fan
SF-1-17 (HVAC System)	Chem. Lab. (Office Bldg. N. End)

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection Program

The GPUN Fire Hazards Analysis Report (FHAR) describes the fire protection configuration for confinement, detection, extinguishment of fires and demonstrates the capability to achieve and maintain safe shutdown condition in the event of a fire in support of the Fire Protection Program functions.

OCNGS procedure 101.2, "Fire Protection Program", defines the goals, functions, controls, responsibilities and authority of the plant fire protection organization and interfacing departments for implementation of the Fire Protection Program. This document also defines the operability and surveillance requirements for fire detection/suppression systems and associated instrumentation in safety related areas/zones.

These two documents are considered included in the Fire Protection Program.

9.5.1.1 Design Bases

The overall objectives of the fire protection program are to:

a. Reduce the likelihood of occurrence of fires.

b. Promptly detect and extinguish fires if they occur.

c. Maintain the capability to safely shutdown the plant if fires occur.

d. Prevent the release of a significant amount of radioactive material if fires occur.

The basis criterion for fire protection is set forth in General Design Criterion 3 of Appendix A to 10CFR50. Guidance on the implementation of General Design Criterion 3 is provided in Appendix A of Branch Technical Position 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants." In order to facilitate the review of the fire protection program at the OCNGS, a detailed Fire Hazard Analysis was conducted for the plant. The Fire Hazard Analysis was used as the basis for the comparison to Standard Review Plan Section 9.5.1, Appendix A.

In the Fire Hazard Analysis, particular emphasis was placed on safety related equipment as to location, consequences of loss, and exposure from non safety elated equipment. The rating of structural elements was accomplished to ascertain whether existing reinforced concrete walls are of sufficient size and soundness to contain the design basis fire within areas bounded by these walls.

The concept of defense-in-depth has been incorporated into the design and operation of the facility through the implementation of the following measures:

a. Noncombustible materials are used in plant construction whenever possible. The plant design emphasizes minimal use and exposure of materials which are not fire resistant.
b. Administrative measures are implemented to prohibit bulk storage of combustible materials inside buildings which contain safety related equipment, or adjacent to safety related systems, during operation or maintenance periods.

c. Work involving ignition sources is performed under strict supervision, and the procedures governing such work are reviewed and approved by a fire protection specialist.

d. Commercially available aerosol techniques are used in determining the direction of air flows, and in testing for leaks. Open flames or combustion generated smoke are not permitted.

e. Filters, dry ion exchange resins or other combustible supplies used in safety related areas are controlled. Replacement filters or other combustible supplies will not be stored in equipment rooms.

f. Wood scaffolding or lay down blocks, which are used during maintenance periods within areas containing safety related equipment, are treated to make them fire retardant, and would be used only if suitable noncombustible substitutes are not available. This material is removed from the area after use.

g. Adherence to the requirements for quality assurance contained in the Operational Quality Assurance Plan (Section 17.2).

Potentially hazardous materials used on site identified in the Fire Hazard Analysis Report include: mineral oil, turbine oil, grease, Class A Materials (paper, wood), charcoal, electrical cables, resins and plastics. These materials are quantified by building, and by elevation and/or room within each building, in the Fire Hazard Analysis.

The adequacy of fire protection for any particular plant safety system or area must be determined by analysis of the effects of a postulated fire relative to maintaining the ability to safely shutdown the plant and minimize radioactive releases to the environment. There are several arrangements of safe shutdown systems which are capable of shutting down the reactor and cooling the core during and subsequent to a fire. The exact arrangement available in a fire situation depends upon the effects of a fire on such systems, their power supplies and control status. To preclude a single event from affecting redundant systems, adequate separation criteria and/or fire protection capability requirements have been established in the design bases such that a fire will not cause the loss of capability to perform the safe shutdown function.

The effects of: (1) breaks in fire protection piping that may result in water flooding damage to safety related equipment, (2) cracks in fire protection piping that may result in water spray damage to safety related equipment, and (3) inadvertent Fire Protection System actuation that may result in damage to safety related equipment, have been considered in the design of the system.

A remote shutdown panel is provided to assure safe shutdown and cooldown of the reactor in the event of fire causing evacuation of the Control Room or loss of Control Room function due to damage in the cable spreading rooms. This capability utilizes Isolation Condenser "B" for decay heat removal and reactor cooldown to establish a safe shutdown condition. This remote shutdown panel is activated through transfer switches which are keylocked and alarmed in the Control Room to prevent inadvertent actuation. The alternate shutdown monitoring instruments are listed in Table 9.5-11.

9.5.1.2 System Description

9.5.1.2.1 Design Features for Fire Protection and Fire Control

The first step in conducting the Fire Hazard Analysis was an identification and evaluation of existing construction for plant buildings. The evaluation included identifying unprotected penetrations through ratable structural elements. Also included was an analysis of interior finishes. All interior finishes and the general type of construction for the plant are noncombustible and fire resistive, respectively, as defined by NFPA Standard No. 220 unless impractical. Where necessary, fire barriers, fire barrier penetrations, isolation dampers, fire doors and fire covers for openings other than doors have been upgraded. Fire rated cable enclosures and fire resistant cable have been provided.

Safety related areas are reasonably accessible for manual fire fighting, and access and egress and considered adequate.

9.5.1.2.2 Codes and Standards

Codes and Standards used in the design and installation of the Fire Protection System are as follows:

a. National Fire Protection Association Standards, as listed below:

Standard	Areas Addressed
NFPA 10	Portable Fire Extinguishers
NFPA 20	Centrifugal Fire Pump
NFPA 72	National Fire Alarm Code
NFPA 13	Sprinkler System Installation
NFPA 12A	Halon 1301 System
NFPA 14	Standpipe and Hose Systems
NFPA 15	Water Spray Fixed Systems
NFPA 26	Supervision of Valves
NFPA 70	National Electric Code
NFPA 72D	Proprietary Signaling Systems
NFPA 72E	Automatic Fire Detectors
NFPA 80	Fire Doors and Windows
NFPA 90A	Air Conditioning and Ventilation Systems
NFPA 12	Carbon Dioxide Systems
NFPA 252	Fire Tests, Door Assemblies
NFPA 73	Public Fire Service Communications

b. Nuclear Electric Insurance Limited (NEIL) Standards.

c. American Society for Testing and Materials Standards.

d. IEEE 384-77, "Criteria for Independence of Class 1E Equipment and Circuits."

9.5.1.2.3 Fire Protection Water System

The Fire Protection Water System P&ID and piping layout are presented in Drawings JC-19479 and BR 2192.

Water Supply

The fire protection water supply is provided by two fire pumps taking suction from a pond whose volume is 7.2 million gallons. The pond is formed by a small dam on the Oyster Creek. The two fire pumps are housed in a common pumphouse outside the main fenced area, and supply the plant through a single 14 inch line, approximately 1/4 of a mile long.

To satisfy redundancy requirements, a 350,000 gallon Fire Protection Water Tank with a 2000 gpm capacity electric motor driven fire pump is provided.

Fire Pumps

Two vertical shaft centrifugal main fire pumps are provided (Table 9.5-1) each with a capacity of 2000 gpm at 380 feet TDH while at the same time having the capability to deliver 2250 gpm at 350 feet TDH. The pumps are driven by separate diesel engines. Each engine has its own fuel supply located adjacent to the pumphouse. The pumphouse is a metal structure housing only the fire and pond pumps and their associated control equipment. The fire pumps are arranged to start automatically if the pressure drops due to a large water demand. Either pump can be manually started from the Control Room or at the pump house.

Two 400 gpm capacity automatic electric pond pumps maintain pressure on the fire system (Table 9.5-2).

The emergency motor driven electric fire pump (Table 9.5-3) is rated at 2000 gpm with a discharge pressure of 351 feet. This pump and its associated tank constitute an emergency supply when the primary water supply is not available. The pumphouse is located to the northwest of the Turbine Building. The pump can only be started manually, either at the pumphouse or from the Control Room. This unit is normally isolated from the yard loop.

Fire Water Piping

The single 14 inch supply line from the fire pumps extends to a 12 inch underground loop which encircles the plant. All yard fire hydrants, fixed pipe water suppression systems and interior fire hose lines are supplied by the fire loop. Sectionalizing valves of the post indicator type are provided on the loop to allow isolation of the various sections for maintenance. The piping system is arranged to prevent loss of both primary and backup fire suppression capability from a single failure.

The position of other Fire Protection System control valves whose closure would cause loss of water to systems protecting safety related areas is controlled by either electrical supervision or by locks and periodic inspection.

Yard fire hydrants (Table 9.5-4) have been provided at approximately 250 foot intervals around the exterior of the plant. An auxiliary gate valve is provided on each lateral to permit hydrant maintenance without removing any portion of the fire loop from service. Hose houses are also provided in the yard area. The hydrant hose threads are compatible with local fire departments.

In addition to supplying water for fire protection, the system normally provides seal water to the dilution pumps and the circulating water pumps. The system also provides a source of backup water to the Core Spray System, to the Condensate Storage Tank and to the Isolation Condensers; and backup cooling to the main plant air compressors.

Interior Fire Hose Stations

Interior hose stations have been provided within plant buildings as listed in Table 9.5-5. The stations are located so that all areas containing or exposing safety related systems can be reached with a fire hose not over 100 feet in length.

Spray/Sprinkler Systems

Automatic wet pipe sprinkler and deluge systems, manually actuated preaction sprinkler systems, and an automatic preaction sprinkler system have been provided, as listed in Table 9.5-6.

Foam

Portable aqueous film forming foam equipment is provided in the vicinity of the Diesel Generator Building, located in hose houses.

Flooding Protection

In most areas, curbs, drains and the mounting of equipment above floor level minimizes the potential for flooding damage. In other areas, water will drain out of doors or through grating to lower elevations, such that standing water would not affect safety related equipment. In addition, valves are available to isolate sections of fire suppression piping inside buildings to preclude the buildup of water and thus prevent equipment from being incapacitated due to flooding. Protection is provided where water from suppression system piping breaks would result in sprays or flooding which could damage safety related equipment.

9.5.1.2.4 Gas Fire Suppression Systems

A total flooding carbon dioxide system protects the safety related 4160 volt switchgear area, which is enclosed in fire resistant vaults. This carbon dioxide system is manually actuated. The turbine generator exciter and turbine bearing No. 10 are protected by high pressure CO_2 systems automatically actuated by thermal heat detectors. (Table 9.5-7).

Halon 1301 systems (Table 9.5-7) protect the 480 Volt Switchgear Rooms A and B, the Electric Tray Room, the A/B Battery Room, and critical panels in the Control Room. Automatic actuation is provided in each area.

9.5.1.2.5 Portable Fire Extinguishers

Fire extinguishers have been distributed throughout the plant in accordance with NFPA guidelines.

Portable fire extinguishers are provided in the drywell when open for maintenance.

9.5.1.2.6 Fire Detection and Signaling Systems

Three types of detection systems are provided within the plant (Table 9.5-8): products of combustion (ionization and photo electric), thermal (fixed rate of rise and rate compensated/fixed temperature) and flow switches. For areas that are vital, the alarms are fed to a local alarm panel and then to the Fire Alarm Master Panel in the Control Room. Non-vital systems alarm locally only. Flow switches are used as the only means of detection in wet pipe sprinkler systems which do not have flow alarm valves. For wet pipe sprinkler systems with flow alarm valves, a pressure switch is the only means of detecting a fire. The wet pipe sprinkler systems have fusible heads.

The fire detection and signaling system includes fire detector for all safety related areas. Smoke detectors are provided in the ventilation systems of the Control Room and the Office Building. Actuation of automatic suppression systems transmits an alarm on the signaling system to the Control Room. A unique fire alarm signal is provided in the Control Room.

9.5.1.3 Safety Evaluation

The evaluation of the OCNGS Fire Protection System by area and zone was incorporated into the revised Fire Hazard Analysis, and was submitted to NRC as part of the 10CFR50, Appendix R evaluation on June 30, 1982. (Revision 2 was submitted to NRC on May 3, I984; Revision 3 was submitted to NRC on April 3, 1985; Revision 4 was submitted to NRC on July 12, 1985; Revisions 5 and 6 were submitted on August 25, 1986, Revision 7 was submitted to the NRC on December 1, 1992, Revision 8 was submitted to the NRC July 29, 1993. Revisions 9 to present were (are) submitted to the NRC as part of the UFSAR update and specific dates will no longer be listed in this area. The Fire Protection Program has been evaluated by NRC and found acceptable.

9.5.1.4 Inspection and Testing Requirements

Inspection and testing of the Fire Protection System is performed in accordance with the OCNGS Fire Protection Program.

9.5.1.5 Personnel Qualification and Training

Qualification and training requirements for fire protection personnel is contained in the OCNGS Fire Protection Program.

9.5.2 Communication Systems

The following communication systems are provided at the OCNGS:

a. Paging System - The paging system provides for paging and announcement service, plus private intercommunication between two or more selected stations.

b. Dial Telephone System – This is a standard commercial PBX telephone system.

c. Emergency Phone System – The emergency phone system is a dedicated subsystem of the dial telephone system. The emergency phones are used during plant emergencies and during emergency drills.

d. Surveillance Telephone System - The surveillance phones use a small power source for the talking and signaling circuits.

e. KTY-750 Pagers and Backup Offsite Communications - Use of this system is dedicated for pagers and backup communications to Larrabee and Morristown (JCP&L), the remote control location is in the Control Room “JCP&L Console.”

f. KLX-229 Backup Security and Emergency Planning - Use of this system is for security, radiological emergencies and routine site communications.

g. WSG-792 Repeater Operations - The repeater system is intended to achieve communication between otherwise out of range portable units.

h. Control Room “JCP&L Console” - The “JCP&L Console” incorporates remote capabilities for all transceivers and receivers in the Control Room, provides pager control for the KTY-750 transmitters and can access one channel at any given time through the use of a select button.

i. Microwave System - The system provides the primary communication link between the Control Room and Larrabee, its backup is the KTY-750 system.

j. WPZ8655 Security and Emergency Planning – Use of this system is dedicated to security, radiological emergencies, and routine site communications.

9.5.3 Lighting Systems

Lighting throughout most of the plant and office areas is supplied by fluorescent lamps operating at 277 volts. Fixtures in most areas are fed partly from the "A" distribution system and partly from the "B" system. Outdoor areas are lighted by various types of fixtures mounted on structures and poles. Certain indoor areas where 277 volt power is not readily available are lighted with fluorescent or incandescent lamps operating at 120 volts.

An incandescent lighting system supplied by the 125 volt dc battery system is available for lighting stairwells and halls when ac power fails. One dc lighting panel for Control Room lighting is provided. The panel is fed via an energized ac relay. Failure of relay coil voltage allows the relay to drop out and transfer feed to dc power. Battery operated emergency lanterns with extension cords are installed in corridors and other selected points.

Exit lights are normally powered by 120 volt ac lines with automatic switchover to six volt lights, powered by local six volt rechargeable storage batteries.
Emergency 8 hour battery operated lights are provided in vital plant areas (as required by Appendix R).

9.5.4 Diesel Generator Fuel Oil Storage and Transfer System

9.5.4.1 Design Bases

The electrical characteristics of the Emergency Diesel Generators (EDGs) are described in Section 8.3. Generator size was determined from station design and power requirements. The starting load requirement was considered in sizing the generators. The EDGs are capable of starting and carrying the largest vital loads required under postulated accident conditions.

A 15,150 gallon Diesel Generator Fuel Storage Tank was sized to provide three days of fuel supply, as discussed in the Technical Specifications. The tank is maintained above a level corresponding to a capacity of 14,000 gallons by manually transferring fuel from a 75,000 gallon fuel oil tank, located directly east of the boiler house.

To prevent loss of fuel oil supply to both Emergency Diesel Generators in the event of a Diesel Generator fire, two fuel oil supply lines, one to each engine, have been provided. Each dedicated fuel transfer system is provided with two fuel transfer pumps and appropriate fault indication.

An alternate fuel oil supply capability is provided via a connection off the fuel oil line supplying fuel oil from the 75,000 gallon fuel oil tank to the Diesel Generator Fuel Storage Tank. This connection permits fuel oil to be supplied from the 75,000 gallon fuel oil tank directly to either EDG skid via gravity feed.

The fuel oil lines from the Diesel Fuel Storage Tank to the Emergency Diesel Generators have been upgraded and separated. Both fuel oil lines meet the requirements of ANSI B31.1-1977.

The 15,150 gallon fuel oil tank (Diesel Fuel Storage Tank) can be taken out of service for maintenance, in accordance with Technical Specification, by connecting a tank truck at the fuel oil valve station on the north side of the EDG Building.

9.5.4.2 System Description

The Diesel Generator Fuel Storage Tank, the two Emergency Diesel Generators, and auxiliary equipment are located at grade elevation in a concrete structure located in the southwest area of the site. Fuel oil is stored in a 15,150 gallon vertical steel tank, as shown in Drawing 3E-862-21-1000. The tank is provided with a six inch free vent with a flame arrestor, a local float operated digital level gauge and a water sump with a two inch water drawoff connection and antifreeze drawoff valve. Three inch suction and fill connections are provided.

A single fuel oil suction line is provided from the tank with a shutoff valve in the Diesel Generator Fuel Storage Tank Room. Downstream of this valve, within the tank room, the line branches out into two separate lines, one for each diesel generator set. This room is separated from the Emergency Diesel Generators by a concrete wall. The diesel-generator sets are located within separate compartments. The fuel oil supply lines penetrate the common wall between the Fuel Storage Tank Room and the Diesel Generator No. 1 Room, routing is as shown in Figure 9.5-3. The fuel oil supply line to Diesel Generator No. 2 is protected by a three hour rating fire barrier within the Diesel Generator No. 1 Room.

A check valve and a gate valve in the fill line to the Diesel Fuel Storage Tank inside the tank vault prevents draining the tank by a break in the fill line outside the tank vault.

It is possible to identify a leak in the underground fuel oil piping from the 75,000 gallon tank to the Diesel Fuel Storage Tank. Comparisons of fuel oil metering stations and tank level gauges can be made.

The fuel oil system for each generating unit (Figure 9.5-4) includes an auxiliary fuel tank or day tank located in the unit. This tank has a capacity of 130 gallons and acts as a reservoir for fuel suction and fuel return from the engine. Fuel is drawn from the day tank and through a suction strainer to the engine mounted fuel pump. Fuel from the pump travels through a relief valve to the double element engine mounted fuel filter. After passing through the engine mounted filter, fuel flows through manifolds that extend along both banks of the engine. These manifolds supply fuel to the injectors. The fuel pump delivers more fuel to the injectors than the engine can burn. The excess is used to cool and lubricate the fine working parts of the injectors. It is then returned to the fuel oil day tank through the return fuel sight glass, located on the engine mounted filter housing. A second fuel sight glass (normally empty) indicates whether or not the fuel bypass relief valve has lifted which would occur if a fuel filter becomes plugged.

The fuel transfer system for each diesel generator unit is shown in Drawing 3E-862-21-1000. The equipment consists of two motor driven fuel transfer pumps, a suction strainer for each pump, a discharge filter for each pump, and float level gauges and switches. The fuel level is controlled by the float switches located in the day tank of the generating unit. If the fuel level in the day tank rises above the fuel transfer switch high level, both fuel pumps will be de-energized, preventing tanks overfill. When level returns to normal the fuel transfer pumps will again start at their normal actuation points.

The fuel transfer system (Drawing 3E-862-21-1000) functions as follows: as fuel is consumed and the fuel level drops, the fuel transfer switch activates one fuel transfer pump to maintain fuel level. If the fuel level drops below the fuel transfer switch level, the fuel transfer switch will activate the second transfer pump and the FUEL TRANSFER light on the unit annunciator will come on to indicate a fuel transfer fault. The fault indication does not cause an engine shutdown.

Under normal operating conditions, fuel oil is manually transferred from the 75,000 gallon fuel oil tank to the 15,150 gallon EDG Fuel Storage Tank using transfer pump 1-1, located inside the Auxiliary Boiler House. However, in case of loss of offsite power, this fuel oil transfer pump is only available when EDG #2 (M-39-2) starts (which powers MCC 1B24-460v) along with other administrative controls. Otherwise, the bypass line is utilized, if necessary, to provide fuel oil. The fuel oil is fed to the EDG Skid Mounted Oil Day Tank Transfer Pumps (P-39-13 or P-39-14 for EDG #1 or P-39-15 or P-39-16 for EDG #2). These pumps are rotary style pumps that supply fuel to the EDG day tank. The 75,000 gallon Fuel Oil Storage Tank (T-36-1) has administrative controls to assure that there is a minimum 8 foot level of fuel available to ensure the availability of the Alternate Fuel Supply Line. The pumps require a minimum level of 6 feet 3 inches in the tank to ensure an adequate suction pressure. The 8 foot tank level ensures that sufficient fuel is available to one diesel generator for 24 hours of operation at the maximum capacity KEW load.

9.5.4.3 Design Evaluation

The prime mover is a 4000 HP, 20 cylinder, 45 degree Vee, two cycle, turbocharged diesel engine. Each cylinder has a 9 1/16 inch bore with a 10 inch stroke, providing a piston displacement of 645 cubic inches per cylinder.

The 15,150 gallon Diesel Generator Fuel Storage Tank supplies fuel to the Emergency Diesel Generators. The diesel generator tank is maintained above a level corresponding to a capacity of 14,000 gallons by manually transferring fuel from the 75,000 gallon fuel oil tank. This supply of fuel oil will last three days under the conditions discussed in the Technical Specifications.

If additional fuel is required, such fuel would be available as close as Forked River, which is 2 miles north of the site. Tank truck deliveries could be obtained from Forked River and from Toms River, which is 10 miles north of the site. Deliveries can also be made from Manahawkin, which is 10 miles south of the site. Larger tank truck deliveries could be obtained within 6 to 12 hours from Atlantic City, Philadelphia, Trenton, or Perth Amboy, all of which are within a 50 mile radius.

Truck shipment of fuel could be made to the plant from either the north or south directions via U.S. Highway Route 9 or the State of New Jersey Garden State Parkway. In the event access via Route 9 was blocked in both directions, access would still be possible from the Garden State Parkway over company owned property.

Fire detection equipment has been provided in the Emergency Diesel Generator Building. The door between the two Diesel Generator Rooms is three hour fire rated, and the fuel oil supply line to Diesel Generator No. 2 is protected by fire barriers in the Diesel Generator No. 1 Room.

The following provisions enhance Emergency Diesel Generator reliability:

a. The Diesel Generator Fuel Storage Tank and each Emergency Diesel Generator unit are enclosed in individual rooms separated by fire barriers.

b. There is a fuel oil supply line to each diesel generator unit.

c. An auxiliary day tank is provided for each engine.

d. The fuel transfer system for each engine features two pumps.

e. All system malfunctions are alarmed.

f. The Diesel Generator Building compartments are provided with fire detection and fire fighting equipment.

9.5.5 Diesel Generator Cooling Water System

A schematic flow diagram of the cooling system is shown in Figure 9.5-6. Water is circulated through the engine by means of two centrifugal pumps mounted on the front of the engine. The pumps are driven from the front or accessory gear train of the engine. Heated water from the discharge manifold leaves the engine and flows through the water outlet to the radiators. A 135,000 CFM shaft driven fan is mounted at the front of the EDG skid to remove heat from the cooling water radiators. Air is drawn from a grated roof section at the north end of the enclosure and travels down to the louvers and fan at the south end.

Water from the radiators is piped to the lube oil cooler, and from there to the engine water pumps. A temperature switch manifold is mounted on the accessory rack and connected to the inlet piping of the cooler. An immersion heater temperature switch, an engine temperature switch, and a louver control thermistor are mounted on the temperature control manifold. Louvered blade position is controlled by the thermistor and a motorized positioner to vary the air flow across the radiators as required.

During shutdown, the immersion heater temperature switch operates to turn the immersion heater elements on and off to maintain lubricating oil temperature. Water circulates by thermo siphon action through the lube oil cooler, which under these conditions functions as a lube oil heater.

The radiator and its piping are mounted in such a manner as to permit them to drain empty during engine shutdown. This condition eliminates the need for antifreeze in the cooling system. The engine automatically starts and goes to idle speed if the oil temperature falls, indicating potential immersion heater failure. The engine will shutdown and return to standby when temperature returns to normal standby levels.

9.5.6 Diesel Generator Starting System

9.5.6.1 Engine Starting Motor

Two electric starting motors are used to crank the diesel engine during starting. Each motor is equipped with its own starting solenoid and pinion gear. The 64V starters are wired in series for greater starting torque and comprise one starting unit for the diesel.

Upon a start signal, the starting circuit provides for up to three attempts to engage the starter motor pinions with the ring gear, three failed pinion engagement attempts initiate a sequence shutdown. Additionally, cranking time is nominally limited to 15 seconds. If the engine does not come up to speed within the nominal 15 seconds, a sequence shutdown is initiated. A sequence shutdown due to either these failed pinion attempts or failure to fire the engine annunciates in the Control Room to alert the operators. Operators may manually reinitiate a start sequence from the Control Room. A speed sensing device de-energizes the starting circuit after the engine fires and is accelerating.

During surveillance starts, a starting resistor is used to reduce voltage to the starting motor during the first four seconds of cranking. This limits the cranking torque and prevents buildup of momentum for the first revolution of the engine. Should a hydraulically locked piston be encountered, the engine will cease to rotate. Protective circuits will signal a starting fault and lock the engine out. If the engine is free to rotate, full voltage is applied after four seconds and fuel is injected into the cylinders. The starting resistor is bypassed during emergency starts and during an ECCS signal or low oil temperature initiated starts.

9.5.6.2 Battery Charger

A battery charger is located at each unit, mounted within the generator control compartment. The battery chargers are completely automatic, solid state, constant voltage devices featuring ac voltage compensation, dc voltage regulation and current limiting.

In case of an ac power failure a relay in the charger disconnects the automatic control and thereby eliminates any unnecessary drain on the battery. The charger will automatically resume charging upon return of ac power. During engine cranking, a contactor opens the charger circuit to the battery to avoid excessive charger current and recloses to the battery when the starter motors are dropped out of the circuit.

The charger will charge to its maximum current capacity and begin to limit current if overloaded. The automatic current limiting feature controls the output of the charger to a maximum of 140 percent rated load.

A potentiometer is provided to adjust the dc output so that the desired float voltage may be maintained. An equalizing charge, is initiated by setting the timer control for any amount of time up to 24 hours. The charger will automatically hold the cell voltage at equalizing voltage for the preset time and will drop back to float voltage when the time times out.

9.5.6.3 Batteries

The batteries are located at each unit on either side of the engine under the engine floor ramps. Each 120 volt battery is composed of 56 cells rated at 440 ampere-hours. Surveillance, operating and setpoint requirements are provided in the Technical Specifications. A low battery voltage condition for either diesel unit will be detected and alarmed in the Control Room.

9.5.7 Diesel Generator Lubrication System

The schematic diagram (Figure 9.5-7) and the following paragraphs cover that part of the lube oil system that is external to the engine on the EDG skid.

Each Diesel Generator is equipped with an auto lubrication and warming system. These systems operate continuously to maintain the diesels in a standby condition to reduce engine wear during surveillance fast start testing. An immersion water heater heats the cooling water and circulates it through the lube oil cooler by thermosyphon action. The lube oil is warmed in the lube oil cooler and circulated through the engine by a circulating oil pump. This method utilizes the large surface area of the lube oil cooler and prevents carbonization that might occur if the oil was heated directly.

If the immersion heater is unable to maintain adequate oil temperature or if a failure occurs in the immersion heating system, the lube oil temperature switch trips to initiate an engine idle start. The engine will then idle until oil temperature increases to a normal level.

A separate AC turbocharger oil pump circulates warm oil to turbocharger bearings when the diesel is not running. It also provides cooling oil to remove residual heat from the turbocharger bearing immediately after shutdown. A backup DC turbocharger oil pump is available in case the AC pump fails.

When the engine is operating, three lube oil pumps circulate lube oil for lubrication and cooling of engine components. The main lube oil pump takes a suction from the strainer housing and supplies oil under pressure to most of the moving parts of the engine. A piston cooling oil pump receives oil from a common suction with the main lube oil pump and delivers oil to the piston cooling oil manifolds. The scavenging oil pump takes oil through a strainer from the oil sump. Oil is then directed through the oil filter and cooler, returning to the strainer housing to supply the main lube oil and piston cooling oil pump.

9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

Intake air is drawn from the diesel generator rooms through two filters, exhaust is directed outside the building.

An inertial air filter (Figure 9.5-8) is built into the generator end of the unit and is located above the electrical control cabinet. It supplies filtered air for engine fuel combustion, generator cooling and electrical component cooling.

Ambient air enters the generator compartment through the inertial air filters. The filters are made up of wedge shaped cells which have "U" shaped slots forming each wall of the wedge as shown in Figure 9.5-8. Dirt removed by these filters is expelled through the side of the generating unit by an engine driven Dust Bin Blower.

Engine air then travels through the engine filter assembly into the turbocharger inlet. The engine filter is composed of nine panel type oil bath filters. Oil level and cleanliness are checked periodically.

An additional portion of the air brought in through the inertial air filter is drawn into the generator housing by a second fan on the engine driven dust bin blower shaft. This air circulates through the generator for cooling and exits through the rear of the generator into the engine cabin. This air circulates over the engine and exhaust manifold and is discharged through air vents at each side of the front of the engine compartment.

9.5.9 Diesel Generator Controls and Instrumentation

9.5.9.1 Engine Speed Governor

The governor control system consists of the following assemblies: EGB-13PR hydraulic actuator, Load Sharing and Speed Control, Automatic Power Transfer & Control, Automatic Synchronizer, Digital Reference Unit and other associated relays and components. A brief description of the components is provided in the following paragraphs.

9.5.9.1.1 The purpose of the EGB-13PR hydraulic actuator is to control fuel flow to the engine, as necessary, to maintain the generating unit at a constant predetermined speed. The actuator contains a complete centrifugal governor and the output stage (an electrically operated transducer) of the electrical governor. During normal operation, the transducer controls fuel to the engine in response to a control signal received from the 2301A load sharing and speed control.

If no signal is received from the 2301A load sharing and speed control, the transducer is inoperative and the centrifugal governor assumes control of engine speed mechanically. Therefore, the centrifugal governor provides "backup" control for the transducer. The configuration of the actuator is energize to run and fail to the high speed control so that the engine continues to operate for a failed electric signal.

9.5.9.1.2 The 2301A load sharing and speed control provides signals to the electrically operated transducer located in the EGB-13PR hydraulic actuator. The transducer responds to the signals and controls the hydraulic actuator to maintain a constant, predetermined, engine speed. The 2301A load sharing and speed control receives a speed reference signal internally (for auto operation), or from the digital reference unit for manual speed adjustment. Current, voltage, and frequency signals are provided to the 2301A load sharing and speed control by the generating unit. Steady state load and/or speed control is maintained for operating temperature range of -40 to +185°F. This wide operating temperature range enables precise load/frequency control regardless of machine or ambient temperature.

The governor control design modes are Isochronous for single generator deadline operation and Isochronous-Loadsharing for parallel system operation (synchronized to infinite bus).

9.5.9.1.3 The Automatic Power and Load Control (APTL) is designed to be used with a load sharing and speed control (2301A) to automatically control the unloading and base-load setting of an engine-generator set. The APTL control also provides a bumpless transfer at the moment of connecting or separating an engine-generator set from a utility (infinite bus). The APTL controls load via the 2301A load sharing lines when the diesel generator is operating in parallel with the utility. The APTL is inactive (no signal) when the diesel is operating in deadline mode.

The APTL has an operating temperature range of -40 to +185°F. This wide operating temperature range enables precise load control regardless of machine or ambient temperature.

9.5.9.1.4 The SPM-A Automatic Synchronizer biases the speed of an off-line generator set so that the frequency and phase match those of the bus. Then it automatically issues a contact closure signal to close the circuit breaker when phase and frequency are matched within limits for a specified minimum period of time. The SPM-A is a phase-locked-loop synchronizer and strives for a perfect match of frequency and phase.

9.5.9.1.5 Other associated components, such as the Digital Reference Unit (DRU) and Speed Switch provide various input.

The DRU is used in place of a conventional Motor Operated Potentiometer (MOP). It has adjustable setpoints, one of which is used to reset the governor system to rated value upon each shutdown.

The speed sensing relay has independently adjustable switch setpoints. These setpoints operate other control relays to sequence EDG starting, excitation and shutdown functions.

9.5.9.1.6 Deleted

9.5.9.2 Protective Devices

Phase Sequence Voltage Relay, 47

The 47 relay functions on polyphase voltage in the desired phase sequence. Operation of relay 47 issues a trip to the generator breaker when phase sequence voltage increases above a predetermined value. The 47 relay is bypassed in deadline operation.

Leading VARS Relay, 55

The leading VARS relay 55 is a directional power relay connected to sense leading VARS. Operation of relay 55 issues a trip to the generator breaker when leading VARS increase above a predetermined value. The 55 relay is bypassed in deadline operation.

Overvoltage Relay, 59

The overvoltage relay 59 senses generator output voltage and initiates a unit shutdown on overvoltage conditions. During surveillance mode, an overvoltage condition will initiate a normal shutdown with lockout protection. The 59 relay is bypassed during a fast start condition.

Reverse Power Relay, 67

The reverse power relay 67 senses a reverse power condition and initiates a unit shutdown. When a reverse power condition is sensed, the 67 relay issues a circuit breaker trip signal and an engine stop signal. The 67 relay is bypassed in deadline operation.

Underfrequency Relay, 81

The 81 relay functions on an underfrequency condition. Operation of relay 81 issues a trip to the generator breaker when frequency decreases below a predetermined value. The 81 relay is bypassed in deadline operation.

Differential Current Relay, 87G

The differential current relay 87G protects the diesel generator by initiating a unit shutdown and lockout when a ground or phase fault is detected. The 87 relay is operable in all modes of operation.

Engine Water Temperature Switch, ETS

The engine water temperature switch, ETS, protects the engine by initiating a shutdown on over temperature condition. The ETS switch is bypassed during a fast start condition.

Low Water Pressure Switch, LWS

The low water pressure switch, LWS, provides an ENGINE fault indication and initiates a shutdown in case of low water pressure. The LWS switch is bypassed during a fast start condition.

Main Bearing Oil Pressure Switches, MB-1 and MB-2

The main bearing oil pressure switches, MB-1 and MB-2, provide an ENGINE fault indication and initiate a shutdown on low oil pressure is sensed. Time delays are provided to allow oil pressure to build up during engine start. Both pressure switches are bypassed during a fast start condition.

Crankcase Pressure Detector

The crankcase pressure detector protects the engine from faults that result in a positive, rather than the normally negative, crankcase pressure. If a positive pressure is detected, the device dumps oil from the main bearing oil pressure switches sensing line, activating those switches. Since the main bearing oil pressure switches are bypassed during a fast start condition, the crankcase pressure detector is bypassed as well.

Overspeed Trip Mechanism and Overspeed Trip Limit Switch, OTLS

The overspeed trip mechanism trips the fuel racks to shutdown the engine on an overspeed condition. The overspeed trip limit switch, OTLS is actuated by the overspeed trip mechanism lever. The limit switch provides an ENGINE fault indication and initiates a shutdown. OTLS is bypassed during a fast start condition, the overspeed trip mechanism, however, is not bypassed.

9.5.9.3 Alarms and Annunciators

The local annunciator is located on a door of the electrical control cabinet. It contains neon bulb target lights that go on when the annunciator relays are tripped by electrical or mechanical faults.

Provision is made for remote annunciator reset from the Control Room. Operation of the remote reset pushbutton will reset all "Corrected Faults" except engine overspeed, generator lockout or manual stop position of the local selector switch.

Once tripped each protective device associated with the annunciator will seal itself in and must be reset.

Certain annunciator relays, in addition to giving visual indication, will interrupt the circuit to the normal lockout relay; and the unit will go off the line. The engine will either stop immediately or will idle for 15 minutes before total shutdown. Annunciator relays are presented in Table 9.5-9. Alarms are presented in Table 9.5-10.

9.5.10 Operability Requirements

Operability requirements and testing and surveillance requirements for the Emergency Diesel Generator System are covered in the Technical Specifications.

TABLE 9.5-1
(Sheet 1 of 1)

DIESEL DRIVEN FIRE PUMPS DESIGN CHARACTERISTICS

Pump		
Type	Vertical four stage wet pit turbine pump.	
Design Capacity	2000 gpm at 380 ft TDH 2250 gpm at 350 ft TDH	
Bhp	241 at 2000 gpm 256 at 2500 gpm	
Minimum Flow	50 gpm	
Materials		
Discharge head	Moly iron, Class 35, epoxy coated	
Column	Steel, epoxy coated	
Lineshaft	Steel, AISI 304	
Bowl assembly	Bronze, SAE 63 zincless	
Wear Rings	Stainless Steel	
Lubrication	Open lineshaft, water lubricated	
Cooling Water Requirements	5 gpm	
Engine	Fire Diesel #1	Fire Diesel #2
Type	Six Cylinder Diesel	Six Cylinder Diesel
Displacement	855 cu in.	855 cu in.
Horsepower	300 at 1800 RPM	320 at 1760 RPM 340 at 2100 RPM
Fuel Oil System	Primary and secondary filters, metallic flexible fuel lines on engine	Primary and secondary filters, metallic flexible fuel lines on engine
Cooling System	Closed type with circulating pump, heat exchanger, jacket water heater, pressure regulator, strainer, 3 manual valves, pressure gauge	Closed type with circulating pump, heat exchanger, jacket water heater, pressure regulator, strainer, 3 manual valves, pressure gauge
Cooling Water required	34 gpm	34 gpm
Automatic Starting Equipment Control Panel	24 volt dc operation, with charger	24 volt dc operation, with charger

TABLE 9.5-2
(Sheet 1 of 1)

POND PUMP DESIGN CHARACTERISTICS

Pump	
Type	Vertical multistage wet-pit turbine pump.
Design TDH	250 ft
Design Capacity	400 gpm
Materials	
Discharge head	Moly iron, Class 35
Column	Steel, epoxy coated
Bowl and impellers	Bronze, SAE 63
Shaft	Stainless steel, AISI 316
Wear Rings	Stainless steel, AISI 316
Lubrication	Open lineshaft lubricated by pumped fluid
Motor	
Horsepower	40
Speed	1770 rpm
Full-Load Current	31.3 amp
Power Requirements	460 volts, 3 phase; 120 volts, single phase
Power Source	MCC 1B2A

TABLE 9.5-3
(Sheet 1 of 1)

REDUNDANT FIRE PUMP DESIGN CHARACTERISTICS

Pump	
Design Capacity	2000 gpm
Pressure	351 Feet
Motor	
Horsepower	300
Speed	1775 rpm
Power Requirements	460 volts, 3 phase; 120 volt, single phase
Power Source	MCCIE-17 (Substation 1E-1)

TABLE 9.5-4
(Sheet 1 of 1)

HYDRANTS AND HOSE HOUSES

Hydrant No.	Hose House No.	Location
1	1	North of Turbine Bldg
2	2	West of Chlorination Bldg
3	5	North of Acid and Caustic Tanks
4	3	Next to Gasoline Pump
5	8	Outside Main Office Bldg Lobby
6	10	Southwest of Site Emergency Bldg
7	4	North of Old Radwaste Bldg
8	9	South of Diesel Fuel Tank
9	6	East of Augmented Offgas Bldg
10	7	West of New Radwaste Bldg
11	11	Northeast of Site Emergency Bldg
14	14	Northeast of Low Level Radwaste Bldg
15	15	Southeast of Low Level Radwaste Bldg
16	16	Northwest of Low Level Radwaste Bldg
17	17	Southwest of Low Level Radwaste Bldg

TABLE 9.5-5
(Sheet 1 of 5)

HOSE STATIONS

Hose Station No.	Locations
1	Machine Shop - South Wall
2	Old Q.A. Storeroom - East Wall
3	Turbine Basement by Hydrogen Seal Oil Unit
4	Turbine Basement by Stator Cooling Unit
5	Turbine Basement Outside SJAE Door
6	Turbine Basement - Feed Pump Room East Wall
7	Turbine Basement - Feed Pump Room West Wall
8	Turbine Oil Tank NE Wall
9	Turbine Oil Tank NW Wall
10	Condenser Bay East by "A" Condenser
11	Condenser Bay West by "A" Condenser
12	Condenser Bay West by "C" Condenser
13	Condenser Bay East by "C" Condenser
14	Turbine Operating Floor – East Wall by Overhead Door
15	Turbine Operating Floor – East Wall by "C" Hood
16	Turbine Operating Floor – East Wall by "A" Hood
17	Turbine Operating Floor – North Wall
18	Turbine Operating Floor – West Wall by "A" Hood
19	Turbine Operating Floor – West Wall by "B" Hood

TABLE 9.5-5
(Sheet 2 of 5)

HOSE STATIONS

Hose Station No.	Locations
20	Turbine Operating Floor - West Wall by Lift Pumps
21	Office Building Third Floor by Lunch Room
22	Office Building Second Floor by North Stairwell
23	Boiler House SE Corner
24	Old Warehouse North Wall
25	Old Warehouse South Wall
26	AOG Building - Second Floor SW Corner
27	Feedwater Heater Bay – West*
28	Feedwater Heater Bay – East*
29	Reactor Building 23' NE
30	Reactor Building 23' NW
31	Reactor Building 23' SE
32	Reactor Building 23' SW
33	Reactor Building 23' outside drywell airlock
34	Reactor Building - 1'11" NW (CRD Pump Rm)
35	Reactor Building - 6'5" SW (RBEDT Room)
36	Reactor Building - 19' NE
37	Reactor Building - 19' SE
38	Reactor Building - 51' NE
39	Reactor Building - 51' NW

TABLE 9.5-5
(Sheet 3 of 5)

HOSE STATIONS

Hose Station No.	Locations
40	Reactor Building - 51' SE
41	Reactor Building - 51' SW
42	Reactor Building - 75' NE
43	Reactor Building - 75' NW
44	Reactor Building - 75' SE
45	Reactor Building - 75' SW
46	Reactor Building - 95' NE
47	Reactor Building - 95' NW
48	Reactor Building - 95' SE
49	Reactor Building - 95' SW
50	Reactor Building - 119' N
51	Reactor Building - 119' S
52	Outside Cable Spreading Room
53	Outside Control Room
54	Outside Chem Lab and Laundry Room
55	Turb. Bldg. Basement near Cond. Bay South Door
56	New Warehouse - Center North Wall
57	New Warehouse - NE Corner
58	New Warehouse - Center East Wall

TABLE 9.5-5
(Sheet 4 of 5)

HOSE STATIONS

Hose Station No.	Locations
59	New Warehouse - Near West Wall Roll-up Door
60	New Warehouse – SW Corner
61	New Warehouse - North Near Roll-up Door
62	New Warehouse – Second Floor
63	Upper Cable Spreading Room
64	Cable Bridge Tunnel
65	Site Emergency Bldg - 1st Floor East Entrance
66	Site Emergency Bldg - 1st Floor West Entrance
67	Site Emergency Bldg - 2nd Floor East Stairwell
68	Site Emergency Bldg - 2nd Floor Southwest Stairwell
69	Low Level Radwaste - Service Head Center Hall
70	Low Level Radwaste - South Wall Elec. Equip. Room
71	Low Level Radwaste - Cell Storage Southwest
72	Low Level Radwaste - Cell Storage Southeast
73	Low Level Radwaste - Truck Bay South Wall
74	Low Level Radwaste - Cell Storage Northwest
77	Low Level Radwaste - Cell Storage Northeast
80	Low Level Radwaste - DAW Storage South Wall
81	Low Level Radwaste - DAW Compaction Room East Wall
82	Low Level Radwaste - DAW Storage East Wall
83	Low Level Radwaste - DAW Storage West Wall

TABLE 9.5-5
(Sheet 5 of 5)

Hose Station No.	Locations
86	Fresh Water Pmp House Test Header/Hose Connection
90	34’-6” Machine Shop – North Wall
91	23’-6” Turbine Bldg – Column D3
92	23’-6” Turbine Bldg – NE Entrance to 4160V Room

TABLE 9.5-6
(Sheet 1 of 2)

SPRINKLER SYSTEMS

Sprinkler System No.	Area
1	Turbine Building Basement South, Hydrogen Seal Oil Unit Area, Turbine Building Operating Floor Lift Pump Area
2	Turbine Building - Condenser Bay
3	Turbine Building Basement North, Turbine Mezzanine North
4	Office Building - Reactor Recirculation Pump M-G Set Room
5	Old Warehouse (Bldg. 4)
6	Machine Shop, Tool Room, Electric Shop and Radiation Control Office (Bldg. 3)
7	Turbine Building Operating Floor - Bearing No. 1 through 9
8	New Warehouse
9	Turbine Building Basement South
10	Reactor Building - El. 119'
11	Reactor Building - El. 75' (Primary Spent Fuel Pool Cooling Pumps)
12	Office Building - Operations Support Area, Monitor & Change Room, Stairway
14	New Maintenance Building and Machine Shop
15	Office Building - Upper Cable Spreading Room & MUX Corridor
16	Deleted
17A 17B	Site Emergency Bldg
18	LLRW Service Head, Truck Bay, Cell Storage Areas
19	LLRW DAW Storage, Compactor Areas
20A	New Office Building, 1st. Floor
20B	New Office Building, 2nd. Floor
20C	New Office Building, 3rd. Floor
21 (Dry Pipe)	Heater Bay Roof Buildings
22 (Automatic Preaction)	Turbine Building 1A & 1B 4160V Room, 1C & 1D Switchgear Vault Roof Area and C Battery Room

TABLE 9.5-6
(Sheet 2 of 2)

SPRAY SYSTEMS

Deluge System No.	Area
1	Turbine Building - Main Transformer 1A, Auxiliary Transformer, Main Generator Bus Penetration
2	Turbine Building - Main Transfer 1B, Startup Transformer A, Startup Transformer B, Main Generator Bus Penetration
3	Turbine Building Basement North - Turbine Lube Oil Bay (Lube Oil Tanks A and B)
4A 4B	Office Building - Cable Spreading Room
5	Reactor Building North - Cable Trays at El. 51'
6	Reactor Building South - Cable Trays at El. 51'
7	Reactor Building North - Cable Trays at El. 23'
8	Reactor Building South - Cable Trays at El. 23'
9 (Preaction)	Fire Pumphouse - Inside Building, Fuel Oil Tanks A and B
10 (Dry Pilot)	Station Blackout (SBO) Transformer
12	Deleted
13	Deleted
16 (Manual Preaction)	Cable Tray Bridge Tunnels

TABLE 9.5-7
(Sheet 1 of 1)

GASEOUS DISCHARGE SYSTEMS

Halon 1301 Systems	Location
Battery Room/Cable Tray Room	Office Building - Battery Room A and B, Electric Tray Room and Tunnel
480 Volt Switchgear	480 Volt Switchgear Rooms A and B between Reactor Building and Turbine Building at El. 23'.
Control Room (Systems A, B and C)	Office Building - Critical Control Room Panels
Site Emergency Bldg	Computer Room, Battery Room and Elec. Equip. Room

CO_2 Systems	Location
High Pressure CO_2 Systems	Turbine Building - Genrator Exciter and Turbine Bearing No. 10
Low Pressure CO_2 Systems	Turbine Building - 4160 Volt Switchgear General Area, New Vault Area (C and D Sections)

TABLE 9.5-8
(Sheet 1 of 4)

FIRE DETECTION INSTRUMENTATION

Location	Detector Zone	Required No. of Detectors
Reactor Building El. 119'	Sprinkler System No. 10	1 (WFS)*
Reactor Building El. 95'	(Ionization)	24
Reactor Building El. 75'	(Ionization)	22
Reactor Building El. 75'	Sprinkler System No. 11	1 (WFS)*
Reactor Building El. 51'	1-North (Photoelectric)	** and +
Reactor Building El. 51'	2-North (Linear Heat Detection)	** all zones operable
Reactor Building El. 51'	1-South (Photoelectric)	** and +
Reactor Building El. 51'	2-South (Linear Heat Detection)	** all zones operable
Reactor Building El. 38'/51'	Shutdown Pump Room (Photoelectric)	7
Reactor Building El. 23'	1-North (Ionization)	7**
Reactor Building El. 23'	2-North (Ionization)	6**
Reactor Building El. 23'	1-South (Ionization)	6**
Reactor Building El. 23'	2-South (Ionization)	6**
Reactor Building El. (-) 19'	(Ionization)	4 (1 per corner rm.)
4160 Volt Switchgear Room	C & D Vault (Photoelectric)	4 (2 in "C" and 2 in "D")

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* WFS - Water Flow Switch
** Actuate Automatic Suppression System
+ No more than 2 adjacent detectors in any one quadrant shown on drawing DPF 440P-032369 sheet FA4 may be inoperable

TABLE 9.5-8
(Sheet 2 of 4)

FIRE DETECTION INSTRUMENTATION

Location	Detector Zone	Required No. of Detectors
4160 Volt Switchgear Room	General Areas (Photoelectric)	5++
4160 Volt Switchgear Room	Battery Room ("C") Battery (Photoelectric)	2++
Turbine Basement	Feedpump Room & Stairway (Thermal)	7
Turbine Building 23’	Mezzanine South (Thermal)	8
Cable Spreading Room	4A-Zone 1 (Ionization)	3**
Cable Spreading Room	4A-Zone 2 (Ionization)	3**
Cable Spreading Room	4B-Zone 3 (Ionization)	4**
Cable Spreading Room	4B-Zone 4 (Ionization)	5**
Control Room	Gen. Area (Ionization)	6
Control Room	A-Zone 1 (Ionization)	3**
Control Room	A-Zone 2 (Ionization)	3**
Control Room	B-Zone 1 (Ionization)	7**
Control Room	B-Zone 2 (Ionization)	7**
Control Room	C-Zone 1 (Ionization)	1**
Control Room	C-Zone 2 (Ionization)	1**
Control Room	Duct (Ionization)	1
480 Volt Switchgear Room	Zone 1 (Ionization)	3**
480 Volt Switchgear Room	Zone 2 (Ionization)	3**

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[*] WFS - Water Flow Switch
[**] Actuate Automatic Suppression System
[++] Actuates Preaction System

TABLE 9.5-8
(Sheet 3 of 4)

FIRE DETECTION INSTRUMENTATION

Location	Detector Zone	Required No.of Detectors
480 Volt Switchgear Room	Zone 3 (Ionization)	7[**]
480 Volt Switchgear Room	Zone 4 (Ionization)	6[**]
480 Volt Switchgear Room	Corridor (Ionization)	2
"A" and "B" Battery Room	Zone 1 (Ionization)	4[**]
"A" and "B" Battery Room	Zone 2 (Photoelectric)	4[**]
"A" and "B" Battery Room	Zone 4 (Duct) (Ionization)	1**
Reactor Recirculation Pumps MG Set Room	NA	1 (WFS)[*]
Monitor and Control Area	Below Ceiling (Photoelectric)	2
Monitor and Control Area	Above Ceiling (Photoelectric)	10
Monitor and Control Area	Sprinkler System No. 12	1 (PS)[*]
Monitor and Control Area	Hallway and Stairwell (Photoelectric)	3
Condenser Bay	Sprinkler System No. 2	1 (PS)[*]
Turbine Lube Oil Bay	Deluge System No. 3 Thermal (Rate of Rise)	1 (PS)[*]
Turbine Building Basement-South	Sprinkler System No. 9	1 (PS)[*]

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[*] WFS - Water Flow Switch
[**] Actuate Automatic Suppression System

TABLE 9.5-8
(Sheet 4 of 4)

FIRE DETECTION INSTRUMENTATION

Location	Detector Zone	Required No. of Detectors
Transformers	Deluge System No. 1 Thermal (Rate Compensated)	1 (PS)*
Transformers	Deluge System No. 2	1 (PS)*
Emergency Diesel No. 1	Thermal (Rate of Rise)	5
Emergency Diesel No. 1	Photoelectric	1
Fuel Storage Area	Thermal (Rate of Rise)	1
Emergency Diesel No. 2	Thermal (Rate of Rise)	5
Emergency Diesel No. 2	Photoelectric	1
Fire Water Pump House (at Fire Road)	Thermal (Rate of Rise)	2
	Thermal (Rate Compensated/Fixed Temperature)	2
New Cable Spreading Room	Zone 1 (Ionization) Deluge System No. 15	12 (IPS)
Cable Bridge Tunnel	Thermal (Fixed) Manual Preaction No. 16	1 (PS)*

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* PS - Pressure Switch

TABLE 9.5-9
(Sheet 1 of 1)

DIESEL GENERATOR ANNUNCIATOR RELAYS

Designation	Condition	Remarks
Fuel Transfer (FT)	Normally high or low day tank level	Does not affect engine operation (no shutdown)
Sequence (SEQ)	Abnormal condition during starting	Initiates a normal shutdown sequence
Engine Temperature (ET)	Coolant temperature excessive	Initiates a normal shutdown sequence (bypassed in fast start mode)
Generator Breaker (GB)	The 52 circuit breaker tripped open during operation under load (may be accompanied by engine fault)	Initiates a normal shutdown sequence
Engine (EN)	One of four faults: 1) Low Lube Oil Pressure; 2) Positive Crankcase Press.; 3) Low Water Pressure; 4) Engine Overspeed	Generating Unit 52 circuit breaker trips open, and engine stops immediately and is locked out without timed delay period (bypassed in fast start mode)

TABLE 9.5-10
(Sheet 1 of 1)

DIESEL GENERATOR ALARMS

1. EDG DISABLED

   Normal engine lockout due to any of the following annunciator relay trips: Sequence, engine temperature, engine, or generator breaker. See Table 9.5-9.

2. EDG ENG TEMP HI

   See Table 9.5-9.

3. EDG CNTRL DC LO/LOST

   \- Two inputs

   (A) DC voltage lost at DG breaker; diesel is disabled because breaker will not close

   (B) Low Battery voltage; setpoint designed to provide sufficient voltage to start DG. (Tech. Spec. Sec. 4.7)

4. EDG OV/GND

   \- Two Inputs

   (A) Neutral overvoltage (59), possibility of a generator fault.

   (B) DC Ground (64X/DG), Ground on + OR - Bus.

5. EDG NOT IN AUTO

   Local mode selector switch at SWGR out of normal "Auto" Position or other test control switches are out of normal position.

6. EDG Fuel HI/LO/LUBE LOST

   Fuel transfer fault (FT) or loss of standby lube oil pressure.

7. EDG LKOUT RELAY TRIP

   Diesel Generator lockout relay actuation (differential current).

TABLE 9.5-11
(Sheet 1 of 1)

ALTERNATE SHUTDOWN MONITORING INSTRUMENTATION

Functional Unit	Readout Location	Min. Channels Operable
Reactor Pressure	RSP	1
Reactor Water Level (fuel zone)	RSP	1
Condensate Storage Tank Level	Local	1
Service Water Pump Discharge Pressure	Local	1
Control Rod Drive System Flow Meter	Rx 23' near V-15-30	1
Shutdown Cooling System Flow Meter	Local	1
Isolation Condenser "B" Shell Water Level	RSP	1
Reactor Bldg. Closed Cooling Water Pump Discharge Pressure	Local	1

(RSP-Remote Shutdown Panel)