SECTION 9

AUXILIARY SYSTEMS

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SECTION 9

AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

The terms “fuel bundle” and “fuel assembly” are used to describe fuel. Individual fuel rods are visible in a “fuel bundle”. Once the “fuel bundle” is channeled, it is called a “fuel assembly”.

HCGS can store and handle either GE or ABB/Westinghouse fuel. Both GE and ABB/Westinghouse fuel may be received as fuel bundles or fuel assemblies. GE fuel bundles may be channeled at HCGS in either the fuel inspection stand or a fuel preparation machine. ABB/Westinghouse fuel bundles may be channeled at HCGS in either the new fuel storage vault or a fuel preparation machine. An ABB/Westinghouse fuel bundle consists of four (4) sub-bundles.

9.1.1 New Fuel Storage

The new fuel storage facility provides specially designed dry, clean storage space for new fuel assemblies and unused, new channels. It provides a safe and effective means of storage and handling of nuclear fuel from the time it reaches the plant in a non-irradiated condition until it enters the spent fuel pool. The facility is located at the refueling floor elevation adjacent to the spent fuel pool.

A new fuel bundle cannot be placed in the new fuel storage racks unless it is channeled (forming a fuel assembly) or inserted into a pre-staged channel to form a fuel assembly. The channel protects the fuel bundle from damage due to interference with the components of the new fuel storage facility and maintains the geometry assumed in the criticality analyses.

9.1.1.1 Design Bases

The design bases for the new fuel storage are as follows:

1. The new fuel storage racks provide storage spaces for up to 230 new fuel assemblies and are designed to withstand all credible static and dynamic loadings.

2. The racks are designed to protect the new fuel assemblies from excessive physical damage, which may cause the release of radioactive materials in excess of 10CFR20 requirements, caused by impacting from either new fuel bundles, new fuel assemblies, or other equipment.

3. The racks are constructed in accordance with the quality assurance requirements of 10CFR50, Appendix B.

4. The new fuel storage racks are categorized as Seismic Category I.

5. The new fuel storage racks and the reinforced concrete structure of the new fuel storage vault are designed to remain functional following a safe shutdown earthquake (SSE).

6. The new fuel storage racks are designed and maintained with sufficient spacing between new fuel assemblies to ensure that when racks are loaded to their administrative limits, the array satisfies the subcriticality requirements (Section 9.1.1.3).

7. Failures of systems or structures not designed to Seismic Category I standards, and located in the vicinity of the new fuel storage facility, do not result in a violation of the subcriticality requirements (Section 9.1.1.3).

8. General compliance or alternate assessment for Regulatory Guide 1.13, which provides design criteria for the building containing the new fuel storage vault, may be found in Section 9.1.2.

9. The design of the new fuel storage racks, the design of any associated loading templates, and the implementation of administrative controls are such that a new fuel bundle (requires pre-staged channel) or fuel assembly cannot be inserted anywhere other than designated storage locations.

10. The biases between the calculated results and experimental results, as well as the uncertainty involved in the calculations, are taken into account as part of the

calculational procedure to ensure that the subcriticality requirements are met (Section 9.1.1.3).

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

9.1.1.2 New Fuel Storage Facility Description

The new fuel storage facility is a reinforced concrete vault. The new fuel rack arrangement is shown on Figure 9.1-1.

The new fuel storage racks contain 23 sets of castings arranged in three tiers. Each tier of castings is supported by two box beams, which are attached to embedment plates in the walls of the new fuel storage vault. Each of the 23 sets of castings can hold up to 10 fuel assemblies. The minimum center to center spacing between fuel assemblies within the row in a casting is 7 inches. The minimum center to center spacing between fuel assemblies in adjacent rows is 12.25 inches.

The subcriticality requirements may limit the number of fuel assemblies and the loading pattern in the new fuel storage racks. In such cases, loading templates will be used to allow the insertion of fuel bundles (require pre-staged channels) or assemblies only in approved locations. These templates are basically metal sheets with holes uncovering the approved locations. If loading templates do not cover the entire new fuel storage vault, then administrative controls will be used to prevent insertion in locations not covered by the loading templates.

The fuel bundles (require pre-staged channels), fuel assemblies, or channels are loaded into the rack through the top. Each hole has adequate clearance to preclude damage on insertion or withdrawal.

The lower casting supports the weight of the fuel assembly and restricts lateral movement; the center and top castings restrict only lateral movement of the fuel assembly. The design of the racks prevents accidental insertion of the fuel assembly in a position not intended for fuel. This is achieved by abutting the sides of each casting to the adjacently installed casting. In this way, the only spaces in the rack are those intended for fuel.

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

The new fuel storage vault is provided with a solid, segmented cover to prevent the entry of foreign objects or substances into the vault. The cover may be part of the subcriticality requirements since it restricts entry of spray of mist leading to optimal moderation conditions. The cover is constructed of 4 steel plates. These plates may also be referred to as the "covers". Underneath this cover, there are 13 separate grating; each covers a maximum of 2 rows of castings. With the gratings installed, no fuel or channel can be inserted into the castings.

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

9.1.1.3 Safety Evaluation

9.1.1.3.1 Criticality Control

10CFR50.68 governs Criticality Accident Requirements for fuel once it is unloaded as new fuel from the vendor's truck. While the new fuel is still on the truck, it is governed by 10CFR71 and the fuel vendor is responsible for the associated transport conditions.

10CFR50.68(a) allows for the holder of an operating license for a nuclear power plant to comply with either 10CFR70.24 or 10CFR50.68(b). Hope Creek complies with 10CFR50.68(b). In addition, Hope Creek complies with the following conditions documented in Operating License Condition 2.C.(6).

1. No more than a total of three (3) fuel bundles and assemblies shall be out of inner shipping containers, NRC-approved dry spent fuel storage systems, the fuel storage racks (new and spent), or the reactor core at any one time.

2. The above three (3) fuel bundles and assemblies, as a group, shall maintain a minimum edge-to-edge spacing of twelve (12) inches from the shipping container arrays and the fuel storage racks (new and spent).

3. New fuel bundles, when stored in their inner or outer shipping containers, shall be stacked no more than three (3) containers high.

10CFR50.68(b) specifies seven (7) conditions under which subcriticality is maintained. Hope Creek meets these seven conditions using the following techniques. NRC approved codes are used for all analyses.

(1) Plant procedures prohibit the handling and storage at any one time of more fuel bundles and assemblies than have been determined to be safely subcritical under the most adverse moderation conditions feasible by unborated water. Limits are established for the number of fuel bundles and assemblies allowed outside of inner shipping containers, fuel storage racks (new and spent), and the reactor core as well as how high shipping containers can be stacked in an array.

(2)&(3) If the new fuel storage racks are used, then an analysis is performed to demonstrate subcriticality for the new fuel storage racks using the acceptance criteria specified in 10CFR50.68(b)(2) and (3). This analysis includes cases for flooding the racks with unborated water and establishing optimal moderation unless administrative controls and/or design features prevent such conditions.

(4) An analysis is performed to demonstrate Subcriticality for the spent fuel storage racks using the acceptance criteria specified in 10CFR50.68(b)(4).

(5) The quantity of non-fuel Special Nuclear Material (SNM) is verified to be less than the quantity necessary for a critical mass as defined in 10CFR70.4. This quantity includes any Salem non-fuel SNM stored at Hope Creek such as unirradiated detectors.

(6) Radiation monitors are provided in storage and associated handling areas when fuel is present to detect excessive radiation levels and to initiate appropriate safety actions.

(7) New fuel pellet enrichment is limited to a maximum nominal enrichment of five (5.0) percent by weight.

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9.1.1.3.2 New Fuel Rack Design

The design of the new fuel rack is as follows:

1. The new fuel storage vault contains 23 sets of castings, each of which may contain up to 10 new fuel assemblies. Each casting set consists of three levels of individual castings which support the fuel assemblies along their length. A maximum of 230 fuel assemblies can be stored.

2. The storage racks provide an individual storage compartment for each fuel assembly and are secured to the vault wall through associated hardware. The fuel assemblies are stored in a vertical position.

3. The weight of the fuel assembly is carried by the lower casting. The middle and upper castings restrict lateral movement.

4. The new fuel storage racks are made of aluminum. Materials used for construction are specified in accordance with the latest issue of applicable ASTM specifications. The material choice is based on a consideration of the susceptibility of various metal combinations to electrochemical reaction. When considering the susceptibility of metals to galvanic corrosion, aluminum and stainless steel are relatively close together insofar as their coupled potential is concerned. Therefore, stainless steel fasteners are used in the aluminum racks to minimize galvanic corrosion.

5. The minimum center to center spacing for the fuel assembly between rows is 12.25 inches. The minimum center to center spacing within the rows is 7 inches. Fuel assembly placement between rows is not possible.

6. Lead in and lead out guides at the top of the racks provide guidance of the fuel assembly during insertion or withdrawal.

7. The rack is designed to withstand the impact force of 3960 foot-pounds, while maintaining the safety design basis. This impact force could be generated by the vertical free fall of a fuel assembly from the height of 6 feet.

8. The storage rack is designed to withstand the pull-up force of 4000 pounds and a horizontal force of 1000 pounds. There are no readily available forces in excess of 1000 pounds. The racks are designed with lead outs to prevent sticking. However, in the event of a stuck fuel assembly, the maximum lifting force of the fuel handling platform grapple, assuming limit switches fail, is 3000 pounds.

9. The storage rack is designed to withstand horizontal combined seismic loads up to 3 gravities.

10. The fuel storage rack is designed to handle nonirradiated, low emission radioactive fuel assemblies. The expected radiation levels are well below the design levels.

11. The fuel storage rack is fabricated from noncombustible materials. Plant procedures and inspection ensure that combustible materials are restricted from this area. The elimination of combustible materials and fluids negates the need for fire protection.

12. Loading templates, if used, are made of aluminum.

9.1.1.4 Tests and Inspections

The new fuel storage facility does not require any special periodic testing or inspection for nuclear safety purposes.

9.1.2 Spent Fuel Storage

The spent fuel storage pool facility provides specially designed underwater storage space for the spent fuel assemblies. The general arrangement of the spent fuel storage pool is shown on Figure 9.1-2.

Spent fuel assemblies are stored in storage racks in the spent fuel pool or in dry storage systems at the on-site Independent Spent Fuel Storage Installation (ISFSI), which is discussed later. The spent fuel racks provide a safe and effective means for storage, cooling, and handling of spent fuel, from the time it is transferred to the spent fuel pool from the reactor, until it is ready for movement to the ISFSI or offsite transfer. The spent fuel is moved underwater and placed in the spent fuel storage racks via the reactor well cavity and through the fuel transfer canal.

New fuel assemblies can be stored temporarily in storage racks in the spent fuel pool prior to transfer to the reactor.

9.1.2.1 Design Bases

The design bases for the spent fuel storage pool facility are as follows:

1. The spent fuel storage pool facility is designed to store fuel assemblies in a subcritical array so that the K_{eff} of fuel in the spent fuel storage racks, when flooded with pure water, shall not exceed 0.95, at a 95 percent probability, 95 percent confidence level under normal and abnormal storage conditions.

a. Normal storage conditions exist when the fuel storage racks are located in the pool and are covered with about 25 feet of water for radiation shielding, and with the maximum number of fuel assemblies in their design storage position.

b. An abnormal storage condition may result from accidental dropping of a fuel assembly, or from damage caused by the horizontal movement of fuel handling equipment without first disengaging the fuel from the hoisting equipment.

2. Not used.

3. The racks are designed to protect the fuel assemblies from physical damage caused by impact from fuel assemblies. The rack design would prevent the release of radioactive materials in excess of 10CFR20 limits under normal and abnormal storage conditions.

4. The racks are constructed in accordance with the QA requirements of 10CFR50, Appendix B.

5. The spent fuel storage racks are constructed in accordance with Seismic Category I requirements. The applicable code for the design of racks is ASME Section III, Subsection NF.

6. Spent fuel storage space is provided in the fuel storage pool to accommodate up to 3976 fuel assemblies.

7. Spent fuel storage racks are designed and arranged so that the fuel assemblies can be handled efficiently during refueling operations.

8. The spent fuel storage pool facility and all piping connections are designed to prevent a loss of cooling water from the spent fuel pool that could uncover the stored fuel.

9. The spent fuel storage pool facility is designed to prevent criticality of stored fuel under adverse environmental and postulated fuel handling accident conditions.

10. Shielding for the stored spent fuel assemblies is designed to protect plant personnel from exposure to direct radiation greater than that permitted for continuous occupational exposure during normal operations.

11. The spent fuel storage pool facility is designed to remain functional during and following a safe shutdown earthquake (SSE).

12. Failures of systems or structures not designed to Seismic Category I standards and located in the vicinity of the spent fuel storage pool facility do not cause a decrease in the subcriticality provided.

13. The spent fuel pool is designed to withstand thermal stresses resulting from the pool water boiling.

14. The rack design prevents accidental insertion of fuel assemblies between adjacent racks.

15. The spent fuel storage pool facility is designed so that failure of structures, systems, or components that are not Seismic Category I will not result in a loss of function of the facility.

The following design bases for the spent fuel storage pool facility and the new fuel storage facility are discussed in the sections indicated below:

1. Seismic and system quality group classifications - Sections 3.2.1 and 3.2.2

2. Protection against dynamic effects associated with postulated rupture of piping - Section 3.6

3. Seismic design - Section 3.7

4. Design of Seismic Category I structures - Section 3.8

5. Environmental design of mechanical and electrical equipment - Section 3.11

6. Fire Protection System - Section 9.5.1.

9.1.2.2 Spent Fuel Storage Pool Facility Description

9.1.2.2.1 General Description

Spent fuel storage racks located in the spent fuel pool are provided for storing spent fuel assemblies discharged from the reactor vessel. New fuel assemblies may also be temporarily stored in the spent fuel pool pending transfer to the reactor vessel. These are top entry racks designed to maintain the fuel in a space

geometry that precludes the possibility of criticality under normal and abnormal conditions.

The location of the spent fuel pool is shown on Figure 9.1-2. A typical spent fuel rack is shown on Figure 9.1-3. The spent fuel rack arrangement in fuel pool is shown on Figure 9.1-4.

9.1.2.2.2 Component Description

9.1.2.2.2.1 Spent Fuel Pool

The spent fuel pool is a reinforced concrete structure that forms an integral part of the Containment Enclosure Building. The pool has a volume of approximately 57,960 ft^3 and is filled with demineralized water to a normal depth of 40 feet 0 inches. This provides about 25 feet of water above the tops of stored fuel assemblies and about 9 feet of water above the active fuel in transit.

The spent fuel pool, reactor well, dryer and separator storage pool, and cask loading pit, including all gates, are designed to Seismic Category I requirements. All pools and the reactor well are lined with stainless steel to minimize leakage and reduce corrosion product formation. The spent fuel pool is designed so that it cannot be drained to a level that uncovers the top of the stored fuel. The cooling water supply lines enter the spent fuel pool from above the normal water level and are provided with high point vent lines to prevent siphoning of water from the pool.

A Leakage Collection System is provided to permit expedient liner leak detection and measurement, and to prevent uncontrolled loss of contaminated pool water to other locations within the Reactor Building. The Leakage Collection System is depicted on Figure 9.1-38 and Plant Drawing M-53-1.

Gravity drain paths are formed behind the full length of each of the thirty-three vertical wall liner weld seams, and behind the full length of the single horizontal wall seam at Elevation 180 feet, by

the wide flange structural beams that are embedded in the Seismic Category I concrete and welded to the liner. These paths guide any wall leakage to the horizontal channels formed by the 2x2x1/4 inch angles welded to both the vertical liner and the horizontal beams around the perimeter at the base of the fuel pool.

Sloped channels in the concrete Seismic Category I floor slab form the leakage collection paths beneath the floor liner. The design segregates potential floor leakage into two source areas. The north area consists of that portion of the floor north of the east-west liner floor seam, and the south area consists of the portion south of the seam. The east-west seam is located approximately one foot south of building column line 21R, shown on Plant Drawing P-0047-1. The floor leak channels for each source area are located between and parallel to each of the north-south floor liner seams, rather than directly behind them. Two east-west channels for each source area, one at each end of the north-south channels, run nearly the full width of the pool as required to tie the north-south channels together.

The wall and floor leakage, depending on area of origin, would gravitate to a drain line, as shown in Table 9.1-16.

The portion of each drain line that is embedded in the Seismic Category I concrete, plus the exposed portion out to the first isolation valve, is classified Seismic Category I. The exposed portion of each drain line downstream of the Seismic Category I boundary is classified non-Seismic Category I, but is seismically analyzed up to an anchor or the piping terminus since it is connected to Seismic Category I piping. The piping quality group classification is shown on Plant Drawing M-53-1.

The 1-inch drain lines are individually routed through the concrete. Because drains number 12 and 15 terminate above the same floor drain collection hub, the seven fuel pool lines terminate above six different radwaste floor drain system collection hubs. Each drain line includes a manual globe type isolation valve.

The source of a liner leak can be identified to the extent that leakage from an individual drain line will be due to a source within the liner leakage area corresponding to that line, as shown in Table 9.1-16. Any leakage will be detected by the periodic visual observation of each drain hub that is required by station procedures. Liner leakage can also be detected from the main control room by observing an increased frequency of operation of the normal fuel pool water makeup system or of the reactor building floor drain sump pumps.

If a leak is not detected by the above methods, and is of magnitude greater than the normal makeup system, the fuel pool skimmer surge tanks low-low level alarm in the main control room will signal the leak. Fuel pool low level is also alarmed in the main control room, and serves as a backup to surge tank low-low level for detection of a liner leak.

The liner is not within the jurisdiction of ASME Section XI and is, therefore, not subject to the HCGS inservice inspection program. The appropriate level of inspection is provided by the station administrative procedures, which require visual inspection of the drain lines. Because the leak detection channels behind the wall and floor liner plates are not designed to be pressure tight, and because the leak detection piping cannot be isolated and pressurized, no tests of the leak detection system are planned.

Control rod storage hangers on the spent fuel pool walls provide storage for 62 control rods.

9.1.2.2.2.2 High Density Spent Fuel Storage Racks

High density spent fuel storage racks in the fuel pool store spent fuel assemblies transferred from the reactor vessel. These are top entry racks.

The spent fuel storage racks are of freestanding design and are not attached to either the fuel pool wall or the fuel pool liner plate. The racks are constructed of stainless steel, and the neutron absorber is Boral. See Figure 9.1-3 for design details of a typical rack and the special rack.

All parts of the spent fuel racks, except the adjusting screws in the feet of each module and the poison material, are made from ASTM A240, Type 304L, stainless steel. The adjusting screws are made from ASTM A564, Type 630 stainless steel with H1100 heat treatment. Heat treatment scale is removed. Boral is the poison material.

Thin (0.024 inch thick) outer canister sheets hold the Boral tightly against the 0.090 inch thick inner canister walls, for the Cimcorp/Par Racks and (.06" thick) outer canister sheets with .060" thick inner walls for the Holtec Racks. The outer canisters are spot welded to the inner canisters along the bottom and both vertical sides of the outer canister. The top edge of each outer canister is seam welded to the inner canister. The poison vents are shown on Figure 9.1-3.

See Appendix 9B for a description of the design, analysis, and construction of the spent fuel storage racks.

The spent fuel pool has been designed for, and now provides, a storage capacity for 3976 fuel assemblies (typical rack), plus 30 multipurpose cavities for storage of control rods, control rod guide tubes, and sources.

Irradiated components and tools can be stored in the spent fuel pool under procedural control.

The spent fuel storage pool and associated fuel handling area is located within the Reactor Building which serves as a low leakage barrier to provide atmospheric isolation.

9.1.2.2.2.3 Refueling Area Cavities

As shown on Figure 9.1-2, the cask loading pit and the reactor well are adjacent to the spent fuel pool. The dryer and separator pool

is adjacent to the reactor well. Like the spent fuel pool, these cavities are lined with stainless steel plate and are provided with liner leakage collection systems. The reactor well and the cask loading pit are connected to the spent fuel pool by fuel transfer canals approximately 4-feet wide. Each canal is provided with two gates and concrete plugs to prevent loss of water from the spent fuel pool during periods when the adjacent cavity is not filled with water.

The cask loading pit is designed to permit the underwater loading of spent fuel assemblies into spent fuel shipping or dry storage canisters inside transfer casks. The pit can be drained of water during periods when cask loading operations are not being performed. The spent fuel shipping or transfer cask can be decontaminated in the cask washdown area on the refueling floor adjacent to the cask loading pit. The Holtec International HI-TRAC 100D transfer cask model is the only dry storage transfer cask currently analyzed for use in the cask loading pit and cask washdown area.

The reactor well is a circular cavity located directly above the primary containment. Removal of the drywell head and reactor vessel head provides direct access from the reactor well to the inside of the reactor vessel. The reactor well is filled with water during transfer of fuel assemblies from the reactor vessel to the spent fuel pool. Seals are provided at the bottom of the reactor well between the drywell and reactor well wall and between the reactor vessel and the drywell to prevent water leakage.

The dryer and separator pool provides for storage of the steam dryer and steam separator when they are removed from the reactor vessel. The dryer and separator pool is connected to the reactor well to permit underwater transfer of components between the two cavities. Concrete seal plugs are provided to minimize water loss during normal and abnormal storage conditions when the reactor well is not filled with water. Gaskets are attached to the horizontal surfaces of the seal plugs to further reduce water loss.

9.1.2.2.2.4 Other Features

The Spent Fuel Pool Area Ventilation System is discussed in Section 9.4.2.

The area radiation and airborne radioactivity monitoring instrumentation is described in Section 12.3.4.

9.1.2.3 Safety Evaluation

9.1.2.3.1 Criticality Control

Geometrically safe configurations of fuel stored in the spent fuel array, and poison materials, are employed to ensure that the K_{eff} of fuel in the spent fuel storage racks, when flooded with pure water, shall not exceed 0.95, at a 95 percent probability, 95 percent confidence level under any normal or abnormal storage condition. To ensure that the design criteria are met, the following normal and abnormal spent fuel storage conditions are analyzed:

1. Normal positioning of fuel assemblies in the spent fuel storage array

2. Eccentric positioning of fuel assemblies in the spent fuel storage array

3. Not used

4. Moving or placing a fuel bundle or assembly along the outside of storage racks

5. Spent fuel assembly falling onto the rack with spent fuel

9.1.2.3.2 High Density Spent Fuel Rack Design Criteria

The principal design criteria of the spent fuel racks are as follows:

1. Up to 3976 fuel assemblies may be stored in the fuel pool.

2. The storage racks provide an individual storage compartment for each fuel assembly. The fuel assemblies are stored in a vertical position with the lower tie plate engaged in a captive slot in the lower fuel rack support plate.

3. The weight of the fuel assembly is held by the lower rack support plate.

4. The spent fuel storage racks are made from 304L stainless steel.

5. The center to center spacing for the fuel assembly within the rows is shown on Figure 9.1-3. Fuel assembly placement between rows is not possible.

6. The racks are designed to withstand the impact force due to the postulated accidental drop of a fuel assembly. A first scenario impact force of 40 kips applied at the top of the rack is generated by the vertical free fall of a fuel assembly from a height of 6 feet. A second scenario impact force of 49.6 kips applied at the lower rack support plate is generated by the vertical fall of a fuel assembly through the height of a storage compartment in addition to the 6 feet free fall height.

7. The storage rack is designed to withstand a pull-up force of 4000 pounds and a horizontal force of 1000 pounds. There are no readily available forces in excess of 1000 pounds. In the event of a stuck fuel assembly, the maximum lifting force of the fuel handling platform grapple, assuming limit switches fail, is 3000 pounds.

8. The maximum stress in the fully loaded rack in a faulted condition is 30.45 Ksi versus an allowable of 36.18 Ksi. This stress occurs at the ball joint of the foot pad and height adjusting screws.

9. The spent fuel storage racks also have the capability of storing control rod guide tubes, control rods, and sources.

10. Several design features reduce the possibility of heavy objects dropping into the fuel pool. The main and auxiliary hoists of the Reactor Building polar crane are single failure proof. In addition, the main hoist is physically prevented from traveling in the truncated segment shown on Figure 9.1-31 by mechanical stops on the girders of the polar crane. The crane design is discussed in Section 9.1.5. The removable guardrail and the four-inch curb around the refueling cavities further limit the possibility of heavy objects dropping into the fuel pool.

11. The fuel storage pool has water shielding for the stored spent fuel. Liquid level sensors are installed to detect a low pool water level. Makeup water is available to ensure that the fuel will not be uncovered should a leak occur.

12. Since the fuel racks are made of noncombustible material and are stored underwater, there is no potential fire hazard. The large water volume also protects the spent fuel storage racks from potential pipe breaks and associated jet impingement loads.

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9.1.2.4 Spent Fuel Rack Inservice Inspection

The Boral Monitoring Program assures the adequacy of the neutron-absorbing material in the spent fuel racks. Boral test coupons are available to support this program. However, since Boral performance at other Boiling Water Reactor (BWR) sites is representative of Boral performance at HCGS, HCGS monitors the Boral test coupon inspection and/or testing results at other BWR sites rather than inspecting and/or testing the HCGS Boral test coupons. The Boral performance at other BWR sites is considered representative for the following reasons.

- Similar Boral manufacturing materials, processes, and tolerances due to a common manufacturer.
- Similar high-density spent fuel rack geometry due to the limited range of nuclear fuel assembly geometry and the limited number of spent fuel rack vendors.
- Similar water chemistry due to common EPRI Water Chemistry standards.
- Similar nuclear fuel radiation characteristics due to the limited number of nuclear fuel vendors and the interchangeability of fuel types.
- Similar nuclear fuel storage practices due to common storage requirements and similar refueling outage practices.
- Demonstrated consistency of Boral test coupon inspection and test results across the BWR fleet.

The Boral Monitoring Program will be expanded to include inspection and/or testing of HCGS Boral test coupons if any of the following conditions is met.

- The inspection and/or test results from other BWR sites indicate a significant reduction in the neutron-absorbing capacity of Boral.
- The inspection and/or test results from other BWR sites indicate that the Boral performance at other BWRs can not be considered representative of the Boral performance at HCGS.
- Operational problems with the HCGS spent fuel racks indicate potential Boral performance outside of industry expectations.

9.1.2.4.1 Test Coupon Description and Installation

There are three Boral test coupon holders (also called “coupon trees”) in the spent fuel pool. The spent fuel pool racks were installed in two major phases. Two of the coupon holders correspond to the racks installed in the first phase (Cimcorp/PaR racks). The remaining coupon holder corresponds to the racks installed in the second phase (Holtec racks).

Each test coupon holder contains multiple Boral test coupons that can be removed for inspection and/or testing. The Boral test coupons were made at the same time as the associated racks. Inspection is performed on-site. Testing is typically performed off-site.

9.1.2.5 SRP Rule Review

In SRP Section 9.1.2, Acceptance Criterion II.1 requires conformance to ANS 57.2, Paragraph 5.1.1, which states that the spent fuel storage facility, including its equipment and safety-related structures, shall be designed to Seismic Category I requirements.

The spent fuel liner plates are non-Seismic Category I and are not considered safety-related. These liner plates are welded to embeds in the pool walls. The primary functions of the liner plates are to minimize pool leakage and facilitate decontamination of the pool walls. Since they are essentially non-load bearing, they will not adversely affect the structural integrity of the fuel pool and the spent fuel storage racks, and therefore do not have to comply with Seismic Category I requirements. Any safety related pool wall attachments will always be affixed to Seismic Category 1 wall embeds.

Acceptance Criterion II.6, ANS 57.2, Paragraph 5.4.1 states that at least one radiation monitor with audible alarm should be installed on the fuel handling machine.

At HCGS, permanent radiation monitors scanning the entire refueling floor are mounted on the reactor building walls. These monitors indicate and actuate audible alarms locally and in the control room. In addition, portable health physics instrumentation will be installed on the fuel handling platform whenever the refueling machine is used over the spent fuel pool and the reactor core. The Radiation Monitoring System, including the portable platform mounted health physics instrumentation, is considered to be adequate for protection of personnel in the reactor building during all phases of station operation.

Acceptance Criterion II.6, ANS 57.2, Paragraph 5.4.2 states that high and low level alarms shall be provided in the spent fuel building and in the control room to indicate if the fuel pool water level falls below, or exceeds, predetermined limits.

At HCGS, high and low fuel pool water level alarms are provided only in the main control room since any corrective action to control the water level generally must be coordinated from that location. The adequacy of the pool water level can be determined locally by visual observation, based on the level of the skimmer weir and scuppers along the pool wall. Periodic visual inspection is performed and the spent fuel pool liner checked for any abnormal leakage whenever the spent fuel pool is filled with water.

9.1.2.6 Dry Spent Fuel Storage

In order to provide necessary additional interim on-site spent fuel storage capacity for HCGS, an Independent Spent Fuel Storage Installation (ISFSI) has been constructed on the Artificial Island site. The dry storage systems have been certified by the NRC in accordance with 10 CFR 72, Subpart L. Channeled or unchanneled spent fuel meeting the specifications in the dry storage system 10 CFR 72 Certificate of Compliance (CoC) may be stored.

The ISFSI is located on the planned site of the HCGS Unit 2 cooling tower. ISFSI licensing and operations are conducted under the general license provisions of 10 CFR 72, Subpart K. The Hope Creek 10 CFR 72.212 evaluation report contains the required licensing and design information to support operations of the ISFSI at HCGS under the general license.

Specific information pertaining to the spent fuel storage system design, operation, and safety analyses may be found in the storage system 10 CFR 72 CoC and updated FSAR, which is controlled by the CoC holder. Fuel assembly transfer and heavy load handling evolutions in the HCGS plant that are required to support spent fuel dry storage operations are governed by the regulations of 10 CFR 50 and associated administrative controls. These evolutions are discussed elsewhere in Section 9 of this UFSAR.

9.1.3 Fuel Pool Cooling and Cleanup System and Torus Water Cleanup System

The Fuel Pool Cooling and Cleanup (FPCC) System is designed to remove decay heat released by the spent fuel assemblies stored in the spent fuel pool, and to purify and minimize contamination and radiation exposure from fission and corrosion product buildup in the pool water. The FPCC system maintains fuel pool water temperature, purity, clarity, and water level within specified limits to facilitate spent fuel handling in a safe and efficient manner.

The Torus Water Cleanup System is designed to maintain suppression pool (torus) water purity, clarity, and level within specified limits.

The FPCC system and the Torus Water Cleanup System have no function related to the safe shutdown of the plant.

The FPCC system and Torus Water Cleanup System piping and instrumentation diagrams are shown on Plant Drawings M-53-1 and M-54-0.

9.1.3.1 Design Bases

1. The FPCC system is designed to preclude uncovering the spent fuel assemblies in the event of an accidental pipe break or valve opening. This design ensures that an operator error or loss of piping integrity cannot result in loss of water from the fuel pool that could uncover the stored spent fuel.

2. The FPCC system cooling loop (consisting of skimmers, surge tanks, fuel pool cooling pumps, fuel pool heat exchangers, and interconnecting loop piping) and the emergency fuel pool water makeup piping are designed to meet Seismic Category I requirements, except for the surge tanks. The surge tanks are of non-Seismic Category I design, but are embedded in a Seismic Category I concrete structure that provides the pressure boundary for this part of the FPCC system cooling loop. The FPCC system purification loop, consisting of the filter-demineralizers, their interconnecting piping, and associated equipment, is non-Seismic Category I.

3. The FPCC system is designed to handle the decay heat released by all anticipated combinations of spent fuel that could be stored in the fuel pool. The pool water temperature is maintained at a maximum of 135°F under the design load of 17.2×10^6 Btu/h. This heat load is the discharge of a reload quantity of spent fuel (approximately one third of the core) at the end of a fuel cycle, plus the decay heat of the reload spent fuel from all previous refuelings.

4. The FPCC system is designed to permit the Residual Heat Removal (RHR) System to be operated in parallel with the FPCC system through a crosstie, to remove the maximum heat load and to maintain the bulk water temperature in the spent fuel pool at or below 150°F, with a maximum anticipated heat load of 43.0×10^6 Btu/h. This heat load is the discharge of one full core of fuel at the end of a fuel cycle, plus the decay heat of the reload spent fuel from all previous refuelings. If required, one RHR pump and one RHR heat exchanger can be aligned to augment the FPCC system through the system crosstie. For this system configuration, a heat load greater than 45 million Btu/hr can be removed from the spent fuel pool with a maximum SACS inlet temperature to the RHR heat exchanger of 95°F and a spent fuel pool temperature of 135°F.

"During refueling outages, when a full core off-load is planned, additional heat removal capability for the fuel pool provided by the RHR system is required to be available. However, prior to the core being fully discharged, RHR is also required for shutdown cooling. In order to satisfy heat removal and forced circulation requirements simultaneously for both the reactor and fuel pool as the core is being off-loaded, and alternate RHR Fuel Pool Cooling Assist mode is available."

"The RHR system can be aligned to provide fuel pool cooling assist with its suction flow path from the reactor vessel and discharging through the RHR pump and heat exchanger, and returning back to the spent fuel pool through the normal RHR/fuel pool return header. This alternate RHR-FPCC assist mode permits higher RHR pump flow (a nominal flow rate of 9000 gpm with a design SACS temperature of 95°F and the maximum decay heat load of 43.0 x 10^6 Btu/hr), which compensates for the reduced cooling efficiency due to the lower coolant temperature from this suction flow path."

"The alternate RHR-FPCC assist mode will create a "forced" circulation flow from the fuel pool to the reactor vessel and back to the fuel pool. This configuration is capable of maintaining the bulk water temperature in the reactor vessel and spent fuel pool at or below 135°F with a maximum anticipated heat load of 43.0 x 10^6 Btu/hr (for the heat load in the spent fuel pool) and 46.4 x 10^6 Btu/hr (for the combined heat load in the vessel and the spent fuel pool) with a maximum SACS inlet temperature to the RHR heat exchanger of 95°F."

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5. The FPCC system is designed with additional capability to provide a source of makeup water to ensure against loss of fuel pool cooling, in compliance with Regulatory Guide 1.13.

6. The FPCC system is designed to monitor fuel pool water level and potential leakage paths and maintain a sufficient level above the spent fuel elements to provide radiation shielding for normal building occupancy.

7. All piping and components of the FPCC system cooling loop are designed to remain functional following a line break in the non-Seismic Category I purification loop. If a line break occurs, the purification loop isolation valves are closed by operator action or automatically on surge tank low-low level.

8. The FPCC system is designed to maintain the clarity of the water in the spent fuel pool and other refueling area cavities, e.g., cask loading pit, reactor well, and dryer and separator pool, so that fuel handling and equipment handling operations are not hampered by limited visibility.

9. The FPCC system is designed to limit the fission product and activated corrosion product concentrations in the water of the spent fuel pool and other refueling area cavities to permit continuous occupancy of the refueling area by plant personnel.

10. The FPCC system is designed with capability of water transfer from the condensate storage tank (CST) to the skimmer surge tanks to make up evaporation and leakage losses and ensure that fuel pool cooling is maintained.

11. The FPCC system purification loop is designed with two Reactor Building isolation valves.

12. The Torus Water Cleanup System is designed with piping connections to permit processing suppression pool water through the FPCC system filter demineralizer.

13. Primary containment isolation valves are provided on the torus water cleanup system pump suction and discharge lines.

The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the FPCC and torus water cleanup systems are discussed in Section 3.2.

9.1.3.2 System Description

9.1.3.2.1 General Description

The FPCC and the Torus Water Cleanup Systems are shown on Plant Drawings M-53-1 and M-54-0. The FPCC system consists of two surge tanks, two half capacity fuel pool cooling water pumps, two half capacity fuel pool heat exchangers, two full capacity fuel pool filter demineralizers, and associated piping, valves, and instrumentation.

The torus water cleanup equipment consists of one torus water cleanup pump and its associated piping, valves, and instrumentation.

9.1.3.2.2 Component Description

Design parameters for individual components of the FPCC and torus water cleanup systems are listed in Table 9.1-1.

9.1.3.2.2.1 Skimmer Surge Tanks

Two vertical, cylindrical tanks serve as the source for FPCC pump suction. The surge tanks are embedded in concrete and are accessible only from above by removing a concrete hatch. They are arranged and cross connected so that their levels are equal at all

times. Each of the surge tanks is provided with a removable debris screen. During normal operation, water flows into the surge tanks at the FPCC system design flow rate of 1400 gpm from the fuel pool via overflow weirs. Overflow weirs are also provided in the reactor well to route FPCC system recirculation flow to the surge tanks when any of these volumes are flooded. Skimmer drains with overflow weirs are provided in the reactor well and in the dryer and separator pool to help keep the water surface clear. A wave suppression scupper drain is provided along the working end of the fuel pool. The skimmer surge tanks provide a suction head for the fuel pool cooling pumps and serve as a buffer volume during transient flows in the normally closed loop FPCC system. Normal surge tank level control is automatic. Low level opens the makeup valve, and high level closes the makeup valve. The makeup valve can also be controlled manually from the main control room (MCR).

9.1.3.2.2.2 Fuel Pool Cooling Pumps

Two single stage, horizontal, motor driven, centrifugal, half capacity recirculation pumps circulate water through the FPCC system. The pumps are piped in parallel and take suction from the skimmer surge tanks through a common header. The pump motors, pump control circuits, and power supplies are Class 1E. Each pump is provided with controls for starting and stopping the motor as follows: For normal and accident operation, the primary control in the MCR is used. If it is necessary to start or stop either pump when the MCR is inaccessible, the control in the remote shutdown panel (RSP) is used. Each pump is automatically stopped by skimmer surge tank low-low level, or low discharge flow.

9.1.3.2.2.3 Fuel Pool Heat Exchangers

Two half capacity, plate type heat exchangers are provided for the FPCC system. They are designed to transfer the system design heat load of 17.2×10^{6} Btu/h from 135°F pool water, flowing at the system

design flow rate of 1400 gpm, to the Safety Auxiliaries Cooling System (SACS) at its maximum temperature of 95°F.

The heat exchangers are arranged in parallel. Fuel pool heat exchanger inlet and outlet temperatures are monitored and recorded by the Control Room Integrated Display System (CRIDS).

9.1.3.2.2.4 Fuel Pool Filter Demineralizer System

The cleanup loop of the FPCC system includes a Filter Demineralizer System located in the Auxiliary Building. The Filter Demineralizer System consists of two vessels, located separately in shielded cells, and two holding pumps. One of the vessels, including its holding pump, normally serves as a spare. The holding pumps and the equipment common to the two vessels, including the resin tank with agitator, dust evacuator, and resin eductor, and the associated piping, valves, and instrumentation, are located in a separate room adjacent to the vessel cells.

The Filter Demineralizer System also services the torus water cleanup system for the purification of suppression pool water.

The stainless steel filter demineralizer vessels are of the pressure precoat type. A tube nest assembly consisting of the tube sheet, clamping plate, filter elements, and support grid is inserted as a unit between the flanges of the vessel. The filter elements are stainless steel and are mounted vertically in the vessel. Air scour connections are provided below the tube sheet, and vents are provided in the upper head of each vessel. The filter elements are installed and removed through the top of each vessel. The holding elements are designed to be coated with powdered ion exchange resin as the filtering medium.

Fuel pool water quality is maintained in accordance with applicable industry guidelines (e.g., EPRI BWR Water Chemistry Guidelines, fuel vendor specifications).

The spent fuel pool demineralizer will be operated as required to maintain radiation levels ALARA on the refueling platform.

The pressure drop across the demineralizer is continuously monitored and when the differential pressure increases to a predetermined level the ion exchange media will be replaced. Typically this level is 30 psid.

The effluent water of the FPCC is continuously monitored by online conductivity instrumentation. In addition, grab samples of the FPCC influent and effluent water will be analyzed periodically in accordance with station procedures.

The filter demineralizers are designed to be backwashed periodically with water to remove resin and accumulated sludge from the holding elements. Service air pressure loosens the material from the holding elements and the backwash slurry drains through the gravity drainline to the waste sludge phase separator in the solid waste management system.

The resin tank provides adequate volume for one precoating of one filter demineralizer vessel.

The resin eductor transfers the precoat mixture of resin to the holding pump suction line.

The holding pumps are designed to recirculate a uniform mixture of resin through the filter demineralizer vessel being precoated and to automatically start and maintain the precoat material on the filter elements when the system flow rate falls below the value necessary to keep the precoat on the elements.

A resin strainer in the effluent stream of each filter demineralizer limits the migration of filter medium particles that pass through the filter elements. The strainer is capable of withstanding a

differential pressure greater than the shutoff head of the fuel pool cooling pumps.

9.1.3.2.2.5 Torus Water Cleanup Pump

One single stage, horizontal, motor driven, centrifugal recirculation pump is provided for the torus water cleanup system.

The pump motor is started and stopped manually from the filter demineralizer panel. The pump is automatically stopped on low suction flow and alarmed in the radwaste control room.

9.1.3.2.3 System Operation

The FPCC system is designed to operate continuously during reactor power operation and refueling. It removes decay heat from the fuel pool, except when storage of a full core unload in the spent fuel pool is necessary, and it includes equipment to maintain the purity of the water in the system. The RHR system operates in parallel with the FPCC system to remove the maximum heat load, which is due to a full core unload. The fuel pool water is continuously recirculated in a closed loop. The water flows from the pool surface through recirculation overflow weirs and wave suppression scuppers to the surge tanks. Overflow weirs and skimmer drains in the reactor well, and skimmer drains in the dryer and separator pool route FPCC system recirculation flow to the surge tank when any of these volumes are flooded. The FPCC pumps take suction from the surge tanks, circulate the water through the heat exchangers and filter-demineralizer, and discharge it through diffusers located at the bottom of the fuel pool, reactor well, and cask pool.

A total of seven diffusers, four in the fuel pool, two in the reactor well, and one in the cask loading pit, distribute the cooled fuel pool return water efficiently and with minimal turbulence. The diffusers minimize stratification of both temperature and contamination. Two of the diffusers in the fuel pool distribute

water recirculated by the fuel pool pumps, and the other two distribute water recirculated by an RHR pump when the RHR system is connected to provide supplementary cooling. The two reactor well diffusers and the cask pool diffuser also distribute the water recirculated by the fuel pool pumps.

The FPCC system operates with two pumps and two heat exchangers on-line when the spent fuel decay heat load is such that one pump and one heat exchanger cannot keep the pool temperature below 135°F. During normal operation, the heat load is highest during and just after a refueling outage when a new one-third of a core of spent fuel has been added to the pool. At this time, the two pumps and two heat exchangers are required. As the spent fuel heat load decreases, one pump and one heat exchanger are taken out of service at the operator's discretion according to station operating procedures.

The Filter Demineralizer System in the cleanup loop maintains pool water purity and clarity by a combination of filtration and ion exchange. Disposable ion exchange resins in the filter demineralizer remove fission and corrosion product impurities, and also serve as a filter for particulate matter. The process cycle consists of precoating, filtering demineralizing, holding, and backwashing. The ion exchange resins are replaced when the pressure drop across the filter demineralizer ranges between 25 and 35 psi, or when the resins are exhausted, as indicated by high discharge conductivity.

When a filter demineralizer is not available for water purification, or when water quality permits, the demineralizer is bypassed and the entire flow circulated from the heat exchangers to the fuel pool via the fuel pool diffusers.

When two FPCC system pumps operate, and only one filter demineralizer is available or required for purification, the excess flow bypasses the filter demineralizer. The bypassed flow

rejoins the purified flow downstream of the filter demineralizer and returns to the fuel pool via the fuel pool diffusers.

During refueling outages, when a full core off-load is planned, additional heat removal capability for the fuel pool provided by the RHR system is required to be available. However, prior to the core being fully discharged, RHR is also required for shutdown cooling. In order to satisfy heat removal and forced circulation requirements simultaneously for both the reactor and fuel pool as the core is being off-loaded, and alternate RHR Fuel Pool Cooling Assist mode is available.

The RHR system can be aligned to provide fuel pool cooling assist with its suction flow path from the reactor vessel and discharging through the RHR pump and heat exchanger, and returning back to the spent fuel pool through the normal RHR/fuel pool return header. This alternate RHR-FPCC assist mode permits higher RHR pump flow (a nominal flow rate of 9000 gpm with a design SACS temperature of 95°F and the maximum decay heat load of 43.0 x 10^6 Btu/hr), which compensates for the reduced cooling efficiency due to the lower coolant temperature from this suction flow path.

The alternate RHR-FPCC assist mode will create a "forced" circulation flow from the fuel pool to the reactor vessel and back to the fuel pool. This configuration is capable of maintaining the bulk water temperature in the reactor vessel and spent fuel pool at or below 135°F with a maximum anticipated heat load of 43.0 x 10^6 Btu/hr (for the heat load in the spent fuel pool) and 46.4 x 10^6 Btu/hr (for the combined heat load in the vessel and the spent fuel pool) with a maximum SACS inlet temperature to the RHR heat exchanger of 95°F.

During normal plant operation, the FPCC system serves only the spent fuel pool. The design flow rate during normal operation is 1400 gpm.

During refueling operations, condensate transfer to the reactor well, and the dryer and separator storage pool (refueling volume), may be accomplished in two ways. The water is transferred either from the main condensate system or from the CST by the two 1500 gpm refueling water transfer pumps. Plant Drawing M-08-0 shows the refueling water transfer pumps. Manual valves are aligned to establish the fill flow path, and the pumps are manually started. Provision is made to permit filling the cask pool or the reactor well independently.

Also during Operational Condition 5, various alignments of the FPCC pumps and heat exchangers and RWCU pumps and non-regenerative heat exchanger may be used as an alternative decay heat removal method in the event that one or both of the RHR shutdown cooling loops are out of service or become inoperable. Core circulation will be provided as required. The time after shutdown when specific combinations of heat exchangers and pumps may be used is dependent on the core and spent fuel decay heat load and the SAC/RACS temperatures.

After refueling or spent fuel cask loading or unloading activities are completed, either the reactor well and the dryer and separator storage pool, or the cask loading pit are drained via gravity drain lines to the refueling water transfer pumps' suction header from which the water is pumped through the A or B condensate demineralizer and back to the CST. Alternately, the reactor well, dryer and separator storage pool, and cask loading pit can be drained via gravity drain lines to the fuel pool pumps' suction header from which the water is pumped through the fuel pool filter demineralizers and back to the CST. During refueling operations, a portion of the cooling system flow is diverted from the fuel pool return line to the reactor well via the reactor well diffusers. The recirculation pattern established by the diverted flow allows the heated water that rises above the reactor core to be cooled in the fuel pool heat exchangers. This supplements the parallel RHR system (operating in the shutdown cooling mode) decay heat removal from the core region. When the spent fuel is in the cask loading pit, a portion of the FPCC system flow is diverted from the fuel pool diffusers to the cask loading pit via the cask loading pit diffuser. When the RHR system is operated in parallel with the FPCC system to provide fuel pool cooling during a full core unload, one RHR pump takes the suction either from the skimmer surge tanks or from the reactor vessel via the shutdown cooling suction piping, circulates the water through one RHR heat exchanger, and returns it to the spent fuel pool via the two RHR intertie return diffusers.

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The cask loading pit is filled via the refueling fill line and drained through a condensate demineralizer or the fuel pool filter demineralizers in the same manner as the refueling volume is filled and drained. Filling of the cask loading pit is normally done prior to spent fuel loading (or unloading) into (or from) the cask, and draining is normally accomplished after cask loading or unloading operations are complete.

The FPCC system design heat load is 17.2 x 10^{6} Btu/h. The FPCC system's maximum heat load is 43.0 x 10^{6} Btu/h. For the maximum heat load condition, an RHR heat exchanger is operated in parallel with the FPCC system. The RHR system is only interconnected when the reactor is shut down, and larger than normal batches of spent fuel, such as a full core load, are stored in the pool. The RHR interconnection is also required in the case of an FPCC system cooling loop line leak. The interconnecting piping between RHR and the FPCC system is designated Seismic Category I and is independent of the FPCC piping, except at the surge tank outlet header. Normal makeup to the fuel pool is provided from the non-Seismic Category I CST.

To prevent loss of FPCC system cooling due to system water loss, and an unlikely condition where normal makeup is lost, a 2-inch Seismic Category I emergency fuel pool water makeup line from SSWS loop A ties into one of the FPCC return lines immediately upstream of the point where it enters the fuel pool. A redundant 2-inch line from SSWS loop B ties similarly into the other return line. These Seismic Category I emergency makeup lines meet the requirements of Regulatory Guide 1.13. In addition to the above, a 2-inch fire hose fill connection located in the auxiliary building and tied into the

makeup line from SSWS loops A and B provides the supplementary water makeup from a reliable source, such as a tank truck or fire main. To prevent inadvertent admission of river water, each SSWS loop is separated from the FPCC return lines by two normally closed, key locked, motor operated butterfly valves. The pipe between the butterfly valves is normally empty and continuously drained. In addition, the pipe between the butterfly valves is equipped with a high pressure alarm that detects the presence of water resulting from leaks or inadvertent operation of an outboard butterfly valve.

The Torus Water Cleanup System is designed to be manually initiated and operated intermittently, as necessary, to maintain suppression pool water quality within the following limits:

Conductivity	≤2 μmho/cm at 25°C
Chloride (Cl^-)	≤0.1 ppm
pH	5.3 ≤pH ≤8.5
Suspended solids	≤.01 ppm

During normal operation, the torus water cleanup pump takes suction from the suppression pool and circulates the water through the fuel pool Filter Demineralizer System and back to the suppression pool. One torus water cleanup pump, with a design capacity equal to the filter demineralizer design flow rate of 700 gpm is provided to perform this function. Operation of the torus water cleanup system is periodically initiated per operating procedures, or when samples indicate that the suppression pool water quality is no longer within the specified limits and when the filter demineralizer is available. The torus water cleanup system is also designed to be used for partially draining the suppression pool if it is ever necessary. In this mode of operation, the torus water cleanup pump takes suction from the torus and circulates the water through a fuel pool filter demineralizer and to the CST. Operator action is necessary to terminate torus water cleanup operation, except on low pump suction flow.

9.1.3.3 Safety Evaluation

The FPCC system cooling loop (skimmers, skimmer surge tanks, fuel pool cooling pumps, fuel pool heat exchangers, interconnecting loop piping), and the emergency fuel pool water makeup system are designed to the requirements of Seismic Category I, except for the surge tanks. The surge tanks are of non-Seismic Category I design, but are embedded in a Seismic Category I concrete structure that provides the pressure boundary for this part of the FPCC system cooling loop. The surge tanks were designed to withstand an external loading of 690 lb/ft^2 during construction. The actual concrete loading during construction (approximately 300 lb/ft^2) was lower than the design value due to the use of a slower pour rate. This external loading induced a stress level less than one half of the design stress level in the tank shell. An analysis has been performed to determine the effect of seismic loads on the skimmer surge tanks. This analysis indicates that the induced stresses resulting from the seismic loads are insignificant (approximately one percent of the stresses due to concrete placement) and that the skimmer surge tanks will not fail following a safe shutdown earthquake. The interconnecting piping between RHR and the FPCC system is designed to Seismic Category I requirements.

HCGS has performed an analysis of non-Seismic Category I structures, systems and components whose failure may adversely affect any portion of the spent fuel pool cooling system or the Seismic Category I makeup system, as discussed in Section 3.5.1.1.3, and has determined that there are no adverse effects.

The cooling water return lines to the spent fuel pool, associated with both the FPCC and the RHR systems, penetrate the walls of the spent fuel pool horizontally above the normal pool water level. Each of these cooling water return lines is provided with two vacuum breakers to prevent the water from being siphoned out of the pool. No piping connections are made to the pool below the normal water level to prevent any accidental lowering of the water level. Therefore, there is no operator error or FPCC system malfunction

that could result in draining the spent fuel pool and uncovering the stored spent fuel. The fuel pool structures are also designed to Seismic Category I requirements. If a line break occurs in the non-Seismic Category I purification loop, the remotely operated purification loop isolation valves close automatically on surge tank low-low level or by operator action.

Any leakage between the fuel pool gates, cask loading pit gates, or through the vessel to drywell seal or drywell to reactor well seal is alarmed in the MCR. A segmented leak channel system behind the liner weld seams is provided to detect fuel pool, cask loading pit, reactor well, and dryer and separator pool leakage.

The Torus Water Cleanup System suction and return piping from the torus, out through and including the primary containment isolation valves on each line, is designed to Seismic Category I requirements.

The design of the FPCC and torus water cleanup systems, with respect to the following areas, is discussed in the sections listed below:

1. Seismic Category I requirements - Section 3.2
2. Protection from wind and tornado effects - Section 3.3
3. Flood design - Section 3.4
4. Missile protection - Section 3.5
5. Protection against dynamic effects associated with postulated rupture of piping - Section 3.6
6. Environmental design - Section 3.11.

Class 1E power is provided for the safety-related equipment of the FPCC system. All annunciators are provided with non-Class 1E uninterruptible power. Class 1E power is provided for the

containment isolation valves in the suction and discharge lines for the Torus Water Cleanup System.

The radiological evaluation of the FPCC system is provided in Section 12.2. Radiation monitors mounted on the Reactor Building walls indicate and actuate audible alarms locally and in the MCR.

A failure mode and effects analysis of the FPCC and torus water cleanup systems is provided in Table 9.1-3.

The fuel pool evaporation rate, the time for the pool water to reach 212°F, and the time required to initiate the makeup water, in the event of loss of the FPCCS, are discussed in Table 9.1-17.

9.1.3.4 Inspection and Testing Requirements

The FPCC and torus water cleanup systems are preoperationally tested in accordance with the requirements of Section 14. The safety-related systems that provide makeup water are periodically tested in accordance with the requirements of the HCGS Technical Specifications.

The spent fuel cooling system does not perform a specific function in shutting down the reactor or in mitigating the consequences of an accident; therefore does not meet the criteria for being included in ASME B&PV Code Section XI testing requirements.

9.1.3.5 Instrumentation Applications

Primary FPCC system control is from the MCR with emergency control available at the RSP. The FPCC filter demineralizer is provided with a control panel located in the radwaste control room. The filter demineralizer panel is provided with an "FPCC system trouble" alarm in the MCR.

The torus water cleanup pump is controlled from the filter demineralizer panel. The containment isolation valves in the

torus water cleanup system are controlled from the MCR.

The surge tanks are provided with high, high-high, low, and low-low level controls. The high and low levels control normal FPCC system makeup. Surge tank high level closes and surge tank low level opens the normal makeup valve. The high-high level also closes the normal makeup valve, and alarms in the MCR. The low-low level alarms in the MCR. The surge tank level indication is provided by a Class 1E level recorder in the MCR. The surge tanks are also provided with redundant low-low level controls that trip the pumps when surge tank reserve capacity is reduced to the equivalent of 25 seconds of operation with one pump at rated capacity, and that close the purification loop isolation valves. These pump trip and isolation valve circuits and power supplies are Class 1E. The air operated normal makeup valve is opened and closed by a control on one of the MCR panels, as well as by the surge tank high and low levels. A fuel pool high-low water level is alarmed in the MCR and monitored with CRIDS. The trip point is adjustable over the range of skimmer weir adjustment.

Each FPCC pump is provided with controls located in the MCR and on the RSP. The MCR is the primary control station during normal plant operation, loss-of-coolant accident (LOCA), and loss of offsite power (LOP) conditions. Transfer switch capability is provided, as required, to enable each pump to be started and stopped from the RSP whenever the MCR is inaccessible.

The FPCC system pump motors, pump control circuits, and power supplies are Class 1E. Each pump is automatically stopped on low-low level in the skimmer surge tanks, or low discharge flow. A pressure transmitter measures suction pressure of each pump. Low pump discharge flow is alarmed in the MCR. A pressure indicator is located in the discharge piping of each pump. A pressure transmitter measures discharge pressure of each pump. In addition, a flow element that senses system flow for indication and computer input is located in the common discharge piping of the pumps. Each pump is provided with a vibration sensor

for computer monitoring of bearing vibration. Bearing temperature is sensed at two locations and recorded in the computer. Suction and discharge pressures are computer-monitored and recorded in the CRIDS.

A temperature element is located in the FPCC system pumps' common discharge line to measure heat exchanger inlet temperature. This temperature is indicated, recorded, and alarmed in the MCR, and is indicated on the RSP. A temperature element is located in the outlet line of each heat exchanger to measure heat exchanger outlet temperature. These three temperatures are monitored and recorded in the CRIDS.

Differential pressure and conductivity measurement is used for each filter demineralizer unit to determine when backwash is required. Additional differential pressure, pressure, flow, and temperature instrumentation are provided to monitor the system status.

Each Spent Fuel Pool Filter Demineralizer (SFPFD) is equipped with an online specific conductivity cell on the effluent stream. These online instruments are connected to a recorder.

The effluent conductivity provides a qualification indicator of fuel pool water purity on a rapid basis.

Reactor well water level is monitored in the CRIDS, and an annunciator alarm is provided in the MCR to indicate a low reactor well water level during refueling. An interlock trips the refueling water transfer pumps on low reactor well level when the well is draining back to the CST after fuel transfer.

The torus water cleanup pump is started and stopped from the FPCC filter demineralizer panel and the pump is stopped automatically by low suction flow. Low suction flow is alarmed on the FPCC filter demineralizer panel. A pressure indicator is located in the pump discharge line.

9.1.3.6 SRP Rule Review

Acceptance Criterion II.l.d.(4) of SRP 9.1.3 limits the water temperature in the fuel pool to 140°F at the maximum normal heat load with the normal cooling system operating in a single active failure condition.

The bulk water temperature in the fuel pool remains below 152°F if one FPCC pump was not available or 174°F if one FPCC pump and one FPCC heat exchanger were not available with a maximum normal heat load of 17.2 x 10^6 BTU/hr. The radiological consequences of the fuel pool temperature reaching 152°F and 174°F have been evaluated. The resultant doses will not exceed 10CFR20 limits at the site boundary. However, the RHR System can be manually aligned to provide supplemental cooling. The performance of the demineralizer will not be affected up to a water temperature of 165 °F and there will only be a 10% reduction in performance with a water temperature of 175 °F.

With the above system configuration it has been conservatively estimated that after 90 days the fuel pool heat load will be such

that only one fuel pool heat exchanger is required for fuel pool cooling.

The fuel pool heat loads are calculated based on NUREG-0800, Standard Review Plan, Section 9.1.3 and Branch Technical Position ASB 9-2 except for the following:

1. For HCGS "annual refueling" means 18 month refueling.

2. The decay time is assumed to be 8 days for calculating the normal heat load and 10 days for the maximum heat load.[(1)] The decay heat load is calculated as a function of time, using ANSI/ANS Standard 5.1 – 1979 with 2 sigma uncertainty added. It is slightly more conservative than the one recommended in Branch Technical Position ASB 9-2.

(1) These times are somewhat longer than recommended in SRP 9.1.3, but are consistent with the times presented in "BWR Servicing and Refueling Improvement Program - Phase 1 Summary Report" (NEDG 21860, September, 1978).

9.1.4 Fuel Handling System

9.1.4.1 Design Bases

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

The Fuel Handling System is capable of handling GE and ABB/Westinghouse fuel.

Design criteria for major Fuel Handling System equipment are provided in Tables 9.1-5 through 9.1-7, which lists the essential classification, code classification, and seismic category. Where applicable, the appropriate ASME, ANSI, industrial, and electrical codes are identified. Additional design criteria are shown below and expanded further in Section 9.1.4.2.

The transfer of inner shipping containers between the Reactor Building receiving bay and the refueling floor is accomplished using the Reactor Building crane auxiliary or main hoist equipped with an inner box lifting sling or multibox lifting rig. Each inner shipping container holds up to two fuel bundles.

The transfer of new fuel bundles or new fuel assemblies between the upending stand, the new fuel inspection stand (if used), the new fuel storage vault (if used), and a fuel preparation machine (if used), is accomplished using the Reactor Building crane auxiliary or main hoist equipped with a general purpose grapple (GE fuel) or ABB/Westinghouse J-Hook (GE or ABB/Westinghouse fuel).

The Reactor Building crane auxiliary hoist is used with a general purpose grapple (GE or ABB/Westinghouse fuel) or ABB/Westinghouse J-Hook (GE or ABB/Westinghouse fuel) to transfer new fuel assemblies from the new fuel inspection stand (if used) and the new fuel vault (if used) to a fuel preparation machine. From this point on, the fuel assemblies will be handled by the telescoping fuel grapple on the refueling platform.

The refueling platform is classified Seismic Category 1 from a structural standpoint. It is designed in accordance with the applicable requirements of 10CFR50, Appendix A and B. Allowable stress due to safe shutdown earthquake (SSE) loading is 120 percent of yield or 70 percent of ultimate, whichever is least. A dynamic analysis is performed on the structures using the response spectrum method, with dynamic load contributions resulting from each of three orthogonal directions combined by the root mean square procedure.

Working loads of the platform structures are in accordance with Reference 9.1-2. All parts of the hoist systems are designed to have a safety factor of five, based on the ultimate strength of the material. A redundant load path is incorporated in the fuel hoists so that no single component failure could result in a fuel assembly drop. To maintain relative stiffness of the platform, limitations are imposed on deflection of the main structures. Welding of the platform is in accordance with AWS D14-1 or ASME B&PV Code, Section IX. Gears and bearings meet specifications in Reference 9.1-3 and ANSI B3.5. Materials used in construction of load bearing members are to ASTM specifications. For personnel safety, OSHA Part 1910-179 is applied. Electrical equipment and controls meet References 9.1-6 and 9.1-7.

The two general purpose grapples and the telescoping fuel grapple have redundant hooks and an indicator that confirms positive grapple engagement. The ABB/Westinghouse J Hook meets the single-failure proof guidelines of NUREG-0612 Section 5.1.6.

The telescoping fuel grapple is used for lifting and transporting fuel assemblies. It is designed as a telescoping grapple that can extend to the proper work level and, in its fully retracted state, still maintain adequate shielding over fuel by keeping it in the water.

To preclude the possibility of raising radioactive material out of the water, the cables on the auxiliary hoists incorporate an adjustable, removable stop that will jam the hoist cable against some part of the platform structure to prevent hoisting when the free end of the cable is at a preset distance below water level. A removable bar stop on the operator cab floor physically prevents the main fuel hoist grapple from swinging up and out of the water if it accidentally comes in contact with the fuel pool wall. In addition, the grapple and auxiliary hoist designs include redundant electrical interlocks to prevent fuel or other radioactive material from being raised above the preset limits.

Both the main trolley-mounted and the auxiliary trolley-mounted auxiliary hoists are provided with a geared rotary limit switch that provides normal up and down limit stops. In addition, a stop block fastened to the hoist cable operates a safety limit switch if the normal up limit should fail.

If the motor is not stopped by either up limit, the stop block will jam against the hoist and trip the motor upon

1. The load cell sensing a jam (load >500 pounds), or

2. Stalling of the hoist motor.

In either event, there will be no resulting impact load on the cable because the block stops against the energy absorbing portion of the hoist (i.e., the spring-loaded plate or the pivoted sheave arm).

Procedures require that each cable is inspected prior to every refueling outage.

Provision of a separate cask loading pool, capable of being isolated from the fuel storage pool, eliminates the potential accident of dropping a cask and rupturing the fuel storage pool. Refer to Section 15 for consideration of this accident.

As described in Section 9.1.4.6, in the event a light load must be handled over stored fuel, a single failure-proof handling system will be used.

9.1.4.2 System Description

The following paragraphs describe the use of the major tools and servicing equipment and address safety aspects of the design.

9.1.4.2.1 Spent Fuel Shipping Cask

A spent fuel cask is used to transport spent fuel assemblies from the cask loading pit to an off-site fuel storage or disposal facility. The cask can also be used for offsite shipment of irradiated reactor components, such as control rod blades and in-core monitors.

The maximum loaded weight and, hence, the capacity of the cask, is determined by the 130-ton maximum critical load lifting capacity of the Reactor Building crane. The maximum loading height of 19 feet 9 inches, i.e., the height of a hypothetical open shipping cask in the storage pit, is chosen equal to the distance from the bottom of the transfer canal to the cask loading pit floor. This maximum cask height permits fuel in transit from the spent fuel racks to remain at a minimum of 8 feet 10 inches below the water surface at all times, to ensure adequate shielding.

The shipping cask is designed to dissipate the maximum allowable heat load from contained irradiated fuel either by natural convection to the environs or using a forced cooling system, depending on the design of the cask. The specifics of any shipping cask design and operation are located in the shipping cask 10 CFR 71 Certificate of Compliance (CoC) and associated Safety Analysis Report.

The plant design allows underwater installation of the shipping cask lid and other operations that might otherwise pose unacceptable radiation hazards to personnel.

Further, decontamination considerations are incorporated in the design. The shipping cask design meets all applicable regulations of the Department of Transportation and 10 CFR Part 71, with respect to shipping large quantities of fissile materials.

No specific type of shipping cask has been chosen. Over the lifetime of the plant, several different sizes and models that the fuel handling facilities can accommodate may be used for the variety of radioactive materials that may require shipment off-site. However, the capacity of the Reactor Building crane and the cask pit dimensions are based on a 10-foot-diameter, 125-ton spent fuel cask.

9.1.4.2.2 Cask Crane

The Reactor Building polar crane handles casks. The crane design is discussed in Section 9.1.5.

9.1.4.2.3 Fuel Servicing Equipment

The fuel servicing equipment described below has been designed in accordance with the criteria listed in Table 9.1-5.

9.1.4.2.3.1 Fuel Preparation Machine

The two fuel preparation machines, shown on Figure 9.1-7, are mounted on the walls of the fuel storage pool. They can be used for stripping reusable channels from the spent fuel assemblies and for channeling new fuel bundles. The machine can also be used in a repair/reconstitution capability or with the fuel inspection fixture to provide an underwater inspection capability.

Each fuel preparation machine consists of a work platform, a frame, and a movable carriage. The frame and movable carriage are located below the normal water level in the fuel storage pool, thus providing a water shield for the fuel assemblies being handled. All parts remain underwater when the fuel preparation machine removes and installs channels. The carriage on the fuel preparation machine

has permanently installed mechanical uptravel stops to prevent raising the active fuel above the safe water shield level of 8 feet below the surface. The movable carriage is operated by a foot pedal controlled, air operated hoist.

9.1.4.2.3.2 New Fuel Inspection Stand

The new fuel inspection stand can serve as a support for the new fuel bundles undergoing receiving inspection and provides a working platform for technicians engaged in performing the inspection. It can be used to channel GE fuel bundles following inspection.

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

9.1.4.2.3.3 (Section Deleted)

9.1.4.2.3.4 Channel Handling Tool and Boom Crane

The channel handling boom has a 500 pound capacity and is used in conjunction with the channel handling tool to transport fuel assembly channels. It can also be used in the repair/reconstitution of a leaking fuel assembly to move irradiated fuel within its capacity.

The channel handling tool is used in conjunction with the fuel preparation machine to remove, install, and transport fuel channels in the fuel storage pool.

9.1.4.2.3.5 Fuel Pool Sipper

The fuel pool sipper provides a means of isolating a fuel assembly in demineralized water in the fuel pool in order to concentrate any leaking fission products in relation to a controlled background.

9.1.4.2.3.6 Fuel Inspection Fixture

The fuel inspection fixture is used in conjunction with the fuel preparation machine to permit remote inspection of fuel elements. The fuel inspection fixture permits the rotation of the fuel assembly in the carriage and, in conjunction with the vertical movement of the carriage, provides complete access for inspection.

9.1.4.2.3.7 Channel Gauging Fixture

The channel gauging fixture is a go/no-go gauge used to evaluate the condition of a new channel for GE fuel, prior to channeling.

9.1.4.2.3.8 General Purpose Grapple

The general purpose grapple, shown on Figure 9.1-14, is a handling tool generally used with the fuel (GE or ABB/Westinghouse with a bail handle). It can not be used with ABB/Westinghouse fuel equipped with a transport handle. The grapple can be attached to the Reactor Building crane auxiliary hoist, to either of the jib crane hoists, or to the auxiliary hoists on the refueling platform. It can also be attached to the Reactor Building crane main hoist for loads that do not pass over the spent fuel pool.

9.1.4.2.3.9 Fuel Grapple

The fuel grapple, shown on Figure 9.1-13, is a telescoping mast with a double hook grapple head. The grapple lifts and orients fuel assemblies for core and spent fuel rack placement. It is a triangular, open sectioned mast, constructed of tubular stainless steel. The grapple mounts on the refueling platform, which is discussed in Section 9.1.4.2.7.1.

Nylon bearing pads provide section-to-section guidance on the mast. A dual wire rope cable hoist provides vertical motion and a redundant load path. It is mounted on the main trolley of the refueling platform. A rocker arm and clevis assembly provides hoist cable attachment to the innermost grapple section and allows load equalization on the hoist wire rope. The double hook redundant) grapple head features one proximity switch and one air cylinder. The proximity switch wiring and interlocks prevent the accidental raising of a fuel bundle when hooks are not engaged. The fuel grapple is equipped with an internally mounted camera system for close-up viewing of the fuel assembly and reactor core.

9.1.4.2.3.10 ABB/Westinghouse J-Hook

The ABB/Westinghouse J-Hook is a handling tool used to move new GE and ABB/Westinghouse fuel bundles and assemblies between the upending stand and a fuel preparation machine (includes various intermediate locations). It is compatible with the ABB/Westinghouse transport handle as well as the GE and ABB/Westinghouse bail handles. Between the upending stand and the new fuel fault, it is attached to the Reactor Building crane auxiliary or main hoist. Between the new fuel vault and a fuel preparation machine, it is attached to the Reactor Building crane auxiliary hoist.

9.1.4.2.4 Servicing Aids

General area underwater lights are provided with a suitable reflector for illumination.

A radiation hardened, underwater television camera is provided. The camera is lowered into the reactor vessel or fuel storage pool to assist in the inspection and/or maintenance of these areas.

A general purpose, portable, plastic viewing aid floats on the water surface to provide better visibility. The brightly colored sides of the viewing aid allow the operator to observe the aid should it accidentally fill with water and sink.

9.1.4.2.5 Reactor Vessel Servicing Equipment

The essential and code classifications, and the seismic category for this equipment, are listed in Table 9.1-6, and descriptions of the equipment follow below.

9.1.4.2.5.1 Reactor Vessel Service Tools

Various tools are used when the reactor is shut down and the reactor vessel head is being removed or reinstalled. These tools are designed for a 40-year life. The stud handling tool is designed with a safety factor of five with respect to the ultimate strength of the material used. When carbon steel is used, it is either hard chrome plated, Parkerized, or coated with an acceptable paint.

9.1.4.2.5.2 Main Steam Line Plug Assembly

The four Main Steam Line Plug (MSLP) Assemblies are used during reactor refueling or servicing. The MSLP Assembly, comprised of a MSLP and its installation device, is a passive component used to maintain the integrity of the reactor cavity water level during fuel movement activities. The MSLPs are installed from the refueling platform with water in the reactor cavity at the level of the refuel floor.

The MSLP Assembly is lowered from the refueling platform into position using an auxiliary hoist on the refueling platform. With the plug at the azimuth and elevation of the main steam outlet nozzle, the scissors jack is actuated from the service pole caddy using an assembly of rigid poles and an end effect tool. With the plug inserted in the main steam outlet nozzle, the lower part of the installation device spans the nozzle, and the upper part is firmly engaged with the vessel flange. An air operated impact wrench, integral in the plug, is remotely actuated, draws the pressure plate and compression plate together, and forces the grips to engage the nozzle inner diameter. The water seal is achieved by compressing an O-Ring between the pressure plate and the nozzle inner diameter. A backup to the O-Ring water seal is provided by an inflatable seal. The installation device remains in the vessel while the MSLP is in the nozzle.

The plugs are designed to seal against a hydrostatic head of approximately 35 feet of water (15 PSIG) without leakage and be capable of holding in place and

sealing against a back pressure of 48.1 PSIG (plus 10%) of air with no leakage. Each new plug is hydrostatically tested by the manufacturer to demonstrate capability to withstand a pressure 1.5 times the design pressure. The plugs have also been tested pneumatically to a pressure 1.25 times the back pressure of 48.1 PSIG.

The MSLP performs its safety related function by maintaining itself firmly positioned in the internal diameter of the steam outlet nozzle. The items which provide the structural integrity required to maintain the MSLP within the nozzle also provide the major restriction to flow through the plug. Therefore, the items which provide the structural integrity of the plug are considered critical.

The critical characteristics of these items are their machined dimensions and their materials of construction. The critical items have been dedicated through a QC receipt inspection for their critical dimensions, and, after assembly, through QC observed testing to qualify the materials of construction. It is important to note that all dedicated items are machined components, and all of the dedicated items are joined mechanically. There are no welds included in the items which require dedication. Dedication of these critical characteristics are maintained through continuing plant maintenance and storage.

9.1.4.2.5.3 (Section Deleted)

9.1.4.2.5.4 (Section Deleted)

9.1.4.2.5.5 RPV Head Nut and Washer Storage Ring

The reactor pressure vessel (RPV) head nut and washer storage ring is used for transporting and storing the head nuts and washers. The RPV head nut and washer storage ring is also referred to as the circular head nut and washer rack. The circular nut rack will be transported to and from the vessel head using the auxiliary or main hoist and slings per Section 9.1.5.1.14. The slings are designed for a safety factor of at least 5, the nut rack is designed using Reference 9.1-2 as a guide.

9.1.4.2.5.6 Head Stud Rack

The head stud rack is used for transport and storage of studs. It is suspended from the Reactor Building crane auxiliary or main hook when lifting studs from the reactor well to the refueling floor.

The rack is made of aluminum to resist corrosion.

9.1.4.2.5.7 Dryer/Separator Sling Assembly

The Dryer/Separator Sling Assembly (DSSA) is a lifting device used for underwater transport of the steam dryer or the shroud head with the steam separator between the reactor vessel and the storage pool. The DSSA is comprised of the four 50 ton capacity Kevlar slings, shackles and links, a 250 ton capacity shackle, a cruciform shaped Dryer/Separator strongback and 4 turnbuckles. When lifting the separator with the cavity flooded, the main hook and the redundant hook block of the Reactor Building crane must be just below the normal water level. To keep the hook dry, a nylon fabric reinforced rubber Hook Boot is installed on the hook before attaching the slings.

The DSSA is a "special lifting devices" which satisfies the guidelines of ANSI N14.6-1978, "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 pounds (4500 kg) or more for Nuclear Materials." The Kevlar slings also satisfy the guidelines of ANSI/ASME B30.9-1984, "Slings", which includes a section on fabric slings. Each sling, shackle and link is designed to have an ultimate strength five (5) times greater than the rated working load. Each sling, shackle and link is load tested (proof tested) at two times the rated working load (50 tons). The proof tests are observed and documented by a qualified QC inspector. The slings are fabricated as commercial items but reclassified (dedicated) through the QC observed and documented proof test and through on-site maintenance and storage. The Hook Boot is non-safety related. Its sole purpose is to isolate the main hook from the contaminated cavity water.

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9.1.4.2.5.8 Head Strongback

The head strongback is used for lifting both the reactor vessel head and the drywell head. It has a cruciform shape, with four equally spaced lifting points on the ends of the arms. In the center, it has a hook box that attaches to the Reactor Building crane main hook using hook pins. The design complies with the requirements of NUREG 0612 (see Section 9.1.5).

The strongback is designed so that one main beam of the cruciform will support the rated load. The structure is designed using Reference 9.1-2 as a guide. All welding is in accordance with the ASME B&PV Code, Section IX. A minimum safety factor of five, in reference to the ultimate strength of the material, is used for the design. The completed assembly is proof tested at 125 percent of rated load. After the load test, all structural welds are magnetic particle inspected.

9.1.4.2.5.9 Service Platform

The service platform facilitates maintenance work on reactor internals. It provides a working platform for people and hand operated tools, and it also includes a socket for supporting a jib crane. The service platform is supported by four wheels that run on a portable circular track that rests on the vessel flange and is confined by the vessel closure studs.

The service platform is a non-Seismic Category I component that has been designed for 0.75g horizontal and 0.00g vertical seismic acceleration. Because the outer diameter of the platform is greater than the inner diameter of the reactor vessel, the platform cannot accidentally fall into the vessel and damage the fuel.

The structural design uses Reference 9.1-2 as a guide. Materials are in accordance with ASTM Standards. Welding is in accordance with ASME B&PV Code, Section IX or Reference 9.1-5.

The electrical system is in accordance with References 9.1-6 and 9.1-7.

Painting and surface preparation is in conformance with the Steel Structures Painting Council standards.

9.1.4.2.5.10 Service Platform Support

The service platform support serves as a sealing surface protector for the reactor vessel flange and as a track for the service platform. The vessel flange provides continuous vertical support. The vessel studs and strapping to the outer edge of the flange provide horizontal confinement. The service platform support is made from aluminum, and all welding is done in accordance with Reference 9.1-5.

9.1.4.2.5.11 Service Pole Caddy System

The Service Pole Caddy System (SPCS) is a rigid pole handling system mounted to the side of the refueling platform opposite the fuel handling grapple. The SPCS consists of a frame structure, a platform, a hoist and other equipment used to service the reactor internals. The platform supports the rigid poles, a pole handling station and the workers.

The SPCS was designed to provide a single location for storage of the rigid poles and vessel in-service tools and an assembly station and hoist for support of the poles. The SPCS augments the existing working space on the refueling platform by providing a rack to store the poles in one place off the refueling platform and a pole assembly station which captures the poles during assembly and use.

Ten (10) stainless steel rigid poles, each eight feet long, are provided. The pole and connectors are of the twist lock socket type with a locking collar. The connectors are solid body structures welded to the ends of the poles. The solid bodies eliminate internal contamination of the poles and provide the equivalent of eight feet of water shielding (12.5 inches of steel per pole) in an assembly of one pole and end effect tool. Each pole weighs approximately 14 pounds in water.

The refueling platform is classified as passive essential; therefore, the SPCS has also been classified as passive essential for procurement, installation, and operation. It is supplied within the constraints of 10CFR50, Appendix B and 10CFR21. (Passive essential classification is applied to equipment that has a passive safety function; see HCGS UFSAR Table 9.1-6).

9.1.4.2.5.12 (Section Deleted)

9.1.4.2.5.13 GE 360 Degree Scorpion II Service Platform

The GE 360 Degree Scorpion II platform is designed as a non-nuclear safety related outage-servicing tool and is a non-seismic Category I structure. It has been analyzed as a Seismic II/I component for storage on the refueling floor when not in use during normal power operations and for installation over the open reactor vessel cavity, supported by structural feet that rest on the reactor vessel upper cavity shield block ledge, during refueling outages. GE has analyzed the platform when installed over the reactor cavity for static and dynamic loads (safe shutdown earthquake), including hydro-dynamics, in accordance with the plant seismic response spectra. The platform was for the Level D Faulted condition such that stress in any member will not exceed 120% of the yield or 70% of ultimate strength; whichever is the more conservative. The platform is designed to maintain its structural integrity under all postulated load conditions and cannot collapse or fall inside the reactor cavity creating an unanalyzed or different type of fuel handling accident.

The lifting devices for the GE 360 Degree Scorpion II platform have been designed and constructed is accordance with NUREG-0612 and ANSI N14.6. The jib hoist is constructed in accordance with ANSI B30.16 requirements. Dropping the Scorpion II platform, or its associated subassemblies, while using the Polar Crane is considered not credible because it will be rigged single failure proof as necessary to meet the NUREG-0612 requirements. All of the Scorpion II platform heave load lifts will be accomplished in accordance with the station’s Heavy Loads Program such that they will not jeopardize equipment important to safety or necessary for achieving and maintaining safe shutdown.

The GE 360 Degree Scorpion II service platform provides a temporary, multiple configuration, work platform that can accommodate a variety of in-vessel outage work scopes. Key design features include: above water main structure, modular construction, open refueling slot, approximately 360 degree access to the annulus, below water work troughs, above water work carriages, and removable deck plates. In addition, it can accommodate two 1000-pound capacity jib hoists. The platform facilitates in-vessel inspection tooling installations and movements except at certain locations adjacent to the refueling slot where the platform has an opening corresponding to the refueling slot to allow transport of irradiate components between the reactor cavity and the spent fuel pool. The platform has removable bracing across this opening to help support the stability of the platform during its erection. The platform is set into place using the reactor Building overhead Polar Crane.

The GE 360 degree Scorpion II platform can be used in one of two configurations, either in the inspection configuration or in the servicing and modification configuration. The inspection configuration slows personnel using the platform to have access to a semi-submerged work trough that is low enough to permit the Refueling Bridge to pass overhead without interfering with in-vessel visual inspection work in the trough. Because the horizontal span of the jib hoist is limited to preclude interaction with the mast of the Refueling Bridge when it is in operation, the jib hoist may be used when in this configuration. In the servicing and modification configuration, the work troughs are concealed with aluminum covers, thus creating a larger working deck above the water line; however, use of the Refueling Bridge is prohibited in this configuration. In this configuration the above-water mobile work carriages that ride along the inner platform diameter are provided to allow greater reach and access to the vessel interior, extending out approximately 4 feet over the core.

9.1.4.2.6 In-Vessel Servicing Equipment

The essential and code classifications, and the seismic category for this equipment, are listed in Table 9.1-7, and descriptions of the equipment follow below.

9.1.4.2.6.1 (Section Deleted)

9.1.4.2.6.2 (Section Deleted)

9.1.4.2.6.3 (Section Deleted)

9.1.4.2.6.4 Control Rod Grapple

The control rod grapple assists in removing, installing, and transporting control rods. It is air actuated and consists of a structural frame, air cylinder, and hook mechanism. The grapple captures the control rod handle. Once latched, the hook mechanism cannot be disengaged unless air pressure is applied to open the mechanism and the control rod weight is removed. A ring on the hook permits manual unlatching if the air pressure fails. The refueling platform auxiliary hoist cable attaches to a stud on top of the frame for transporting the grapple.

9.1.4.2.6.5 Control Rod Guide Tube Grapple

The control rod guide tube grapple assists in removing, installing, and transporting control rod guide tubes. It is air actuated and consists of a frame that fits through the reactor vessel top guide and enters the top of the guide tube. Inside the frame, an air cylinder actuates two plungers that engage two guide tube coolant ports and permit lifting. The refueling platform auxiliary hoist cable attaches to a stud on the frame for transporting the grapple.

9.1.4.2.6.6 Fuel Support Grapple

The fuel support grapple assists in removing and installing the fuel supports in the control rod guide tubes. This grapple consists of a fail-safe mechanism that is installed on a rectangular frame. The mechanism includes four cam actuated valves and associated pneumatic tubing and two air cylinders. Each air cylinder operates a lock lever and plunger. The refueling platform auxiliary hoist cable attaches to a stud on the frame for transporting the grapple. The grapple is lowered through the top guide into a cell from which four fuel assemblies have been removed. The grapple comes to rest on the fuel support, the plungers and lock levers engage the fuel support, and the load is lifted a few inches. The operator tests the fail-safe function to ensure that fuel support is retained, then raises the grapple out of the reactor vessel.

9.1.4.2.6.7 Control Rod Latch Tool

The control rod latch tool assists in removing control rods by unlatching the control rod from the control rod drive (CRD). It is air operated and consists of a latch mechanism in the lower part of the frame and a safety hook in the upper part of the frame. The safety hook engages the control rod handle after it is unlatched so it can be lifted out of the vessel for storage or maintenance.

9.1.4.2.6.8 (Section Deleted)

9.1.4.2.6.9 Control Rod Guide Tube Seal

The control rod guide tube seal prevents reactor water leakage in cases where both a control rod and its drive mechanism are removed.

9.1.4.2.6.10 (Section Deleted)

9.1.4.2.6.11 (Section Deleted)

9.1.4.2.6.12 (Section Deleted)

9.1.4.2.6.13 Fuel Bundle Sampler

The fuel bundle sampler provides a means of isolating a fuel assembly in the demineralized water of the reactor core in order to concentrate fission products in relation to a controlled background. This method is used to detect defective fuel assemblies.

9.1.4.2.6.14 Grid Guide

The grid guide provides an extension structure just above the fuel support grapple, control rod grapple, combined CRB/FSP grapple, control rod guide tube grapple, or control rod latch tool. The grid guide slips over the refueling platform auxiliary hoist cable and is secured by means of

a hand-operated cable grip. The combined guide and grapple assembly is manipulated by the actuating pole. Once engaged in the reactor top guide, the grid guide prevents grapple rotation.

9.1.4.2.6.15 Combined Control Rod Blade/Fuel Support Piece (CRB/FSP) Grapple

The Combined CRB/FSP grapple assists in removing, installing, and transporting both a control rod and fuel support piece simultaneously or individually. The CRB grapple portion captures the control rod handle with one hook. The CRB hook can be raised via a slide assembly to verify uncoupling. Once engaged, the hook mechanism cannot be disengaged unless the control rod weight is removed and air pressure is applied to open the mechanism. The hook permits manual disengagement if the air pressure fails. The fuel support grapple portion consists of two plunger "hooks" that are contained within guides which insert and guide the hooks into diagonally opposed flow openings of a four-lobed fuel support. When the hooks are engaged, they grapple the fuel support by the inside lip of the orifice opening. The valves controlling the fuel support grapple portion are mechanically linked and do not allow disengagement unless the grapple is seated fully and oriented correctly on the core plate anti-rotation pin and air pressure is applied. The valve actuators can be lifted manually if the air pressure fails.

9.1.4.2.6.16 GE 360 Degree Scorpion II Platform (IVVI Support Configuration)

The GE 360 degree Scorpion II platform can be used in one of two configurations, either in the inspection configuration or in the servicing and modification configuration. The inspection configuration slows personnel using the platform to have access to a semi-submerged work trough that is low enough to permit the Refueling Bridge to pass overhead without interfering with in-vessel visual inspection work in the trough. Because the horizontal span of the jib hoist is limited to preclude interaction with the mast of the Refueling Bridge when it is in operation, the jib hoist may be used when in this configuration.

9.1.4.2.7 Refueling Equipment

The essential and code classifications, as well as the seismic category for this equipment, are listed in Table 9.1-8, and descriptions of the equipment follow below.

9.1.4.2.7.1 Refueling Platform

The refueling platform spans the reactor well, spent fuel pool, new fuel vault, and cask loading pit. It permits various fuel movement and reactor servicing operations to be performed from above these cavities.

The refueling platform is a gantry crane that transports fuel and reactor components between the reactor vessel and the fuel pool, or between the fuel pool and the cask loading pit. The platform travels on rails embedded in the refueling floor. A telescoping mast and grapple suspended from a trolley system transports and orients individual fuel assemblies for core, storage rack, dry storage canister, or shipping cask placement. An operator controls the platform from a station on the main trolley. A position indicating system controls the position of the grapple over core, rack, or canister locations. The platform control system includes interlocks to verify the grapple load, prevent unsafe operation over the vessel during control rod movements, and limit vertical travel of the grapple. The Service Pole Caddy System (SPCS) is mounted on the side of the refueling platform opposite the fuel handling grapple. The SPCS provides a single location for storage of most of the rigid poles used for in-vessel services, a pole assembly station and a 500 pound capacity hoist for support of the poles. The SPCS will not be used for fuel or control rod handling. Two 1000-pound capacity auxiliary hoists, one main trolley mounted and one auxiliary trolley mounted, assist with such nonfuel-handling activities as local power range monitor (LPRM) replacement, fuel support replacement, jet pump servicing, and control rod replacement. When the main hoist retracts to the normal up uptravel stop, the grapple provides a minimum of approximately 8 feet of water shielding over the active fuel during transit. Uptravel is limited as described in Section 9.1.4.2.12.3. The fuel grapple hoist has a redundant load path, so that no single component failure will result in a fuel bundle drop.

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9.1.4.2.7.2 Refueling Equipment Service Tools

The fuel grapple installation sling assists in assembling or removing the fuel grapple from the refueling platform. The two unequal length sling cables support the grapple at its storage position angle. The capacity of each cable is 2600 pounds. The reactor building crane auxiliary or main hoist transports the fuel grapple installation sling.

The service platform sling assists in transporting the service platform and service platform support assembly to and from the RPV flange. The sling consists of three cables with safety hooks at the platform end and a common eye that attaches to the reactor building crane auxiliary or main hook. The sling capacity is 14,400 pounds.

The general purpose grapple sling consists of a loop that attaches to the reactor building crane auxiliary or main hook and a threaded adapter that attaches to the general purpose grapple. The single cable sling capacity is 1000 pounds.

The sling assembly for the circular head nut washer rack transports the rack from its storage location on the refueling floor to the vessel head prior to detensioning and from the vessel head to its storage location after tensioning. The sling assembly consists of slings per Section 9.1.5.1.14 attached to the reactor building crane auxiliary or main hook. The total sling capacity is 20 tons.

9.1.4.2.8 Storage Equipment

The essential and code classifications, as well as the seismic category for this equipment, are listed in Table 9.1-8, and descriptions of the equipment follow below.

Specially designed equipment racks are provided. Sections 9.1.1 and 9.1.2 contain descriptions of the new and spent fuel storage racks.

9.1.4.2.8.1 Defective Fuel Storage Containers

Individual fuel rods that are separated from a fuel assembly will be stored in a defective fuel storage container. A defective fuel storage container is designed to hold and contain individual fuel rods, with or without cladding defects. The Westinghouse designed fuel storage container is called a Quiver and is similar in design to a Westinghouse fuel assembly. The refueling bridge will be used to transport a defective fuel storage container within the Spent Fuel Pool boundary. If the defective fuel storage container contains one or more fuel rods, then it cannot be inserted into the Special Racks.

9.1.4.2.8.2 Channel Storage Rack

The channel storage rack provides underwater storage for irradiated and nonirradiated fuel channels during fuel preparation (channeling and dechanneling) tasks. The rack rests on a platform and bracket support between the two fuel preparation machines on the working (north) wall of the fuel pool. The rack includes lifting lugs at the top that enable the reactor building polar crane, plus a sling, to move it if desired. Underwater storage ensures adequate shielding for the irradiated channels. The spaces in the channel storage rack have center posts that prevent accidental insertion of a fuel assembly into a space.

9.1.4.2.8.3 In-Vessel Rack

During refueling or reactor servicing operations, the in-vessel rack provides temporary storage in the reactor vessel for one complete fuel cell (four fuel assemblies, one control rod, one fuel support) plus one blade guide. A mechanical latch closes and causes an orange flag to appear when an individual fuel assembly or control rod is seated in its vertical storage channel. The orange flag provides confirmation to the operator on the refueling platform that the component is properly seated.

The in-vessel rack rests on the edge of the core shroud by means of support legs on the rack bottom plate that prevent inward rack movement. Two lateral guides that bear against the RPV inner wall prevent outward movement. A clamp mechanism that captures a steam dryer and shroud head guide rod locks the rack in position. Stainless steel weights beneath the fuel support storage box counterbalance the rack. The empty rack weighs 575 pounds. The reactor building crane auxiliary or main hoist, plus a grapple and a sling, transports the in-vessel rack between the reactor vessel and the refueling floor.

9.1.4.2.9 Under-Reactor Vessel Servicing Equipment

The function of the under reactor vessel servicing equipment is to:

1. Remove and install CRDs

2. Service thermal sleeves

3. Install and remove the neutron detectors.

Table 9.1-9 lists the equipment and tools required for servicing. Of the equipment listed, the equipment handling platform and the CRD handling equipment are electrically powered.

9.1.4.2.9.1 Control Rod Drive Servicing Tools

The CRD servicing tools assist in disassembly or reassembly of the control rod drives.

9.1.4.2.9.2 Control Rod Drive Hydraulic System Tools

The CRD hydraulic system tools assist rod drive disassembly or reassembly, as well as testing such CRD performance characteristics as trip time, internal drive friction, continuous insert and withdrawal, or jogging operation.

9.1.4.2.9.3 Control Rod Drive Handling Equipment

The CRD handling equipment assists with the removal from and installation of the CRDs in their housings. This equipment is designed in accordance with the requirements of Reference 9.1-2 and References 9.1-6 through 9.1-8. All lifting components are equipped with adequate brakes or gearing to prevent uncontrolled movement upon loss of power or component failure.

9.1.4.2.9.4 Equipment Handling Platform

The equipment handling platform provides a working surface for equipment and personnel performing work in the under vessel area. It is a polar platform capable of 360° rotation. This equipment is designed in accordance with the applicable requirements of References 9.1-2, 9.1-7, and 9.1-9.

9.1.4.2.9.5 (Section Deleted)

9.1.4.2.9.6 (Section Deleted)

9.1.4.2.9.7 In-Core Flange Seal Test Plug

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

9.1.4.2.9.8 (Section Deleted)

9.1.4.2.10 Description of Fuel Transfer

9.1.4.2.10.1 Arrival of Fuel on Site

New fuel arrives on site by truck. Each truck carries a number of metal crates. Each metal crate consists of an outer metal overpack and an inner metal shipping container containing the new fuel. The inner shipping container is also referred to as the "Metal Shipping Container (MSC)", or "new fuel inner box". Both the inner and outer containers are reusable. There are two methods that can be used to transport the fuel to the Reactor Building receiving bay at grade, elevation 102 feet, below the Reactor Building equipment hatches.

1. The truck enters the Reactor Building through the receiving bay door on the South side of the building, and parks below the Reactor Building equipment hatches. The crate top covers are removed.

2. The crates are off loaded from the truck outside the Reactor Building receiving bay door on the south side off the building. The crate top covers are removed and the inner shipping containers are removed from the crates. The inner shipping containers are transported to the Reactor Building through the receiving bay door. They are placed below the Reactor Building equipment hatches. Unless a single failure proof handling system is used to transport the inner shipping containers through the receiving bay door, limitations on weight and height will be applicable due to safety-related, safe shutdown, and decay heat removal equipment located below the receiving bay (NUREG-0612).

Once the fuel is in the Reactor Building, the pressure tight receiving bay door is closed to establish secondary containment. The Reactor Building crane auxiliary or main hoist then raises the inner shipping containers from elevation 102 feet up to the refueling floor, elevation 201 feet.

Handling of new fuel on the refueling floor is illustrated on Figure 9.1-18. Transfer of new fuel between the inner shipping container (C) and the new fuel inspection stand (D), and/or the new fuel storage vault (E), and/or a fuel preparation machine, is accomplished using the Reactor Building crane auxiliary or main hoist with a general purpose grapple (GE fuel) or the ABB/Westinghouse J-Hook (GE or ABB/Westinghouse fuel). Fuel cannot be handled horizontally without support, so the lid of the inner shipping container is removed, bundle/assembly hold-down devices are installed, and the container is placed in an almost vertical position prior to the bundles/assemblies being removed. The upending stand is used to secure the inner container in a near vertical position while the bundles/assemblies are removed.

The auxiliary hoist, with a general purpose grapple (GE or ABB/Westinghouse fuel) or the ABB/Westinghouse J-Hook (GE or ABB/Westinghouse fuel), transfers new fuel from the new fuel vault or inspection stand or upending stand to a fuel preparation machine in the spent fuel pool. From this point on, the fuel is handled by the fuel telescoping grapple on the refueling platform.

New fuel inspection (as required) either takes place during transit from the upending stand (GE or ABB/Westinghouse fuel) in the new fuel inspection stand (GE or ABB/Westinghouse fuel) or the new fuel vault (ABB/Westinghouse fuel).

The new fuel inspection stand holds one or two bundles in the vertical position. The inspectors ride up and down on the inspection stand platform and manually rotate the bundles on their axes. This permits the inspectors to see all visible bundle surfaces. GE fuel may be channeled/unchanneled in the new fuel inspection stand. After receiving inspection (if required), the auxiliary or main hoist transfers the new fuel into the new fuel storage racks or a fuel preparation machine.

In the new fuel vault, unchanneled ABB/Westinghouse fuel may be inspected as it is lowered into a new channel. The inspectors stand in the new fuel vault next to the fuel bundle as it is lowered. This permits the inspectors to see all visible bundle surfaces.

New fuel can be carried over both stored new fuel and stored spent fuel at a height greater than three feet above the stored fuel. Plant Drawing P-0047-1 shows a plan view of the fuel storage facilities.

Plant procedures require that when a new fuel assembly is moved to (or from) the new fuel racks the assembly is lowered (or raised) close to the vault wall. Because the closest approach (nearest edge) of a new fuel cell is more than 9 inches from the wall the assembly is not directly over the stored new fuel when it is lowered (or raised). The lowered assembly is then moved horizontally to its storage location. The new fuel racks are designed to withstand a 6 foot fuel bundle or assembly drop, with no adverse effect on criticality.

Plant procedures prohibit carrying any object weighting more than a fuel assembly over stored new fuel.

Plant procedures require that when a new fuel bundle or assembly is moved to a fuel preparation machine, the assembly is lowered close to the spent fuel pool wall after it passes over the pool curb. Because the closest approach of a spent fuel rack to the north wall of the spent fuel pool is 32.5 inches and to the northernmost 10.5 feet of the west wall is 16.5 inches, the assembly is not directly over the stored fuel when it is lowered. The lowered assembly is then moved horizontally to its storage location. The spent fuel racks are designed to withstand a 6 foot fuel assembly drop with no adverse effect on criticality. Paragraph 9.1.1.3.2.g reflects a 6 foot drop.

As discussed in Section 9.1.5.6, the fuel pool gates are routinely handled over the spent fuel pool. A single failure proof handling system lifts the gates and any other non-routine heavy loads that must be carried over the spent fuel pool. Therefore, objects heavier than a fuel bundle will not be dropped onto stored spent fuel.

New fuel must be channeled before it is ready to be loaded into the reactor core. Either new channels can be used or spent fuel can be dechanneled and the channels reused.

The new fuel is either unloaded from the shipping container (if channeled), new fuel vault or removed from the new fuel inspection stand and transported to the fuel racks in the spent fuel pool. If they are not yet channeled, then channeling will take place in the spent fuel pool. Channeling new fuel is usually done concurrently with dechanneling spent fuel (unless new channels are used). The two fuel preparation machines are located in the spent fuel pool. One is normally used to dechannel spent fuel and the other to channel new fuel. Using a jib crane and the general purpose grapple, a spent fuel assembly is transported to a fuel preparation machine. The channel is unbolted from the assembly. The channel handling tool is fastened to the top of the channel, and the fuel preparation machine carriage is lowered to remove the fuel from the channel. The channel is then positioned over a new fuel assembly located in the other fuel preparation machine, and the process is reversed. The channeled new fuel is stored in the spent fuel pool storage racks, ready for transfer to the reactor.

Prior to the plant shutdown for refueling, all equipment is placed in readiness. All tools, grapples, slings, strongbacks, and stud tensioners are given a thorough check and any defective or well worn parts are replaced. Air hoses on grapples are routinely leak tested. Required load tests are completed. Crane cables are routinely inspected. All necessary maintenance and interlock checks are performed to reduce the chance of an extended outage due to equipment failure.

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

9.1.4.2.10.2 Refueling Activities

A typical plant refueling and servicing flow diagram is shown on Figure 9.1-16. Plant Drawing P-0047-1 shows a plan view of the refueling floor. Fuel handling activities are described below and illustrated on Figures 9.1-18 through 9.1-20. Component drawings of the principal fuel handling equipment are shown on Figures 9.1-7 through 9.1-15 and 9.1-41. The plant's refueling and servicing activities described and illustrated herein provide the predominant work sequence for a typical refueling outage. When constrained by prevailing operating conditions, minor variations in the work sequence are permissible, as authorized by approved Station Procedures.

Fifteen refueling floor service boxes - located on the refueling floor around the perimeters of the fuel pool, reactor well, dryer and separator pool, cask loading pit, cask washdown area, and RPV head washdown area - provide service condensate, demineralized water, service air, and 120 V electrical power for the various fuel handling tasks. One of the boxes includes a 480 V electrical power outlet for the RPV service platform.

The fuel handling process takes place primarily on the refueling floor above the reactor. The principal locations and equipment are shown on Plant Drawing P-0047-1 and Figures 9.1-18 through 9.1-20. The reactor, fuel pool, and cask loading pit are connected to each other by slots, as shown at (A) and (B) on Figures 9.1-19 and 9.1-20, respectively.

Slot (A) is open during reactor refueling, and slot (B) is open during spent fuel cask loading and unloading. At other times, the slots are closed by means of redundant watertight gates and concrete shield blocks.

The refueling platform uses a grapple on a telescoping mast for lifting and transporting fuel assemblies. The telescoping mast can extend to the proper work level and, in its fully retracted state, maintain adequate water shielding over the fuel being handled.

The reactor refueling procedure is illustrated on Figure 9.1-19. The refueling platform (G) moves over the fuel pool, lowers the grapple on its telescoping mast (H), and engages the bail on a new fuel assembly that is in the fuel storage rack. The platform lifts the assembly clear of the rack, moves it through the fuel transfer canal (A), through the shielded fuel transfer chute (R), and over the appropriate empty fuel location in the core (J). The mast then lowers the assembly into that location, and the grapple releases the bail.

The operator then moves the platform until the grapple is over a spent fuel assembly that is to be removed from the core. The assembly is grappled, lifted, and moved through the shielded fuel transfer chute (R) and the fuel transfer canal (A) to the spent fuel pool. There, it is placed in one of the fuel preparation machines (K) to be dechanneled or directly in the appropriate empty fuel location in the spent fuel storage rack.

If spent fuel assemblies are to be dechanneled, channeling and dechanneling are performed in several sequences, depending on whether a new or used channel is installed on a new fuel assembly. The channel storage rack,

conveniently located between the fuel preparation machines, provides temporary storage of the channels that are reused.

To preclude the possibility of raising spent fuel assemblies out of the water, the hoist incorporates redundant electrical limit switches and interlocks that prevent hoisting above the preset limit. In addition, the cables on the auxiliary hoists incorporate adjustable mechanical stops that jam the hoist cable against the hoist structure, which prevents further hoisting, if the limit switch interlock system fails.

A number of other tasks that comprise the overall refueling procedure occur before, during, and after actual fuel transfer between the reactor and fuel pool. The following paragraphs describe the main tasks.

The reactor is shut down according to a prescribed procedure. During cooldown, the RPV is vented and filled to above flange level to equalize cooling. The inert nitrogen atmosphere is purged from the drywell and suppression chamber. The Reactor Building crane, with appropriate slings, removes the six reactor well shield plugs and places them on the refueling floor.

This operation is followed by removal of dryer separator pool plugs and the refueling channel slot plugs. Shield plugs are removed and placed in the positions shown on Plant Drawing P-0047-1.

After removal of the reactor well shield plugs, the work to unbolt the drywell head begins. The drywell head is attached by removable studs. The studs are unscrewed from their captive nuts and removed.

The RPV head strongback is attached to the unbolted drywell head, and the head is then lifted by the Reactor Building crane to its storage space on the refueling floor.

When the drywell head has been removed, an array of piping that must be serviced is exposed. The vent piping that penetrates the reactor well is removed, and the penetrations are made watertight. Vessel head piping and head insulation is removed and transported to storage on the refueling floor.

Water level in the vessel is always brought to flange level to provide shielding before the RPV head is removed.

After removal of all the vessel head nuts and washers, the head strongback, transported by the Reactor Building crane, is attached to the vessel head, and the head is transported to the refueling floor. Pedestals keep the vessel head elevated to facilitate inspection and O-ring replacement.

The Reactor Building polar crane main hoist transports the shielded fuel transfer chute from its storage position on the refueling floor to its shielding position between the reactor vessel and the fuel transfer canal, utilizing the transfer chute strongback and slings. The reactor well and storage pool are flooded in preparation for dryer and separator removal and MSLP installation.

The strongback is disconnected from the transfer chute and stored on the refueling floor.

The Dryer/Separator Sling Assembly (DSSA) is lowered by the Reactor Building crane and attached to the dryer using an assembly of rigid poles and an end effect tool, the DSSA is attached to the dryer. The dryer is then transferred to the storage pool.

Working from the SPC work station, the separator is unbolted. The DSSA is lowered into the cavity by the Reactor Building crane and attached to the separator using an assembly of rigid poles and an end effect tool. The separator is then transferred to the storage pool.

The four Main Steam Lines are plugged from inside the reactor vessel using the REM*Light MSLP assemblies. The assemblies are supported by an auxiliary hoist on the refueling platform and installed using an assembly of rigid poles and an end effect tool.

The gates isolating the fuel pool from the reactor well are then removed, thereby interconnecting the fuel pool, the reactor well, and the dryer/separator storage pool. The actual refueling of the reactor then begins.

During reactor operation, the off-gas activity is monitored. If a substantial rise in activity is noted, the fuel sipping of the

reactor core may be performed during the next refueling outage in accordance with the technique discussed in Section 9.1.4.2.6.13. The fuel sampler rests on the channels of a four bundle fuel cell array in the core. The in-core sampling technique is discussed in Section 9.1.4.2.6. If a leaking bundle is found, it is taken to the fuel pool.

During a normal outage, approximately 33 percent of the fuel is removed from the reactor vessel, 33 percent of the fuel is shuffled in the core (generally from peripheral to center locations), and new fuel is installed to replace the removed spent fuel. The actual fuel handling is done with the fuel grapple, which is an integral part of the refueling platform. The platform runs on rails over the fuel pool and the reactor well. In addition to the fuel grapple, the refueling platform is equipped with two auxiliary hoists that are used with various grapples to service other reactor internals.

To move fuel, the fuel grapple is aligned over the fuel assembly, lowered, and attached to the fuel assembly bail. The fuel assembly is raised out of the core, moved through the refueling channel to the fuel pool, positioned over the storage rack, and lowered to storage. Fuel is shuffled in the core, and new fuel is moved from the storage pool to the reactor vessel in a similar manner.

The following steps, when performed, return the reactor to operating condition. The activities are the reverse of those described in the preceding sections. Deviations from this sequence are permissible, as constrained by operating conditions, when authorized by approved Station Procedures. Many steps are performed in parallel instead of in series, as listed here:

- Verify the core position of each fuel assembly to ensure the desired core configuration has been attained.
- Test the CRD System by performing timing, friction and scram tests.
- Remove and store the four steam line plugs.
- Replace and rebolt the separator.
- Replace the steam dryer.
- Install the fuel pool gates.
- Drain the dryer separator storage pool and reactor well to the level of the RPV flange.
- Remove the shielded fuel transfer chute.
- Remove the RPV flange protector and drywell seal surface covering.
- Open the drywell vents; install the vent piping.
- Decontaminate the reactor well and the dryer/separator storage pool.

- Replace the vessel studs.
- Install the reactor vessel head.
- Replace the refueling channel slot plugs.
- Install the vessel head piping and insulation.
- Replace the dryer/separator pool plugs.
- Hydrotest the vessel, if necessary.
- Install the drywell head.

- Provide an inert atmosphere in the drywell and above the suppression pool

- Install the reactor well shield plugs

- Begin the startup tests that will bring the reactor to full power operation. Increase the power gradually in a series of steps until the reactor is operating at rated power. At specific steps during the approach to power, calibrate the in-core flux monitors.

9.1.4.2.10.3 Departure of Fuel from Site

Spent fuel is ready for offsite shipment after it has been determined to meet the requirements of the shipping package 10 CFR 71 Certificate of Compliance (CoC). These requirements include fuel type, and limits on enrichment, cooling time, and burnup. When spent fuel is shipped, it is placed in a shipping cask, as shown on Figure 9.1-20. The refueling platform grapples a fuel bundle in the storage rack in the fuel pool, lifts it, carries it through slot (B) into the cask loading pit, and lowers it into the shipping cask, (M). When the cask is loaded, the Reactor Building polar crane is used to set the cask cover (N) on the cask, and then lift the cask out of the loading pit and place it in the cask washdown area. The cask is decontaminated and prepared for shipment in the cask washdown area in accordance with the 10 CFR 71 CoC. The cask is then lifted out of the cask washdown area with the Reactor Building polar crane and lowered through the open hatchways, (P), to the truck at grade level.

The shipper of HCGS spent fuel will be chosen later, when the specifics of the shipment are known. The fuel shipping cask(s) to be used will then be known. The specific operations to be implemented for shipping cask handling, fuel loading, and preparation of the cask for transportation will be governed by the shipping cask 10 CFR 71 CoC and SAR, HCGS heavy loads program requirements, and plant needs and capabilities at the time. Specific implementing procedures consistent with those requirements will be developed at that time.

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9.1.4.2.11 Jib Crane

Two portable 1000-pound capacity jib cranes handle fuel and other components around the fuel pool and in the open reactor. The cranes mount in any of the three permanent floor sockets along the north fuel pool wall or in the RPV service platform socket. The reactor building crane transports the jib crane between sockets. A nearby refueling floor service box supplies power and service air to the jib crane. The service air supplies piston operated tools that are attached to the hoist cable. A pendant controlled motor rotates the boom through a 355° arc. The pendant controlled motorized trolley travels the length of the boom. The hoist contains single, stainless steel, nonlubricated, nonspinning cable with a threaded sleeve at the end for tool attachment.

9.1.4.2.12 Refueling Operations

9.1.4.2.12.1 Decay Time

The minimum requirement for reactor subcriticality prior to fuel movement ensures that sufficient time has elapsed to allow the radioactive decay of the short lived fission products. This decay time is consistent with the assumptions used in the accident analyses.

The reactor shall be subcritical for at least 24 hours in Operational Condition 5 during movement of irradiated fuel in the reactor pressure vessel.

With the reactor subcritical for less than 24 hours, suspend all operations involving movement of irradiated fuel in the reactor pressure vessel.

Surveillance Requirements

The reactor shall be determined to have been subcritical for at least 24 hours by verification of the date and time of subcriticality prior to movement of irradiated fuel in the reactor pressure vessel.

9.1.4.2.12.2 Communications

The requirement for communications capability ensures that refueling station personnel can be promptly informed of significant changes in the facility status or core reactivity condition during movement of fuel within the reactor pressure vessel.

Direct communication shall be maintained between the control room and refueling floor personnel in Operational Condition 5 during core alterations.

When direct communication between the control room and refueling floor personnel cannot be maintained, immediately suspend core alterations.

Surveillance Requirements

Direct communication between the control room and refueling floor personnel shall be demonstrated within one hour prior to the start of and at least once per 12 hours during core alterations.

9.1.4.2.12.3 Refueling Platform

The refueling platform operability requirements ensure that (1) the refueling platform will be used for handling fuel assemblies and control rods, with limits placed upon auxiliary hoists' usage, within the reactor pressure vessel, (2) each crane and hoist has sufficient load capacity for handling the loads within its permitted usage, (3) the core internals are protected from excessive lifting force in the event that they are inadvertently engaged during lifting operations, (4) the core internals are protected from a fuel bundle or control rod drop with more impact energy than that assumed in the accident analyses, (5) refueling interlocks and rod blocks are initiated to prevent conditions that could result in criticality during refueling operations.

During handling of fuel assemblies or control rods within the reactor pressure vessel, the refueling platform shall be operable with the main hoist to be used for handling fuel assemblies or control rods within the reactor pressure vessel and the frame-mounted or monorail-mounted auxiliary hoists to be used for handling control rods within the reactor pressure vessel.

With the requirements for refueling platform operability not satisfied, suspend use of any inoperable refueling platform equipment from operations involving the handling of control rods and fuel assemblies within the reactor pressure vessel after placing the load in a safe condition.

Surveillance Requirements

The refueling platform main hoists used for handling of control rods or fuel assemblies within the reactor pressure vessel shall be demonstrated OPERABLE within 7 days prior to the start of such operations by:

a. Demonstrating operation of the overload cutoff on the main hoist when the load exceeds 1200 + 0, -50 pounds.

b. Demonstrating operation of the overload cutoff on the frame-mounted and monorail-mounted auxiliary hoists when the load exceeds 500 ± 50 pounds.

c. Demonstrating operation of the main hoist uptravel stop when uptravel brings the point where the grapple attaches to the fuel bundle to 6 feet 6 inches, +3, -0 inches below the normal water level.

d. Demonstrating operation of the frame-mounted and monorail-mounted auxiliary hoists' uptravel stops when uptravel brings the point where the grapple attaches to a control rod to 6 feet, +1, -0 feet below the normal water level.

e. Demonstrating operation of the slack cable cutoff on the main hoist when the load is less than 50 ± 10 pounds.

f. Demonstrating operation of the loaded rod block interlock on the main hoist when the load exceeds 535 ± 50 pounds.

g. Demonstrating operation of the redundant loaded interlock on the main hoist when the load exceeds 550 ± 50 pounds.

9.1.4.2.12.4 Crane Travel-Spent Fuel Storage Pool

The restriction on movement of loads in excess of the nominal weight of a fuel assembly over other fuel assemblies in the storage pool ensures that in the event this load is dropped (1) the activity release will be limited to that contained in a single fuel assembly, and (2) any possible distortion of fuel in the storage racks will not result in a critical array. This assumption is consistent with the activity release assumed in the safety analyses.

With fuel assemblies in the spent fuel storage pool racks, loads in excess of 1200 pounds shall be prohibited from travel over fuel assemblies in the spent fuel storage pool racks unless handled by a single failure proof handling system.

With the above requirements not satisfied, place the polar crane load in a safe condition.

Surveillance Requirements

1. Interlocks and physical stops which prevent polar crane main hoist travel over fuel assemblies in the spent fuel storage pool racks shall be demonstrated OPERABLE within 7 days prior to and at least once per 7 days during polar crane operation.
2. The single failure proof handling system shall be visually inspected and verified OPERABLE within 7 days prior to and at least once per 7 days during polar crane operation.

9.1.4.3 Safety Evaluation - Fuel Handling System

The Fuel Handling System complies with GDC 2, 3, 4, 5, 61, and 62 and applicable portions of 10CFR50, as well as Regulatory Guides 1.13 and 1.29.

None of the light load handling (LLH) devices have redundant interlocks and limit switches. However, the effects of an accidental collision in the spent fuel pool by an LLH device would be less than the effects of the fuel handling accident described in Section 15.7.4.

The LLH devices that could be involved in accidental pool wall collisions are the refueling platform grapple, the two refueling platform auxiliary hoists, the hoist on the SPCS, the two fuel pool jib cranes, and the channel handling boom.

Failure of any of the light load handling systems (LLHS) equipment poses no hazard greater than the effects of the fuel handling accident analyzed in Section 15.7.4. Functional checks will be done for all active LLHS equipment before each use. Visual inspection will be done for all passive LLHS equipment before each use. The checks and inspections will incorporate the guidance of the individual operation and maintenance manuals. The procedures that require these checks and inspections will be prepared for each LLH device before fuel load. The procedures will address appropriate corrective action to be taken when degraded conditions are detected.

A system level, qualitative type failure mode and effects analysis relative to this system is discussed in Section 15.9.6.

9.1.4.3.1 Spent Fuel Casks

The design of the spent fuel shipping cask and the spent furl transfer cask (used for on-site dry fuel storage operations in the Reactor Building) include single failure proof load attachment points. The cask lifting yoke is also single failure proof. Section 9.1.5 includes the safety evaluation for the single failure proof Reactor Building crane. Therefore, the design

of the spent fuel cask handling system precludes a cask drop due to a single failure.

9.1.4.3.2 New and Spent Fuel Storage

The safety evaluations of the storage of new and spent fuel are discussed in Sections 9.1.1 and 9.1.2, respectively.

9.1.4.3.3 Fuel Servicing Equipment

Section 9.1.4.2.3 includes discussions of the safety aspects of the fuel servicing equipment. Failure of any of the fuel servicing equipment listed in Table 9.1-5 poses no hazard greater than the effects of the fuel handling accident analyzed in Section 15.

9.1.4.3.4 Servicing Aids

Section 9.1.4.2.4 includes discussions of the safety aspects of the servicing aids. Failure of any of the servicing aids poses no hazard greater than the effects of the refueling accident.

9.1.4.3.5 Reactor Vessel Servicing Equipment

Section 9.1.4.2.5 includes discussions of the safety aspects of some of the reactor vessel servicing equipment. Failure of any of the vessel servicing equipment listed in Table 9.1-6, except the dryer and separator sling, head strongback, or service platform, poses no hazard greater than the effects of the refueling accident.

Safety evaluation of the dryer and separator sling, head strongback, and service platform is provided in Section 9.1.5.

9.1.4.3.6 In-Vessel Servicing Equipment

Section 9.1.4.2.6 includes discussions of the safety aspects of the in-vessel servicing equipment. Failure of any of the in-vessel

servicing equipment poses no hazard greater than the effects of the refueling accident.

9.1.4.3.7 Refueling Equipment

Section 9.1.4.2.7 includes discussions of the safety aspects of the refueling equipment. The most severe failure of the refueling equipment would be a failure of the refueling platform and its associated fuel grapple, which would cause a fuel assembly to be dropped onto the reactor core. This fuel handling accident is analyzed in Section 15.

The refueling platform is designed to prevent it from toppling into the pools during a safe shutdown earthquake (SSE). The grapple used for fuel movement is on the end of a telescoping mast. The grapple is 6 feet 6 inches below the water surface. Uptravel is limited as described in Section 9.1.4.2.12.3. The grapple is hoisted by redundant wire rope cables inside of the mast and is lowered by gravity. A digital readout is displayed to the operator, showing the exact coordinates of the grapple over the core.

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

The grapple has two hooks operated by a single air cylinder. Engagement is indicated to the operator. Interlocks prevent grapple disengagement until a "slack cable" signal from the lifting cables indicates that the fuel assembly is seated.

Each grapple hook includes a hook engaged switch. The switches are wired in series and interlocked with the grapple loaded switch to prevent inadvertently raising a fuel assembly when either hook is not engaged. A "hook engaged" light on the refueling platform control console provides positive indication to the operator that the grapple hooks are properly attached to the fuel assembly lift bail. The hook-engaged switches include protective covers that prevent accidental actuation. The fuel hoist includes a solid-state electronic load cell with load readout in the operator's cab and a pressure-actuated slack cable switch to provide accurate slack cable sensing.

The control console master switch causes immediate hoist brake actuation when it is moved to the neutral position. This feature prevents load drift that would occur with a regenerative brake design. The design of the couplings of the industrial motor to the speed reducer employs conservative torque values. In addition, a redundant 150-percent-capacity load brake is attached directly to the hoist drum opposite the motor gearbox end. This brake prevents a load drop due to a motor gearbox coupling failure. An emergency stop button instantly actuates this brake.

In addition to the main hoist on the trolley, there is an auxiliary hoist on the trolley, another hoist on its own monorail and a fourth hoist on the Service Pole Caddy. These four hoists are precluded from operating simultaneously because control power is available to only the SPC hoist and one of the others at a time. The two auxiliary hoists have load cells with interlocks, which prevent the hoists from moving any thing as heavy as a fuel bundle. The hoist on the SPC has a reach of only 20 feet, capacity of only 500 pounds and no tools which can engage the bails on fuel or control blades. The two auxiliary hoists have electrical interlocks that prevent the lifting of their loads higher than 6 feet underwater. Adjustable mechanical jam stops on the cables back up these interlocks.

The shielded fuel transfer chute, in its shielding position in the reactor vessel cavity and in its storage position on the refueling floor, has been analyzed for Seismic II/I to be safe against sliding or tipping over into the RPV or other safety-related equipment during a safe shutdown earthquake (SSE).

In the event of a fuel assembly drop, the top edges of the transfer chute walls are above the center of gravity of a fuel bundle, thereby preventing the fuel bundle from falling out of the transfer chute and exposing personnel in the drywell below to very high radiation dose rates.

Safety evaluation of the transfer chute lift is provided in Section 9.1.5.

9.1.4.3.8 Jib Crane

The jib crane hoist cable incorporates an adjustable removable stop that jams the cable against the crane structure when the end of the cable is a preset distance below the water level. This prevents raising a fuel assembly or other radioactive material out of the water accidentally. The crane includes two full capacity brakes and two sets of redundant uptravel limit switches. The first two independently adjustable uptravel limit switches automatically stop the hoist approximately 8 feet below the refueling floor level. Depressing the momentary contact uptravel override push button on the pendant, simultaneously with the normal hoist push button, enables continued hoisting past the first set of limit switches. A second set of two independent uptravel limit switches automatically cuts hoist power at the maximum uptravel limit.

A mechanical force gage automatically stops the hoist on an overload signal of 1000 ± 50 pounds. Two additional normally closed switches, that are set to open at 400 ± 50 pounds, are wired in parallel with the force gage for connection to the service platform receptacle.

9.1.4.4 Inspection and Testing Requirements

9.1.4.4.1 Inspection

Refueling and servicing equipment is subject to the quality assurance requirements of 10CFR50, Appendix B. Components defined as essential to safety, such as the RPV head strongback and the refueling platform, have an additional set of engineering specified "quality requirements," which identify safety-related features requiring specific quality assurance verification of compliance to drawing requirements.

Prior to shipment, every essential component item is reviewed by quality assurance personnel. Conformance with design requirements is noted on a summary product quality checklist. Issuance of this list verifies that all quality requirements have been met, and that confirmation is on record in the product's historical file.

9.1.4.4.2 Testing

Qualification testing is performed on refueling and servicing equipment prototypes prior to multiunit production. Test specifications are defined by the responsible design engineer and may include sequence of operations, load capacity, and life cycle

tests. These test activities are performed by an independent test engineering group and, in many cases, a full design review of the product is conducted before and after the qualification testing cycle. Any design changes affecting function, that are made after the completion of qualification testing, are requalified by test or calculation.

Functional tests are performed in the shop prior to the shipment of production units and generally include electrical tests, leak tests, and sequence of operation tests.

When the unit is received at the HCGS site, it is inspected by quality control personnel to ensure that no damage has occurred during transit. Tools and equipment which do not affect safety may be checked for proper operation prior to use by station maintenance and/or construction procedures. Tools and equipment which do affect safety will be specifically tested to ensure that the electrical and/or mechanical functions are operational prior to fuel loading. Individual operation and maintenance manuals for fuel handling system equipment items define the functional checks to be done after plant startup. Functional and/or visual checks are required before each use of most fuel handling system equipment.

Passive units, such as the dryer/separator sling, are visually inspected before each use. The Kevlar slings have overload indicators ("tell tails"). The overload indicators will shrink into the covers of the slings, if the slings are loaded to more than two times their rated capacity.

Fuel handling and vessel servicing equipment preoperational tests are described in Section 14.

9.1.4.5 Instrumentation Requirements

The majority of the refueling and servicing equipment is manually operated and controlled by the operator's visual observations. This type of operation does not require a dynamic instrumentation system. However, several components do have instrumentation and control systems.

9.1.4.5.1 Refueling Platform

The refueling platform has a nonsafety-related x-y-z position indicator system that informs the operator which core fuel cell the fuel grapple is accessing. Interlocks are provided to prevent the fuel grapple from operating in a fuel cell where the control rod is not in the proper orientation for refueling. Section 7.7.1 contains a discussion of refueling interlocks.

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

A series of load cells provides automatic shutdown whenever lift limits are exceeded on either the fuel grapple or the auxiliary hoist units.

By procedure, fuel or control blade handling is not performed from the SPCS. In addition, the auxiliary hoist on the SPC cannot reach the fuel and no equipment is provided with the SPCS which can engage the bails on a fuel bundle or control blade.

9.1.4.5.2 Fuel Support Grapple

Although the fuel support grapple is not essential to safety, it has an instrumentation system consisting of mechanical switches and indicator lights. This system provides the operator with a positive indication that the grapple is properly aligned and oriented, and that the grappling mechanism is either extended or retracted.

9.1.4.5.3 Service Platform

The service platform control panel is electrically interlocked with the portable refueling jib crane when the crane is installed on the platform. A rod block interlock with the reactor manual control system, and the jib crane load cell, prevents control rod withdrawal while the hoist is loaded with a fuel assembly. Another interlock with the reactor manual control system interrupts power to the hoist motor if the hoist is loaded and all control rods are not fully inserted.

One of the refueling floor service boxes provides the power connection to the platform. A receptacle on the platform supplies power to the jib crane. A switch on the platform control panel controls power to the two 1/2-horsepower drive wheel motors.

9.1.4.5.4 Jib Crane

Jib crane instrumentation and controls are discussed in Section 9.1.4.3.8.

9.1.4.5.5 Radiation Monitoring

The radiation monitoring equipment for the refueling and servicing equipment is evaluated in Section 7.6.1.

9.1.4.5.6 Communication System

Communication between the refueling floor and the main control room, or other plant areas, is discussed in Section 9.5.2.

9.1.4.6 <u>SRP Rule Review</u>

In SRP Section 9.1.4, Acceptance Criteria II.3 and 4 refer to Regulatory Guide 1.13, Position C.3, which requires that interlocks be provided to prevent cranes from passing over stored fuel when fuel handling is not in progress.

At HCGS, only the main hoist of the Reactor Building polar crane is physically restricted from traveling over the spent fuel pool. The 10-ton auxiliary hoist has no such travel restriction. Restricting its travel over the fuel pool is not part of the polar crane design basis. Instead, the alternative crane design basis of a single failure proof auxiliary hoist, described in Section 9.1.5.3.1, is used. No loads are required to be routinely handled over the fuel pool when fuel handling is not in progress. In the event a light load must be handled over stored fuel, a single failure proof handling system will be used.

Acceptance Criterion 3 in this SRP section refers to ANS 57.1, which, in Paragraph 6.2.1.1(a), requires that the auxiliary fuel handling crane be provided with an underload interlock that is actuated upon a reduction in load while lowering to prevent any further downward travel.

At HCGS, the polar crane functions as the auxiliary fuel handling crane. It does not have an underload interlock, since it was purchased prior to the time ANS Standard 57.1 was issued. Reliance on the following aspects of design and operation will assure safe load lowering in compliance with the intent of the underload interlock requirement. In the unlikely event of a reduction in load, visual observation and operator action would be used to stop downward travel. The safety latch on the auxiliary and main hook prevents a sling from accidentally slipping off the hook. Also, a single failure proof handling system will be used to the maximum extent practical for loads lowered in the pool over stored fuel.

Acceptance Criterion 5 in this SRP section refers to Subsection III, Item 6, which requires that the maximum potential kinetic energy capable of being developed by any load handled above stored spent fuel, if dropped, is not to exceed the kinetic energy of one fuel assembly and its associated handling tool when dropped from the height at which it is normally handled above the spent fuel pool storage racks.

At HCGS, light loads handled by the fuel pool jib cranes and the polar crane could exceed the maximum potential energy stated in this acceptance criterion. Normal light loads would include a blade guide, fuel support casting, control rod, or a control rod guide tube. There are no other items which are expected to be carried over the pool which have significant kinetic energy compared to a fuel assembly.

Since each of the listed items weighs considerably less than a fuel bundle, and is carried at no higher elevation, the consequences of a

load drop would be less than those of the fuel handling accident described in Section 15.7.4. No other jib crane loads, if dropped, would have more serious consequences than those of the fuel handling accident.

There are no anticipated polar crane light load handling situations that would require loads to be carried over the fuel pool. They would be handled around the perimeter whenever possible. For an unanticipated case where a load would have to be carried above the pool, the load height would be limited to as low as is practical. The auxiliary hoist design is single failure proof. In the event a light load is handled over the spent fuel pool, a single failure proof handling system will be used.

9.1.5 Overhead Heavy Load Handling Systems

9.1.5.1 Design Bases

1. The Overhead Heavy Load Handling Systems (OHLHS) are designed to move heavy loads from one location to another within the various plant structures.

2. The OHLHS are designed to safely handle all plant heavy loads that range in weight from a maximum of 150 tons in the Reactor Building and 220 tons in the Turbine Building to a minimum of 1200 pounds.

3. The Reactor Building polar crane main hoist and auxiliary hoist are designed to be single failure proof in conformance with NUREG-0554 and NUREG-0612.

4. The OHLHS in the Reactor Building are designed so that releases of radioactive material that could result from damage to spent fuel, due to a postulated heavy load drop, will produce doses that are within 10CFR50.67 limits.

5. The OHLHS in the Reactor Building are designed so that damage to fuel and fuel storage racks due to a postulated heavy load drop will not result in a fuel configuration that causes K_{eff} to exceed 0.95.

6. The OHLHS in the Reactor Building are designed so that damage to the reactor vessel or spent fuel pool, resulting from a postulated heavy load drop, will not cause water loss that could uncover spent fuel.

7. The OHLHS are designed so that damage to equipment resulting from a heavy load drop will not prevent safe shutdown of the reactor.

8. The OHLHS are designed to minimize the potential for heavy load drops on spent fuel or safe shutdown equipment by carrying their loads over safe load paths to the extent practical. They are defined in written load handling procedures, and are shown on safe load path drawings.

9. The Reactor Building polar crane and other OHLHS that handle loads over safe shutdown equipment are operated in compliance with written procedures that include identification of the required equipment, inspections and acceptance criteria required before load movement, sequence of steps to be followed for load movement, definition of safe load path, and any special precautions, for each known load.

10. The OHLHS cranes are operated by operators who are trained, qualified, and conduct themselves in compliance with Chapter 2-3 of ANSI B30.2-1976.

11. The OHLHS cranes are inspected, tested, and maintained in compliance with Chapter 2-2 of ANSI B30.2-1976.

12. The OHLHS crane designs include electrical interlocks and/or mechanical stops to restrict crane travel to those areas that are necessary.

13. The OHLHS cranes are designed to meet the applicable criteria of CMAA-70, and Chapter 2-1 of ANSI B30.2-1976.

14. Lifting devices that are not specially designed are installed and used in accordance with the guidelines of ANSI B30.9-1971. For all hoists that have a maximum hoisting speed equal to or less than 30 ft/min., the load used to select the proper sling is the static load. For hoists that have a maximum hoisting speed greater than 30 ft/min., the load used is the sum of the static and maximum dynamic loads. The maximum dynamic load is determined by multiplying the maximum hoisting speed by 1/2 of one percent of the static load.

    The rating identified on the sling is for the static load that corresponds to the maximum total static plus dynamic load. If a sling is restricted to use with only certain hoists, the identification of the acceptable hoists is clearly marked on the sling.

15. Special lifting devices are designed to meet the applicable criteria of ANSI N14.6-1978.

9.1.5.2 System Description

The cranes and lifting devices that comprise the OHLHS are described in the following sections. Table 9.1-10 includes a summary of the design data, seismic category, and code or standard used for design and manufacture of each OHLHS crane. It also includes monorails for which no dedicated hoists exist but which are used occasionally for equipment maintenance. Table 9.1-11 includes a more detailed listing of the design parameters for just the Reactor Building polar crane.

Cranes are included in the OHLHS if their capacity is greater than 1200 pounds. This is the designated weight of a heavy load for Hope Creek Generating Station (HCGS). It is defined as the weight of one spent fuel assembly and its handling tool. For HCGS, the 1200-pound value consists of assumed weights for a fuel assembly (650 pounds), a fuel assembly channel (100 pounds), and the refueling platform grapple (450 pounds).

Section 9.1.4 includes a description of those aspects of new fuel receipt and storage, reactor refueling operations, and spent fuel cask loading and unloading that involves the Reactor Building polar crane.

9.1.5.2.1 Reactor Building Polar Crane

The Reactor Building polar crane is a bridge crane mounted on a circular rail at Elevation 240 feet that is supported by the Reactor Building superstructure. The bridge consists of two welded box girders with full depth diaphragms. The bridge girders are held together by structural end tie girders. Two dual wheeled trucks that travel on top of the runway rail support each of the two end tie girders and drive the bridge. The crane is shown on Figure 9.1-21.

Two electric motor driven trolleys, one for the main hoist and one for the auxiliary hoist, provide the structural frame support for the polar crane hoisting machinery. The trolleys travel on a single set of rails secured to the tops of the two bridge girders. The main hoist design capacity is 150 tons, and the auxiliary hoist design capacity is 10 tons. Both hoists are single failure proof. The electric motor driven hoists raise and lower their loads using wire rope that is dual reeved through upper and lower sheaves. The lower sheaves are an integral part of the load block. Each hoist includes a hook that is attached to the load block. The hooks are at Elevation 236 feet when they are fully raised.

The design parameters for the Reactor Building polar crane are listed in Table 9.1-11.

The Reactor Building polar crane design includes the features described below.

9.1.5.2.1.1 Structural Components

All the structural components and machinery of the reactor building polar crane are designed for a full capacity of 150 tons, with a minimum safety factor of 10 against ultimate failure for the load carrying parts, including hoist ropes, and the machinery. The calculated stresses of all load carrying parts are in accordance with the requirements of Crane Manufacturer's Association of America (CMAA) Specification 70.

Structural design of the crane complies with the following seismic loading combinations and criteria:

1. Dead load plus live load plus operating basis earthquake (OBE) resultant stresses are less than the normal AISC code allowable stresses.

2. Dead load plus live load plus safe shutdown earthquake (SSE) resultant stresses are less than 1.5 times the normal AISC code allowable stresses, less than 0.9 yield in bending, 0.85 in axial tension or compression, and 0.5 yield in shear.

The earthquake motion considered consists of two horizontal and one vertical component. The total structural response is predicted by combining the applicable maximum codirectional responses, calculated from the three (two horizontal and one vertical) analyses, using the square root of the sum of the squares (SRSS) method.

The structural members of the Reactor Building polar crane are designed for a fatigue loading of 100,000 to 500,000 cycles, with each completed lift representing one cycle. The rotating machinery is designed for a fatigue life expectancy of 2,000,000 cycles, with each rotating component cycle represented by one revolution. Any

load below 50 percent of the crane rated capacity does not reduce the life expectancy of the crane.

9.1.5.2.1.2 Mechanical Components

The crane is of a double trolley, indoor, electric overhead, bridge crane design. The main trolley layout is shown on Figure 9.1-22. The auxiliary trolley layout is shown on Figure 9.1-23.

The main hoist consists of two balanced, eight part reeving systems to provide redundancy. The arrangement consists of two separate and redundant wire cables reeved side by side through the upper and lower sheaves, as shown on Figure 9.1-24. Each cable passes through a paired equalizer unit that adjusts for unequal cable length and is used as a load transfer safety system. This energy absorbing device eliminates sudden load displacement and shock to the crane system in the unlikely event of a cable break. The factor of safety, based on static load, is halved when a cable breaks, but no swinging action occurs because each cable is reeved to both sides of the upper and lower sheaves.

The auxiliary hoist is provided with a two part reeving system, as shown on Figure 9.1-25. The two separate and redundant wire ropes are reeved side-by-side through the upper and lower auxiliary hoist sheaves.

The main functions of the main hoist equalizer system are to continually adjust the hook load so that any load under normal operation is shared equally by the redundant reeving systems and to transfer the shock of a cable break to the remaining cable. The equalizer assembly is shown on Figure 9.1-26. The main hoist uses a redundant equalizer design that consists of an equalizer sheave supported from either end of an equalizer beam.

Before making a series of lifts, the equalizer beam can be visually inspected, and adjusted if necessary, so that an unnecessary power shutoff does not occur. If the equalizer beam needs to be adjusted

during a lift, the load can be lowered and the adjustment made at the cable drum anchors. If the equalizer beam reaches the limits of its travel, which should occur only if one of the cables had already failed, the load can be safely lowered with the remaining cable so that a new cable can be installed.

The main hook is a two pronged sister hook with safety latches and a cored bail hole. Redundancy is provided with the main hook by incorporating a coaxial lifting eye bolt design. The shaft of the sister hook is bored out to accommodate the inner lifting eye bolt shaft, as shown on Figure 9.1-27. The sister hook and the lifting eye bolt are independently supported by their respective crosshead and bearings that are in turn supported by the load block, as shown on Figure 9.1-28. The lifting eye bolt and the sister hook each have a design rated capacity of 150 tons and a safety factor of 10 with respect to ultimate strength.

The auxiliary hook is a single pronged, stainless steel hammer forged shank hook with a safety latch, as shown on Figure 9.1-29. A 12 ton rated screw pin chain shackle, located on either side of the shank hook, provides redundancy for the auxiliary hook. The shank hook and chain shackles are independently supported by the load block, as shown on Figure 9.1-30. The shank hook and the shackles are each designed with a safety factor of 10 with respect to ultimate strength.

The main and auxiliary hoists are each equipped with one load brake and two redundant holding brakes. The load brake is a dc actuated, eddy current, control type brake. It regulates load lowering and raising speed and minimizes wear on the holding brakes when repeated starting and stopping is required. The holding brakes are electric shoe type dc magnet brakes that employ rectifiers to permit the use of ac power supply. The holding brakes are used for normal stopping. They are automatically and sequentially applied with a 2-second time delay when electric power is interrupted or the control is neutral. They are automatically released when the load brake is energized or when power is available. The torque rating of

each of the four hoist holding brakes is at least 150 percent of rated full load hoist motor torque.

The bridge is equipped with two automatic drum brakes that can also be manually actuated, each rated at 125 percent of drive motor full load torque. Each trolley includes two automatic electric disc brakes, each rated at 125 percent of drive motor full load torque. The trolley brakes and the automatic bridge brake each set when power is interrupted or the control switch is in neutral.

9.1.5.2.1.3 Crane Controls

An operator's cab is attached to one of the bridge girders at one end of the reactor building polar crane. The crane is controlled from the cab or from a remote control system. The crane can be operated by the remote control system from the refueling floor.

Movements of the bridge, trolleys, main hoist, and auxiliary hoist are controlled from either the cab or the remote control system. Both the remote control system and cab controls include a main power control switch that can cut all power to the crane. Levers on the remote control system are of the momentary contact type that return to the "neutral" position when released. Cab controls also spring return to the "off" position when released.

A Main Hoist Unbalanced Load Bypass Switch is installed in the cab. This permits the operator to place the switch from “Normal” to “Bypass” to lower a load if the main hoist experiences a rope failure or unbalanced load.

9.1.5.2.1.4 Hoist Limit Switches

The extent of travel for the main hoist is limited for both the raising and lowering directions by programmable limit switches. The extent of travel for the auxiliary hoist is limited for both the raising and lowering directions by a combination of limit switches. Redundant limit switches are

provided for both hoists in the raising direction and single limit switches are provided in the lowering direction. The primary protection for the auxiliary hoist in both directions is a geared limit switch coupled to the hoist drum shaft. When the primary geared limit switch is tripped, power to the hoist motor is interrupted via the control circuitry. This in turn sets the brakes. The primary protection for the main hoist is a programmable limit switch. The programmable limit switch interrupts power to the crane when the setpoints are reached. The secondary protection in the raising direction for both hoists is weighted limit switches. When the weighted limit switches are tripped, power to the hoist motors is interrupted via the control circuitry, and the brakes are set. The limit switches are wired so that the motor can be manually energized in the reverse direction after a limit switch has been tripped.

The programmable limit switch is a microprocessor based instrument that allows for precise control of rotary motion. The limit switch is programmable by a keypad located on the main hoist structure.

Both the main hoist and the auxiliary hoist are equipped with a centrifugal type limit switch, located on the drum shaft, to provide automatic shutdown protection (hoist motor trip and setting of the holding brakes) against overspeed due to a runaway condition of the load. The trip setting is at 120 percent of hoist motor synchronous speed.

A load sensing system is provided for the main and auxiliary hoists, using a transducer mounted in a rope sheave shaft. Overload protection is provided by automatic shutdown (hoist motor trip and setting of the holding brakes), which is actuated at 110% of the rated hoist load.

The response time to stop the main hoist motion if there is actuation of a hoist overspeed, overload, or overtravel limit switch is such that the load block movement is less than 3 inches following actuation of one of the hoist limit switches.

A proximity switch is mounted on the Main Hoist equalizer assembly to sense normal load lifting activities and provide a permissive to stop the Main Hoist movement due to a rope failure or unbalanced load.

9.1.5.2.1.5 Bridge and Trolley Drives and Controls

The bridge and trolleys have 5-step reversing control on travel speed. Both the bridge and trolleys have braking systems that must be energized to release and that automatically set if there is a power loss. Each bridge drive is equipped with a drum brake that has a torque rating equal to 125 percent of maximum torque of one bridge drive motor. The two bridge drive brakes are each energized by two means, electrically and hydraulically. The automatic return of the bridge controller to the neutral position energizes the electric solenoid. As a backup, operation of the foot pedal in the cab energizes the hydraulic cylinder. The trolleys are equipped with two magnetic brakes, each of which has a torque rating equal to 125 percent of the maximum torque of the trolley drive motor.

Zone travel limit switches mounted on each cab end bridge truck stop bridge rotation before it contacts the bridge rail stops. One rail stop, designed to absorb the energy of a full speed, full load collision with the bridge, is located on the bridge rail at both points of intersection with the main hook exclusion area. The main hook exclusion area is a truncated circular segment of the refueling floor that includes the spent fuel pool and over which the main hook never passes. The main hook exclusion area is shown on Figure 9.1-31.

End of travel limit switches on the main trolley restrict its travel to a portion of the bridge, as shown on Figure 9.1-31, so that the main hoist remains outside the main hook exclusion area. Energy absorbing bumpers on each end of the trolley are designed to absorb the energy of a full speed unloaded collision. Main trolley stops located near the middle of the bridge provide backup to the midspan main trolley limit switches.

End of travel limit switches on the auxiliary trolley, and at both ends of the bridge, permit it to travel nearly the full length of the bridge, as shown on Figure 9.1-31. Bumpers at each end of the auxiliary trolley travel path, designed for 100 percent unloaded impact, back up the auxiliary trolley limit switches.

The bridge and trolley limit switches cut the power to their respective drive motors and set the corresponding brakes when they trip.

9.1.5.2.1.6 Thermal Overload Protection

Thermal overload protection is provided for motors on the crane to prevent continuation of motor stalling torque. In addition, thermal overload warning lights in the operator's cab indicate bridge, trolley, or hoist motor high temperature.

9.1.5.2.2 Other OHLHS Cranes

All plant OHLHS cranes, except the Reactor Building polar crane, are described below. The equipment tag numbers are shown in parentheses.

1. Personnel air lock hoist (10H217)

   This 30-ton capacity monorail hoist is located above elevation 102 feet in the reactor building. The top of the rail is at Elevation 126 feet 4.75 inches, and the hoist hook is at Elevation 118 feet 3.25 inches when it is fully raised. It is used to remove nine shield blocks and the drywell personnel air lock (30 tons) during plant shutdown. The upper shield block includes retractable wheels that permit this hoist to tow it forward along the monorail and position it to be lowered by two adjacent 15-ton hoists (item ii.). The 30-ton hoist lifts each of the eight lower shield blocks, moves it a short distance, and lowers it onto a cart. The cart carries the nine blocks out of the reactor building. The 30-ton hoist along with engineering approved rigging that meets NUREG-0612 and applicable ANSI standards, is used when the air lock is moved. The personnel air lock is moved along the monorail and set down on a predetermined spot. A portion of the primary containment suppression pool is located below the load path of this hoist on the next lower elevation.

2a. ‘A’ Reactor recirculation pump motor hoists (1AH201)

Dual 30-ton capacity monorail hoists are located above Elevation 102 feet inside the drywell. The top of the rail is at Elevation 120 feet 1 inch and the hook is at approximately Elevation 116 feet 11 inches when it is fully raised. The hoists lift the ‘A’ recirculation pump motor (24 tons) out of the pump housing for inspection and repair. To remove the motor, the hoists raise it (in place) about 3 feet to clear the pump. The removal cart is then moved beneath the motor. When the cart is in place, the motor is lowered to rest on the cart and tilted to a near horizontal position. It is tilted by simultaneously moving the chain operated trolleys and lowering the lift point. With the motor secured, the cart is pulled out of the containment.

2b. ‘B’ Reactor recirculation pump motor hoist (1BH201)

This 24-ton capacity monorail hoist is located above Elevation 102 feet inside the drywell. The top of the rail is at Elevation 120 feet 1 inch and the hook is at Elevation 116 feet when it is fully raised. The hoist lifts the ‘B’ recirculation pump motor (24 tons) out of the pump housing for inspection and repair. To remove the motor, the hoist raises it (in place) about 3 feet to clear the pump. The removal cart is then moved beneath the motor. When the cart is in place, the motor is lowered to rest on the cart and tilted to a near horizontal position. It is tilted by simultaneously moving the chain operated trolley and lowering the lift point. With the motor secured, the cart is pulled out of the containment.

NOTE: 1BH201 (hoist and monorail) has been removed from the drywell and will be reinstalled on an as-needed basis to support motor removal.

3. Reactor water cleanup filter demineralizer hoist (1AH220, 1BH220)

These 10-ton capacity monorail hoists are located above Elevation 178 feet in the Reactor Building. The hoists are used for removal of the four concrete shield blocks above each RWCS filter demineralizer cell, and the filter tube bundle. The two heaviest blocks weigh 8 tons each. The tube bundle weighs less than 500 pounds and therefore is not a heavy load.

4. HPCI pump and turbine hoists (1AH211, 1BH211)

These 4-ton capacity monorail hoists are located above Elevation 54 feet in the Reactor Building. For each hoist the top of the rail is at Elevation 71 feet 3 1/2 inches, and the hook is at Elevation 66 feet 10 1/2 inches when it is fully raised. They are used during maintenance of the HPCI pump and turbine. There is no lower floor elevation.

5. RCIC pump and turbine hoist (10H212)

This 3-ton capacity monorail hoist is located above Elevation 54 feet in the Reactor Building. It is used during maintenance of the RCIC pump and turbine. There is no lower floor elevation. The heaviest maintenance load (upper half of the turbine case) weighs 785 pounds. Therefore, this hoist does not handle heavy loads.

6. Main steam tunnel underhung crane (10H214, 10H223)

This crane is located above Elevation 102 feet in the Reactor Building. Two parallel manually driven bridge beams connected by end trucks travel on two fixed girders located in the main steam tunnel. The top of the bridge beams is at Elevation 140 feet. A manually operated 2.5 ton capacity trolley and hoist (10H214) is mounted on one bridge beam, and a manually operated 3 ton capacity trolley and hoist (10H223) is mounted on the other. The hook is at Elevation 137 feet 4 inches for 10H214, and 137 feet 3.5 inches for 10H223 when fully raised. It is used to lift the operator off of each of the four outboard MSIVs, the four main steam stop valves, and the two motor operated feedwater stop check valves for maintenance.

7. Inboard MSIV hoist (10H203)

This 2-ton capacity hoist is located above Elevation 102 feet in the Reactor Building. One monorail and four rigging beams are provided above the inboard MSIVs. One rigging beam is located above each valve, and the monorail is perpendicular to the two inner valve rigging beams. Each of the four rigging beams is a S6 x 17.25 I-beam with several lifting lugs welded to its underside at intervals

along the centerline. Several additional lifting lugs are welded to nearby structural steel to supplement the rigging beam lugs. The top of steel elevation for the monorail and the two inner valve rigging beams (above valves F022A and F022D) is 119 feet 7.5 inches. The top of steel elevation for the rigging beam above valve F022C is 117 feet 10.75 inches, and the top of the rigging beam above valve F022B is 119 feet.

Hoist 10H203 is located on the monorail. Its hook is at Elevation 117 feet 10 inches when it is fully raised. Falls that are brought into the drywell when needed and attached to the appropriate lugs on the rigging beams and the structural steel are used together with 10H203 when it is necessary to lift an inboard MSIV operator for maintenance.

8. CRD service hoist

This monorail is located above Elevation 102 feet in the CRD maintenance area of the Reactor Building. The top of the rail is at Elevation 116 feet 6 inches. It is designed to accommodate a hoist for lifting control rods (450 pounds), CRD maintenance equipment (up to 2000 pounds), and the neutron monitoring cask (less than 1150 pounds). Because a dedicated CRD service hoist was not purchased, one will be borrowed from another location when needed.

9. Vacuum breaker valve removal hoist (10H207)

This 2-ton capacity circular monorail hoist is located above Elevation 54 feet in the Reactor Building. The monorail is located inside the suppression pool chamber for maintenance and removal of the vacuum breaker valves. The valves weigh 912 pounds each and thus do not constitute a heavy load.

10. Main steam line relief valve removal hoist (10H202)

This 1-ton capacity circular monorail hoist is located above Elevation 121 feet inside the drywell. The monorail is actually at Elevation 135 feet. It is used to remove the main steam line relief valves as required for maintenance. The main steam line relief valves weigh 1100 pounds each and do not constitute a heavy load.

11. Turbine building bridge crane (10H102)

This crane consists of a 220-ton capacity main hoist and a 45-ton auxiliary hoist. It is located above Elevation 137 feet in the Turbine Building. It is used to lift the parts of the turbine generator. A second crane, identical to 10H102, and originally intended for use with the Unit 2 turbine, travels along the same rails as 10H102. A stator lift beam, supplied with the crane and designed to be simultaneously supported by the main hoist of each crane, is used to lift the 366-ton stator of the turbine generator unit.

12. Feedwater heater removal hoist (1AH103, 1BH103)

These portable 24-ton capacity, manually (chain) operated hoists are designed to operate in tandem on one of the nine I-beam monorails located above elevation 120 feet in the Turbine Building. The beams serve the nine condenser mounted feedwater heaters. The hoists are used during feedwater heater tube removal.

13. Heating and ventilating equipment removal hoist (10H104)

This 15-ton capacity monorail hoist is located above Elevation 171 feet in the turbine building. It is used for moving heating and ventilation equipment through the equipment removal hatch at Elevation 137 feet.

14. Motor generator set hoist (0AH105, 0BH105)

These 15-ton capacity monorail hoists are located above Elevation 137 feet in the turbine building. They service and replace components of the two reactor recirculation pump motor generator sets. Both hoists operate together on the same rail to lift those components such as the motor and exciter, or the generator, that weigh more than 15 tons.

15. Secondary condensate pump hoist (10H106)

This 15-ton capacity monorail hoist is located above Elevation 54 feet in the Turbine Building. It services the three secondary condensate pumps and their electric motor drivers from one common monorail.

16. Reactor feed pump hoist (1AH107, 1BH107, 1CH107)

These 15-ton capacity electric monorail hoists are located above Elevation 137 feet in the Turbine Building. They service the reactor feed pumps and their turbine drivers.

17. Water box removal hoist (10H109, 10H110)

These 12-ton capacity monorail hoists are located above Elevation 77 feet in the Turbine Building. They are used for removal of the condenser water boxes that have inlet and outlet nozzles.

18. Steam packing exhauster hoist (10H115)

This 10-ton capacity chain operated monorail hoist is located above Elevation 77 feet in the Turbine Building. It is used during removal of the tube bundle from the steam packing exhauster condenser.

19. Water box removal hoist (10H111, 10H112)

These 8-ton capacity chain operated monorail hoists are located above Elevation 77 feet in the Turbine Building. They are used for removal of the condenser water boxes that do not have inlet and outlet nozzles.

20. Chiller tube removal hoist (10H118)

This 5-ton capacity chain operated monorail hoist is located above Elevation 171 feet in the Turbine Building. It is used for removal of chiller tube bundles.

21. Emergency air compressor hoist (10H114)

This 4-ton capacity chain operated monorail hoist is located above Elevation 123 feet in the Turbine Building. It is used to service the emergency instrument air compressor.

22. Main air compressor hoist (00H113, 10H113)

These 3-ton capacity, chain operated monorail hoists are located above elevation 123 feet in the Turbine Building. They are used during replacement of the station air compressors and their motor drivers.

23. Vacuum pump water cooler hoist (10H116)

This 2-ton capacity, chain operated monorail hoist is located above Elevation 77 feet in the Turbine Building. They are used for removal of tube bundles from the mechanical vacuum pump seal water coolers.

24. Heating and cooling coil removal hoist (1AH119, 1BH119)

These 1.5-ton capacity monorail hoist are located above Elevation 171 feet in the Turbine Building. They are used for removal of the cooling and heating coils that are located inside the air supply plenum.

25. Turbine generator auxiliary crane (00H100)

This 10-ton capacity bridge crane serves the turbine generator. A set of rails is provided over the turbine generator above Elevation 137 feet. The auxiliary crane is moved by the Turbine Building bridge crane (item 11.), as required.

26. Demineralizer removal hoist (00H302)

This 10-ton capacity monorail hoist is located above Elevation 102 feet in the service and radwaste area. It lifts the fuel pool filter demineralizer and liquid radwaste filter elements out of their vessels for maintenance and replacement. The heaviest load (1800 pounds) is a liquid radwaste filter bundle.

27. Decontamination evaporator hoist (00H305)

This 7-1/2 ton capacity monorail hoist is located above Elevation 54 feet of the service and radwaste area. It is used during maintenance of the decontamination solution evaporator. The hoist lifts the top (1.2 tons) and middle (2.9 tons) sections separately and sets them down on predetermined spots.

28. Equipment decontamination room hoist (00H314)

This 5-ton capacity bridge type crane is located above Elevation 102 feet of the service and radwaste area. It is used for lifting and moving miscellaneous equipment.

29. Machine shop underhung crane (0AH301, 0BH301, 0CH301, 0DH301)

These 5-ton capacity monorail cranes are located above Elevation 102 feet of the service and radwaste area. They are used for lifting and moving miscellaneous plant equipment and parts.

30. Waste evaporator recirculation (WER) pump hoist (00H309, 00H310)

These 2-ton capacity, hand operated monorail hoists are located above Elevation 54 feet of the service and radwaste area. They lift the WER pump (3300 pounds) and motor (3835 pounds), separately, for maintenance.

31. Waste evaporator hoist (00H312, 00H313)

These 1-ton capacity, hand operated monorail hoists are located above Elevation 87 feet of the service and radwaste area. They lift the tops of the evaporators and miscellaneous parts.

32. Diesel generator underhung crane (1AH400, 1BH400, 1CH400, 1DH400)

These 2-ton capacity underhung bridge cranes are located above Elevation 102 feet of the control and diesel generator area. The top of the bridge is at Elevation 124 feet 9 inches, and the hoist hook elevation is 122 feet when it is fully raised. They are used to lift and move miscellaneous diesel generator parts and equipment. The four cranes share a single interchangeable hoist.

33. Intake structure gantry crane (00H500)

This gantry crane is located above Elevation 123 feet of the intake structure. The top of the gantry girder rail is at Elevation 167 feet 5 1/2 inches. The elevation of the 30 ton hook is 163 feet and of the 15 ton hook is 160 feet when fully raised. It has a 30-ton capacity main hoist and a 15-ton capacity auxiliary hoist. The crane's heaviest lifts are parts of the traveling screens (19 tons).

34. Reactor Building personnel lock shield removal hoist (1AH218, 1BH218)

These 15-ton capacity monorail hoists are located above elevation 102 feet in the Reactor Building. One is located on each side of the personnel air lock hoist (item 1.). After the personnel air lock hoist tows it into position, they work in tandem to lower the upper shield block onto a cart that carries it out of the building.

35. Solid radwaste monorail hoist (00H316)

This 1-1/2-ton hoist is located above Elevation 102 feet in the Auxiliary Building. It transfers filled 55-gallon radwaste drums from the two extruder/evaporator turntables to the capper/scanner infeed conveyor and replaces them with empty drums.

36. Solid radwaste bridge crane (00H317)

This 7-1/2-ton double girder crane is located above Elevation 102 feet in the Auxiliary Building. It also serves the radwaste drum storage area loft at Elevation 126.5 feet. It moves filled 55-gallon drums within the storage area, unloads the outfeed conveyor, assists in removing the shipping cask lid, and in truck loading.

37. SACS pumps hoist

Fifteen-ton design capacity monorails, de-rated to 4-tons working capacity, are provided above the SACS pumps to accommodate hoists for removal of the pump motors. One monorail serves pumps A and C in SACS loop A, and the other serves pumps B and D in loop B. The monorails are located above Elevation 102 feet in the Reactor Building. The top of each rail is at Elevation 126 feet 10.75 inches. Because dedicated SACS pump hoists were not purchased, they will be borrowed from other locations when needed.

38. SACS heat exchanger hoist

Two parallel 5-ton capacity monorails at one end of each SACS heat exchanger are designed to accommodate hoists for removal of the heat exchanger end covers. One set of monorails serves both SACS loop A exchangers, and the other set serves the loop B exchangers. The monorails are located above Elevation 102 feet in the Reactor Building. The top of each rail is at Elevation 127 feet 1 1/2 inches. Because dedicated SACS heat exchanger hoists were not purchased, they will be borrowed from other locations when needed.

39. Recombiner system hoists (00H318, 10H318)

These 1-1/2 (00H318) and 2-1/2 (10H318) ton capacity chain operated monorail hoists are located above elevation 67 feet 3 inches in the service and radwaste area of the Auxiliary Building. Each hoist removes the valve operator from one of the control valves in the feed lines to the off gas recombiners, carries it to the hatch in the valve cell, and lowers it to a maintenance cart in the access corridor at Elevation 54 feet. Each valve operator weighs 943 pounds.

40. Feedwater flow straightener hoists (10-H-225, 10-H-226, 10-H-227, and 10-H-228)

These 4-ton-capacity, hand-operated monorail hoists are located above Elevation 137 feet in room 1504 in the Turbine Building. They are used to move the feedwater system flow straighteners to allow for their inspection.

41. CRD transfer cask jib crane (10H205)

This 1 ton jib crane is above elevation 132 feet in the Reactor Building and is located in the CRD maintenance room (4408). The crane is equipped with a dedicated electric, wire rope hoist mounted to a motorized trolley assembly which allows the hoist to traverse the boom. Travel stops are provided at each end of the boom to limit hoist travel. The jib crane is designed to lift a loaded CRD transfer cart, using a load leveling device, from the CRD removal and repair room (4326) on elevation 102'-0" to the CRD maintenance room (4408) on elevation 132'-0" in the Reactor Building.

42. SW Strainers Trolley Beam Hoists

There are two 4-ton capacity trolley beams, one in each active bay, connected to roof framing steel and situated diagonally between strainer and roof hatch. A trolley beam is used in conjunction with a lug located above the center of each strainer, along with the SWIS Gantry Crane (00H500), to rig strainer items (cover and body separately). The trolley beam can be removed/rotated to service either strainer in the bay. The bottom of each trolley beam is at Elev. 116' - 1-1/2, and above floor Elev. 93' - 0. Hoists will be borrowed from other locations when needed.

43. This 1.1-ton capacity A-frame gantry is located outside the Service Water Intake Structure on the 102-foot elevation riverside. It is used by maintenance during silt removal activities in the area between the trash racks and the traveling water screens. The heaviest maintenance load (silt removal pump and equipment) weighs less than 500 pounds. Therefore, this gantry does not handle heavy loads.

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9.1.5.3 Safety Evaluation

All of the OHLHS cranes are evaluated in Table 9.1-10 with respect to whether they carry heavy loads over safety-related equipment located under the load path or on the next lower elevation. Table 9.1-10 excludes from further evaluation those OHLHS cranes that have no safety-related equipment below their load paths or only handle loads lighter than 1200 pounds although their design capacity is greater.

Those OHLHS cranes not excluded in Table 9.1-10 are listed in Table 9.1-12 along with the loads they carry, the lifting device, if any, for each load, and the safety-related equipment beneath the load path. Hazard elimination criteria are applied to each load handling situation identified in Table 9.1-12 to determine if it can be excluded from further evaluation. All equipment hatch load handling situations are dealt with in compliance with the guidelines of NUREG-0612.

Application of the NUREG-0612 guidelines, the exclusion criteria in Table 9.1-10, and the hazard elimination criteria in Table 9.1-12 show that there are no remaining OHLHS for which heavy load drops might prevent safe shutdown or decay heat removal, cause unacceptable radioactivity release, or expose spent fuel. The OHLHS load situations in Table 9.1-12 are lifted in accordance with approved safe load paths. The spent fuel shipping or transfer cask will not be lifted, or pass over any spent fuel in either the spent fuel pool or the reactor. The cask will be handled by a single failure proof overhead handling system that complies with NUREG-0554 and NUREG-0612. Figure 9.1-31 shows the main hook exclusion area. Additional drawings showing plan and elevation views of the reactor building and other areas are provided in the general arrangement drawings and equipment location drawings provided in FSAR Section 1.2.

Normal cask movement will occur only when the reactor and drywell heads and the reactor well shield plugs are in place. Cask movement will be administratively controlled so that it will be moved along its load path only when the reactor head is in place. It will, therefore, not pass over any spent fuel in the reactor.

Because the shipping and dry storage transfer casks will be handled by a single failure proof overhead handling system, they will not be dropped.

The shipping cask will be supported by the single failure proof overhead handling system (polar crane) at all points along its load path, including the cask washdown area, except when it is in the cask loading pit. The walls of the cask loading pit would prevent the cask from tipping or falling into the spent fuel pool. Because the design precludes a dropped or tipped cask, safety-related equipment will not be damaged.

The dry storage transfer cask will also be lifted by a single failure proof overhead handling system (polar crane) at all points along its load path from the cask loading pit, to the cask washdown area, to the cask "stack-up" area in the truck bay at elevation 102 feet. The transfer cask will not be supported by the polar crane during cask preparation activities while resting in the cask washdown area or during MPC transfer operations in the "stack-up" area. In the "stack-up" area, the transfer cask containing a fuel-filled multi-purpose canister (MPC) is placed atop an empty dry storage overpack and the MPC containing fuel is lowered into the overpack.

The transfer cask in the cask washdown area at elevation 201 feet and the stacked overpack/mating device/transfer cask assemblage rest on a device known as the Holtec Earthquake Mitigator (HERMIT), which ensures that the cask will not tip over during a seismic event. The HERMIT permits a limited amount of lateral movement of the cask during a design basis earthquake such that tipover is precluded. Separate HERMITs are used in each location. The HERMIT at elevation 102 feet rests atop a low profile transporter (LPT), which is a wheeled support structure that permits the loaded overpack to be moved with a tug vehicle out of the Reactor Building within the clearance of the truck bay rollup door.

Analyses have been performed to demonstrate that the transfer cask remains kinematically stable (will not tip over) and the Reactor Building floors at elevation 201 feet, 156 feet, and elevation 102 feet will withstand the dead and live loads, including seismic loads, during all required operations. No safety-related equipment will be damaged.

9.1.5.3.1 Reactor Building Polar Crane

Figure 9.1-32 shows the load paths for this crane. The reactor building polar crane is the only one of the OHLHS cranes that is physically capable of carrying heavy loads over irradiated fuel. Both the main and auxiliary hoists are single failure proof.

Trolley and bridge travel limit switches, plus a set of bridge stops on the rail and main trolley stops near the middle of the bridge, together ensure that the main hoist cannot travel over the fuel pool. Figure 9.1-31 shows the main hook exclusion area. The cask loading pit is outside the exclusion area and separate from the spent fuel pool. The spent fuel cask, therefore, can not accidentally drop into the spent fuel pool. The cask is moved directly between the hatch, the cask washdown area, and the cask loading pit on the refueling floor, as shown on the load path drawing, Figure 9.1-32.

Some safety features of the polar crane design are discussed in Section 9.1.5.2.1. In addition, the crane is designed to Seismic Category I criteria so that either hoist will retain its load during and after a SSE. Manually engaged anti-derail devices on both trolleys secure the trolleys when not in use and prevent rolling during an earthquake. Flat plate earthquake restraints welded onto the bottom of the girder end ties transfer the seismic loads to the reactor building wall through the crane rail.

The single failure proof aspects of the polar crane design include complete redundancy for the sheaves, ropes, reeving, reducing gears, holding brakes, and other load path components of both the main and auxiliary hoists.

Failure of one of the three phase power leads to the reactor building polar crane, as either an open circuit or a short circuit, will result in cessation of crane movement.

A phase loss protection (PLP) relay monitors the polar crane supply voltage for open circuit. This relay de-energizes emergency stop relays to stop all crane movement. In addition, undervoltage relays are provided in the crane controls to perform the same function or detection of any power loss downstream from the supply point.

Short circuit protection for the three phase power leads to the polar crane is provided by circuit breakers with all poles mechanically connected. A short circuit on a hoist motor feeder circuit will de-energize that motor and set its brakes. A short circuit at the crane power supply point will stop all crane movement.

The overspeed limit switch on each polar crane hoist drum shaft, described in Section 9.1.5.2.1.4, will also trip the hoist motor and set the brakes as a backup to the phase loss circuit protection.

In the event of a phase loss, the polar crane load movement will be less than 1 inch from the main hoist and less than 5 inches for the auxiliary hoist, both of these movements are within the design parameters of the polar crane.

As described in Section 9.1.5.3.3, all of the plant overhead heavy load handling systems (OHLHS) cranes with motorized hoists, except the polar crane, include one mechanical and one electrical brake. Each is automatically applied on loss of power. As discussed in the OHLHS safety evaluation, Section 9.1.5.3, a heavy load drop would not prevent safe shutdown nor decay heat removal, cause unacceptable radioactivity release, or expose spent fuel. Therefore, an evaluation of the effects of failure of one of the 3 phase power leads to any of these other OHLHS cranes, that are supplied with 3 phase power, has not been done.

Figure 9.1-30 illustrates the single failure proof auxiliary hoist design. The load is supported by the hook and two shackles, one on either side of the hook. The two separate load paths from the hook and shackles extend through the four side plates up to two separate sheave pins. Each of the two plates on either side of the load block is designed to support the design load. The trunnion applies the hook load to all 4 plates. Each shackle applies the hook load to the two side plates on its side. The side plates transmit the load to the two sheave pins. Each pin holds a sheave that is reeved independently. The block housing includes two through bars that are designed to catch the wire ropes and/or sheaves if a sheave or sheave pin fails. Each sheave is independently reeved to the hoist drum, where the ropes are dead ended to the drum.

Table 9.1-13 presents a point by point comparison of the Reactor Building polar crane design with the criteria of NUREG-0554, Single-Failure Proof Cranes for Nuclear Power Plants. Table 9.1-15 presents a failure modes and effects analysis for the Reactor Building polar crane.

9.1.5.3.2 Reactor Building Polar Crane Lifting Devices

Heavy loads lifted by the polar crane, and the lifting device used, are listed in Table 9.1-12. The heavy loads listed on Table 9.1-12 are lifted in accordance with safe load paths. Table 9.1-22 compares the polar crane lifting devices and associated lift points with the NUREG-0612

criteria for special lifting devices and single failure proof systems. The special lifting devices along with the design safety factors are listed in Table 9.1-14.

The polar crane main hoist is single-failure proof, as described in Section 9.1.5.3.1. Additionally, the polar crane main hoist is prevented from traveling over the fuel pool, as described in Section 9.1.5.3.1. Therefore, a hypothetical load drop onto the spent fuel racks, or spent fuel is not a credible event. The RPV service platform, stud tensioner, and head stud rack are light enough to be handled by the polar crane auxiliary hoist. The load paths are administratively controlled to keep these loads out of the main hoist exclusion area, i.e., from over the fuel pool.

All heavy loads that do not need to be carried over the reactor well are restricted from this area during refueling. Administrative procedures help to control safe movement of all heavy loads.

A load drop into the reactor well could not affect safe shutdown capability since the well is only open when the reactor is shut down. Decay heat removal capability could be threatened only by a load large enough to damage the seal plate. Failure of the seal plate would not allow the large, heavy loads to fall into the drywell because their size is greater than the space between the RPV and the drywell. The reactor well and the drywell are lined with steel plate which will retain any concrete which is fragmented by swinging or falling loads. It is doubtful that other debris large enough to damage shutdown cooling piping could fall through the labyrinth of intervening piping and structural steel, including the massive primary containment radial box beams.

The RHR shutdown cooling subsystem described in Section 5.4.7 includes a single suction line from reactor recirculation loop B. Therefore, a load drop into the reactor well could potentially disable the shutdown cooling function of the RHR system. As discussed above, a load drop damaging and bypassing the seal plate is highly unlikely. In addition, any debris that managed to fall and disable RHR shutdown cooling would not have enough residual energy when it reached the components of this subsystem to do

sufficient damage to prevent manual restoration of the cooling function. Damage such as a severed or crimped pipe, or complete loss of function of a suction line valve operator is not considered credible. Shutdown cooling would be manually restored as described in Section 5.4.7.1.5. If manual restoration cannot be achieved, an alternate flow path as described in Section 15.2.9 could be used. Similarly, if debris from the load drop were able to cause leakage from exposed reactor vessel piping, makeup water could be supplied by any of a number of RHR and core spray injection lines until the leak could be repaired. Therefore, the drop of a heavy load into the reactor well would not affect decay heat removal capability.

Heavy loads carried over the refueling floor that employ lifting devices or lift points that are not single failure proof weigh up to 10 tons. These loads are listed below and are also tabulated, with their weights, in Table 9.1-12.

1. Refueling bellows guard ring
2. RPV stud tensioner
3. Flux monitor shipping crate
4. RPV head stud rack

In summary, a load drop on the refueling floor of any of the loads normally carried over the floor by a non-single-failure proof overhead handling system would satisfy the four evaluation criteria of NUREG-0612, Section 5.1. Table 9.1-23 presents an analysis of a postulated heavy load drop against the four evaluation criteria of NUREG-0612. The following paragraphs provide additional details for each polar crane lifting device.

9.1.5.3.2.1 Fuel Cask Yoke

Single failure proof spent fuel cask lifting devices (yokes) and cask lift point designs, in accordance with the requirements of NUREG-0612, are used at HCGS.

9.1.5.3.2.2 RPV Head Strongback

The RPV head strongback is used as a lifting device for the following loads:

1. Drywell head
2. RPV head
3. RPV head insulation and frame (a single failure proof sling arrangement may be used in lieu of the RPV head strongback)
4. RPV head, head nut and washer rack, and head nuts and washers

The RPV head strongback is a special lifting device as defined by NUREG-0612, Section 5.1.1.4. The design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The RPV head strongback design meets the single failure proof guidelines of NUREG-0612, Section 5.1.6(1)(a).

The RPV and drywell heads each have four lift points. The lift points meet the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(a).

The RPV head insulation and its support structure is carried over the RPV when the head is on. The support structure is lifted by either the RPV head strongback or by a four sling arrangement meeting the guidelines of NUREG-0612, Section 5.1.6(1)b and the Polar Crane Aux or Main Hooks, each of which meets the guidelines of NUREG-0612, Section 5.1.6(3)(b) for the lift. The lift points on each piece are designed to meet the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(a).

In summary, the RPV head strongback and the associated heavy load lift points satisfy the single failure proof guidelines of NUREG-0612, Section 5.1.6. A postulated heavy load drop is not considered credible due to the single failure proof design.

9.1.5.3.2.3 Shield Plug Sling

The special lifting device for the reactor well shield plugs and the dryer separator pool plugs is single failure proof in accordance with NUREG-0612, Section 5.1.6(1)(a). The design factors of safety versus yield and ultimate strength are provided in Table 9.1-14. Each plug has four lift points to prevent uncontrolled lowering of the load, assuming a single lift point failure. Each lift point has a maximum combined static plus dynamic design safety factor of greater than 5 with respect to material ultimate strength. The design is conservative and satisfies the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(a). A postulated heavy load drop is not considered credible due to the single failure proof design.

9.1.5.3.2.4 Dryer/Separator Sling Assembly

The dryer separator sling lifts the steam dryer and the moisture separator. The sling design satisfies the guidelines of ANSI N14.6-1978 and complies as recommended by NUREG-0612, Section 5.1.1(4). The design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14.

The dryer separator sling satisfies the single failure proof guidelines of NUREG-0612, Section 5.1.6(1)(a). The moisture separator and the steam dryer each have four lift points. The lift points meet the single failure proof guidelines of NUREG-0612 Section 5.1.6(3)(a). A postulated heavy load drop is not considered credible due to the single failure proof design.

9.1.5.3.2.5 Service Platform Sling

The service platform sling lifts the RPV service platform. The sling design satisfies the guidelines of ANSI N14.6-1978 in general, but does not explicitly comply as recommended by NUREG-0612, Section 5.1.1(4). The design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14.

The RPV service platform has three lift points. The platform is handled as close to the refueling floor as is practical.

The service platform sling and the lift points on the service platform meet the single failure proof guidelines of NUREG-0612, Section 5.1.6. No load drop analysis is required due to the single failure proof design.

9.1.5.3.2.6 Fuel Rack Lifting Fixture

The fuel rack lifting fixture will be used for several non-routine heavy load lifts over the fuel pool. It is used for installing the spent fuel rack modules. As described in Section 9.1.2.2.2.2, a base capacity of 3976 fuel cells plus 30 multipurpose cavities is installed. The lifting fixture design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. These factors meet the criteria of paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof special lifting device.

The lifting eye of the fixture is connected to the crane hook by a sling arrangement. The slings are selected to meet the single failure proof criteria of Section 5.1.6(1)(b) of NUREG-0612. The four legs of the fixture each have a J-shaped plate at the bottom. The fixture legs are lowered through four of the empty cells of the rack module being lifted, moved horizontally a short distance, and raised to hook to the module base. The four J-shaped plates contact the underside of the module base when it is being lifted. This design eliminates the need for lifting eyes on the module. The weight of the module, together with the shape of the lifting fixture plates, provides assurance that the fixture is securely attached to the module during lifting.

Thus, because there are no lift points on the modules, and both the crane and lifting fixture are single failure proof, the modules will

be installed with a single failure proof handling system. A postulated heavy load drop is not considered credible due to the single failure proof design.

The modules will be lifted with the main hoist of the polar crane. Limit switches and travel stops, described in Section 9.1.5.2.1.5, will be temporarily bypassed as necessary to permit the main hook to travel into the main hook exclusion area shown on Figure 9.1-31 when the modules are installed. The temporary bypassing of limit switches and travel stops will be done under strict administrative control.

9.1.5.3.2.7 RPV Stud Tensioner Sling

The RPV stud tensioner has four lift points. The lift points satisfy the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(a). The stud tensioner lifting device consists of four slings supplied with the tensioner. The tensioner sling design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The factors calculated for the maximum combined static and dynamic load, assuming the entire load is carried by only two of the four wire ropes, are greater than the values of 6 versus yield and 10 versus ultimate required by paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof special lifting device.

The tensioner is handled as close to the refueling floor as is practical. The RPV stud tensioner is carried over the RPV while the head is on. A load drop is not considered credible because of the single failure proof handling system.

9.1.5.3.2.8 Miscellaneous Single Failure Proof Slings

Single failure proof slings selected in accordance with NUREG-0612, Section 5.1.6(1)(b), are used to lift the following loads:

- Spent fuel pool slot plugs

- Spent fuel pool and cask loading pit gates
- Head stud rack
- Flux monitor shipping crate
- 4'x4'-6" hatch cover
- 10'x10' hatch cover
- Refueling bellows guard ring
- Jib crane
- dryer separator staircases

The fuel pool slot plug sling is a single failure proof conventional sling selected to meet the requirements of NUREG-0612, Section 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14. Each fuel pool slot plug has a single lifting point designed with a maximum combined static plus dynamic factor of safety greater than 15 with respect to material ultimate strength. This satisfies the NUREG-0612, Section 5.1.6(3)(b) requirement for a safety factor of 10. A postulated heavy load drop is not considered credible due to the single-failure-proof design.

A single failure proof conventional sling selected in accordance with NUREG-0612, Section 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14, is used to lift the fuel pool and cask loading pit gates. The pool/pit gates are the only heavy loads which must routinely be carried over the fuel pool. There are two lift points on each pool/pit gate. A single lift point failure will not result in an uncontrolled lowering of the gate. The lift points, while over the fuel pool, are designed with a maximum combined static plus dynamic factor of safety greater than 15 with respect to material ultimate strength. This satisfies the NUREG-0612, Section 5.1.6(3)(a) requirement for a safety factor of 5. A postulated heavy load drop is not considered credible due to the single failure proof design.

The RPV head stud rack has a single lifting point. The lift point satisfies the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(b). The stud rack is lifted by a sling selected to meet the single failure proof guidelines of NUREG-0612, Section 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14. The stud rack is handled as close to the refueling floor as is practical, and is only carried over the RPV while the head is on. The RPV head stud rack is not carried over the spent fuel pool. A load drop is not considered credible because of the single failure proof handling system.

The flux monitor shipping crate is carried over the refueling floor by slings selected to meet the single failure proof guidelines of NUREG-0612, Paragraph 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14. The shipping crate is not carried over the RPV or spent fuel pool. An analysis of a postulated drop against the four evaluation criteria of NUREG-0612, Section 5.1, is provided in Table 9.1-23.

The 4'x 4'-6" hatch cover and the 10'x10' hatch cover are carried over the refueling floor by slings selected to meet the single failure proof guidelines of NUREG-0612, Section 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14. The hatch covers are not carried over the RPV or the spent fuel pool. The lift points on the hatch covers satisfy the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(a). A postulated heavy load drop is not considered credible due to the single failure proof design.

The refueling bellows guard ring is carried over the refueling floor by a single-failure proof sling selected to meet the guidelines of NUREG-0612, Section 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14. The guard ring is not carried over the spent fuel pool and is only carried over the RPV when the RPV head is on. An analysis of a postulated drop against the four evaluation criteria of NUREG-0612, Section 5.1, is provided in Table 9.1-22.

The fuel pool jib cranes are carried over the reactor vessel when the RPV head is off, but only when the RPV service platform is in place on the RPV flange. A conventional sling, selected in accordance with NUREG-0612, Paragraph 5.1.6(1)(b)(ii), as clarified by FSAR Section 9.1.5.1.n., is used to lift the jib crane. The load used to select the sling is two times the sum of the maximum static plus dynamic loads. The dynamic load is assumed to be 0.25W, where W equals the weight of the jib crane. The load used is, therefore, 2(W±0.25W). The jib crane design has a single lift point with a design safety factor of 10 times the maximum combined concurrent static and dynamic load with respect to material ultimate strength as required by NUREG-0612, Paragraph 5.1.6(3)(b). The jib crane handling system, therefore, meets the single failure proof guidelines of NUREG-0612, Section 5.1.6. A postulated heavy load drop is not considered credible due to the single failure proof design.

The dryer separator staircases are not carried over the RPV or spent fuel pool. They are carried over the refuel floor and into the dryer separator pit by a sling selected to meet the single failure proof guidelines of NUREG 0612, Section 5.1.6(3)(b) as clarified by FSAR Section 9.1.5.1.14. A load drop is not considered credible because of the single failure proof handling system.

9.1.5.3.2.9 Channel Handling Boom Crane

The channel handling boom crane is carried over the refueling floor by a sling selected to meet the single failure proof guidelines of NUREG-0612, Section 5.1.6(1)(b) as clarified by FSAR Section 9.1.5.1.14.

The channel handling boom crane is not carried over the RPV or spent fuel pool. The lift point on the channel handling boom satisfies the single failure proof guidelines of NUREG-0612, Section 5.1.6(3)(b). A load drop is not considered credible because of the single failure proof handling system.

9.1.5.3.2.10 New Fuel Inner Box Lifting Sling

The inner box lifting sling is used to lift a single inner shipping container containing fuel bundles or assemblies from the Reactor Building receiving bay at Elevation 102 feet up to the refueling floor at Elevation 201 feet. Each inner shipping container contains up to two fuel bundles/assemblies. The sling is also used to move a single inner shipping container from the refueling floor back to the receiving bay. The sling consists of a single ring for attachment to the polar crane, and

four stainless steel wire rope legs with safety swivel hooks for attachment to four lifting lugs on the sides of the inner shipping container. The sling is a special lifting device according to the definition in Section 1.2 of NUREG-0612.

Although not originally specified to be designed in accordance with ANSI N14.6-1978, as necessary for strict compliance with Paragraph 5.1.6(1)(a) of NUREG-0612, the sling was provided by GE under appropriate quality assurance requirements and quality control procedures for the specific dedicated application of lifting the inner shipping container. These quality requirements include a certificate of inspection for the sling, and liquid penetrant inspection of the ring and the swivel hooks.

The calculated inner box lifting sling factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The factors meet the 6 versus yield and 10 versus ultimate strength values required by Paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof special lifting device.

The inner shipping container is lifted using four lifting lugs on the sides of the container. A single lift point failure will not result in uncontrolled lowering of the load. The calculated factor of safety under the maximum combined concurrent static and dynamic load after taking a single lift point failure meets the value of 5 versus ultimate required by Paragraph 5.1.6(3)(a) of NUREG-0612 for a single failure proof design. The sling/lift point combination is listed in Table 9.1-21. .

There are six lifting lugs on the sides of the inner shipping container (three per side). Two lugs on each side are connected to the inner box lifting sling. The selection of which ones to use is based on whether there is fuel inside the container. The lugs are labeled. There are also two lifting lugs on the corners of one end of the inner shipping container (called vertical sling fittings). These lugs are not used with the inner box lifting sling.

9.1.5.3.2.11 New Fuel Inner Box Tilting Sling

The inner box tilting sling is used to raise the inner shipping container (also called the inner box) containing fuel from a horizontal to a vertical position. Each inner shipping container contains up to two fuel bundles or assemblies. The sling lifts the inner shipping container several inches off of the floor when it is inserted and removed from the new fuel upending stand. Except for these lifts it does not bear the full weight of the inner shipping

container. The sling consists of a single ring for attachment to the polar crane, two stainless steel wire rope legs with safety swivel hooks, and two shackles for attachment to the two lifting lugs on the top corners of one end of the shipping container (called vertical sling fittings). A non load bearing spreader bar can be used to hold the two wire ropes apart. The sling can be used with or without the spreader bar. The sling can be used with or without the shackles. The sling is a special lifting device according to the definition in Section 1.2 of NUREG-0612.

Although not originally specified to be designed in accordance with ANSI N14.6-1978, as necessary for strict compliance with Paragraph 5.1.6(1)(a) of NUREG-0612, the sling without the shackles was provided by GE under appropriate quality assurance requirements and quality control procedures for the specific dedicated application of tilting and lifting the inner shipping container. These quality requirements include a certificate of inspection for the sling, and liquid penetrant inspection of the ring and the swivel hooks. The shackles were subsequently added to the sling. A new load test of the sling including the shackles and a magnetic particle examination of the shackles were performed in accordance with ANSI N14.6-1978.

The calculated inner box tilting sling factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The factors for the ring meet the 6 versus yield and 10 versus ultimate values required by Paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof special lifting device. The factors for the hooks are greater than 5 versus yield strength, and greater than 10 versus ultimate strength. The holding strength of the splicing sleeves and the breaking strength of the wire ropes provide factors greater than 5 which are comparable to the factors versus yield and ultimate strength that are specified in ANSI N14.6. The safety factors for the shackles at the Maximum Combined Static and Dynamic Load of 1.17 tons meet the 6 versus yield and 10 versus ultimate values required by Paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof special lifting device since each shackle is rated at 6.5 tons. However, the overall factors for the entire sling do not meet the 6 versus yield and 10 versus ultimate strength values required by Paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof special lifting device.

With only two lift points, the factors of safety under the Maximum Combined Static and Dynamic Load after taking a single lift point failure do not meet the value of 5 versus ultimate required by Paragraph 5.1.6(3)(a) of NUREG-0612 for a single failure proof design.

The tilting sling tilts the inner shipping container from a horizontal to a vertical position. It raises the inner shipping container off of the refueling floor when it is inserted and removed from the new fuel upending stand. When the box is raised off the floor, neither the sling nor the lift points meet the single-failure proof criteria of NUREG-0612. Because the box is not carried over the fuel pool or the open reactor, the first three evaluation criteria of Section 5.1 of NUREG-0612 (Releases of radioactive material from damage to spent fuel pool, damage to fuel and fuel storage racks, damage to the reactor vessel or the spent fuel pool) are satisfied. If the inner shipping container is accidentally dropped, it would not penetrate the refueling floor and would not cause spalling on the elevation below the refueling floor. Safe shutdown capability would be maintained. Therefore, the fourth evaluation criterion of Section 5.1 of NUREG-0612 (retained safe shutdown capability) is also satisfied. Table 9.1-22 provides a summary evaluation of a postulated load drop versus the four guideline criteria of Section 5.1 of NUREG-0612.

In addition to the two corner lifting lugs, there are six lifting lugs on the sides of the inner shipping container (three per side). These lugs are not used with the inner box tilting sling.

9.1.5.3.2.12 Shielded Fuel Transfer Chute Strongback and Slings

The shielded fuel transfer chute strongback is a special lifting device as defined by NUREG-0612, Section 5.1.1.4. The design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The transfer chute strongback design meets the single-failureproof guidelines of NUREG-0612, Section 5.1.6(1)(a).

The transfer chute has four lift points. The lift points meet the single-failureproof guidelines of NUREG-0612, Section 5.1.6(3)(a).

Four slings connect the transfer chute strongback to the main hook. These slings are single-failureproof slings selected in accordance with NUREG-0612, Section 5.1.6(1)(b), as clarified by FSAR Section 9.1.5.1.14. In the configuration in which they will be utilized, the slings have safety factors of 13 against their ultimate strength and 8 against their yield strength.

Therefore, all elements of the transfer chute lift satisfy the single-failure proof guidelines of NUREG-0612, Section 5.1.6.

To install the transfer chute in its shielding location, the transfer chute must be transported with the RPV head off, since one end of the transfer chute is supported from the RPV lower flange. Since the purpose of the transfer chute is to provide shielding while fuel is being transferred to or from the RPV, the transfer chute must be transported at the beginning of refueling, before fuel is unloaded, and at the end of refueling, after fuel is reloaded. Also, the transfer chute must be transported by the Reactor Building polar crane main hoist, since its weight of 23 tons exceeds the auxiliary hoist's 10-ton capacity. Due to the main hook travel restrictions (shown on Figure 9.1-31), the necessity of storing the transfer chute beyond a 20-foot radius of the reactor centerline, and insufficient support within a 20-foot radius of the reactor centerline to temporarily set the transfer chute down for re-hooking after rotating the crane, it is necessary to transport the transfer chute directly over the RPV to reach the shielding location. However, a postulated heavy-load drop into the fuel-loaded RPV is not considered credible due to the single-failure proof design of all elements of the lift.

9.1.5.3.2.13 Dryer/Separator Lower Pool Plug Lifting Strongback

The dryer/separator lower pool plug lifting strongback is a special lifting device as defined by NUREG-0612, Section 5.1.1.4. The design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The plug lifting strongback design meets the single-failure proof guidelines of NUREG-0612, Section 5.1.6(1) (a).

The strongback lifting device utilizes the polar crane and the shield plug sling. The stresses in the polar crane and the plug sling due to the increased load caused by the lifting strongback were calculated. From these calculations it was determined that they complied with the criteria of NUREG-0612, Section 5.1.6(1)(a) and, as such, both remain single-failure proof.

9.1.5.3.2.14 New Fuel Inner Box Multibox Lifting Rig

The inner box multibox lifting rig is used to simultaneously lift from one (1) up to three (3) inner shipping containers containing fuel bundles from the Reactor Building receiving bay at Elevation 102 feet up to the refueling floor at Elevation 201 feet. Each inner shipping container contains up to two fuel bundles/assemblies. The rig is also used to simultaneously move from one (1) up to five (5) empty inner shipping containers from the refueling floor back to the receiving bay. The rig consists of a single ring for attachment to the polar crane, a strongback that attaches to the ring, four stainless steel wire rope legs with safety swivels for attaching the strongback to four lifting lugs on each of the inner shipping containers. The rig is a special lifting device according to the definition in Section 1.2 of NUREG-0612.

The inner box multibox lifting rig was designed and tested in accordance with NUREG-0612.

The calculated inner box multibox lifting rig factors of safety versus yield and ultimate strengths are provided in Table 9.1-14. The factors meet the 6 versus yield and 10 versus ultimate strength values required by Paragraph 5.1.6(1)(a) of NUREG-0612 for a single failure proof single load path special lifting device.

The inner shipping container is lifted using four lifting lugs on the sides of the container. A single lift point failure will not result in uncontrolled lowering of the load. The calculated factor of safety under the maximum combined concurrent static and dynamic load after taking a single lift point failure meets the value of 5 versus ultimate required by Paragraph 5.1.6(3)(a) of NUREG-0612 for a single failure proof design. The rig/lift point combination is listed in Table 9.1-21.

There are six lifting lugs on the sides of the inner shipping container (three per side). Two lugs on each side are connected to the multibox lifting rig. The selection of which ones to use is based on whether there is fuel inside the container. The lugs are labeled. There are also two lifting lugs on the corners of one end of the inner shipping container (called vertical sling fittings). These lugs are not used with the multibox lifting rig.

9.1.5.3.2.15 Dry Cask Storage Lifting Equipment

The heavy loads lifted during Dry cask Storage operations inside the Hope creek Reactor Building are lifted in accordance with the single-failure proof guidelines of NUREG-0612, Section 5.1.6. Slings are selected to meet the single-failure proof guidelines of Section 5.1.6(1)(b) of NUREG-0612, as clarified by FSAR Section 9.1.5.1.14. Special lifting devices are designed to meet ANSI N14.6, per the single failure proof guidelines of Section 5.1.6(1)(a) of NUREG-0612, as clarified by FSAR Section 9.1.5.1.15.

The lift yoke used for lifting the Dry Cask Storage System Transfer Cask is described in FSAR Section 9.1.5.3.2.1. The factor of safety versus ultimate strength is provided in Table 9.1-14.

Lift cleats are used for transferring the fuel-loaded MPC during the stack-up configuration described in FSAR Section 9.1.5.3. The lift cleats comply with Section 6 of ANSI N14.6, and therefore the single-failure proof guidelines of Section 5.1.6(1)(a) of NUREG-0612. The factor of safety versus ultimate strength is provided in Table 9.1-14.

Slings used for lifting the heavy loads during Dry Cask Storage operations meet the single failure proof guidelines of Section 5.1.6(1)(b) of NUREG-0612, as clarified by Section 9.1.5.1.14. The heavy loads lifted include the HI-TRAC Pool Lid, HI-TRAC Top Lid, MPC (fully loaded during stack-up), MPC (empty), MPC lid, Mating Device, AWS Baseplate Shield, and Hanging Work Platform. The only loads lifted over the cask loading pit and the fuel-loaded Dry Cask Storage System are the loads necessary to support Dry Cask Storage Operations. A postulated heavy load drop is not considered credible due to the single-failure proof design.

9.1.5.3.3 Other OHLHS Cranes

All plant OHLHS cranes, except the Reactor Building polar crane, are evaluated below. The equipment tag numbers are shown in parentheses.

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Each motorized hoist includes one 125 percent capacity mechanical and one 125 percent capacity electrical brake that are automatically applied on loss of power. Each bridge drive includes a 125 percent capacity brake that automatically sets upon loss of power. Each trolley includes one 100 percent capacity electrical brake that automatically sets upon loss of power.

The cranes and hoists shown as seismically secured in Table 9.1-10 have positive restraints that prevent crane derailment or crane parts from falling during an earthquake. These cranes are designed so that their parts will remain in place under a seismic acceleration of 7g vertical and 7g horizontal. The design also includes locking devices for use when the cranes are parked.

1. Personnel air lock hoist (10H217)

   There is no safe shutdown equipment directly below this crane's load path. A portion of the primary containment suppression pool is located below the load path on the next lower elevation. The air lock strongback design factors of safety versus yield and ultimate strengths are provided in Table 9.1-14.

   The personnel air lock is part of the primary containment pressure boundary. It is only moved when the reactor is shut down. The air lock lift height above the floor is administratively limited to less than 2 feet 6 inches. This is the calculated maximum allowable lift height. A load drop would not penetrate the floor if dropped from less than 2 feet 6 inches above it. Movement of the nine shield blocks in front of the personnel air lock is administratively limited to reactor shutdown. The calculated maximum allowable lift height for the shield blocks is 1 foot. When the upper seven shield blocks are moved, they are higher than this. Administrative procedures require that the removal cart be in position below these seven blocks before the blocks are moved. The cart would absorb some of the energy of a load drop. A major portion of the remaining energy would be absorbed as the load punched through the floor. The low velocity impact on the suppression pool shell below would probably deform but not punch through it. If the dropped block managed to penetrate the upper suppression pool shell, the residual energy would almost certainly be dissipated by the internal hardware (piping and catwalk) and the water itself before the block ruptured the lower portion of the shell and caused any water loss. Because the reactor

would be already shutdown at the time of a shield block drop, the suppression pool would not have to be available for decay heat removal. The residual heat removal (RHR) system, operating in the decay heat removal mode, would take suction from a recirculation loop, pump through a RHR heat exchanger and back to the reactor. Therefore, a load drop that caused suppression pool water loss would not prevent decay heat removal.

2. Reactor recirculation pump motor hoist (1AH201, 1BH201)

This hoist is only operated during reactor shutdown.

Dropping a motor during the short time it is raised and free hanging is unlikely. The load is positively attached to the hoist hook by the hook safety latch. No intermediate lifting device is required. The hook directly engages the shackle pin on the top of the motor. The motor cannot be raised more than 5 feet because of the space limitation. It is normally raised no more than 3 feet.

If the motor were dropped, it would hit the pump and probably damage its coupling, seals, shaft, and bearings. The motor mount and the pump casing and its supports would absorb most of the energy and thereby protect the pump suction line between the pump and its upstream isolation valve from severe damage. The shutdown cooling line required for decay heat removal originates from the recirculation loop B suction line only. A motor drop could not prevent decay heat removal because the line branches from the recirculation loop piping about 15 feet above and more than 20 feet to the side of the potential motor impact point.

3. Reactor water cleanup filter demineralizer hoist (1AH220, 1BH220)

   There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation. Operation of this hoist is unlikely because the pressure precoat type reactor water cleanup filter demineralizer vessels are designed to operate for the life of the plant without undergoing maintenance.

4. HPCI pump and turbine hoists (1AH211, 1BH211)

   Of these hoists only safe shutdown or decay heat removal equipment located in the load path is associated with the HPCI system. There is no lower floor elevation. A load drop during plant operation that disables the HPCI system would not prevent safe shutdown because HPCI does not function during normal shutdown. It may not be necessary to shutdown the plant, provided the applicable requirements of the plant Technical Specifications are met.

5. RCIC pump and turbine hoist (10H212)

   This hoist does not handle heavy loads.

6. Main steam tunnel underhung crane (10H214, 10H223)

   The reactor will be shut down when this hoist is used. There is no decay heat removal equipment located in the load path. All of the equipment below the valves is associated with either the main steam or feedwater systems. If an operator were dropped, it would hit one or more of the following items

before it could hit the steam tunnel floor: its valve body; the pipe on either side of the valve body; one of the other three main steam pipes; one of the feedwater lines; restraint steel; structural steel; and miscellaneous small pipe and valves of the main steam drains system. Because of the congested piping and massive restraint steel beneath the load path it is nearly impossible for a dropped valve operator to reach the steam tunnel floor. Together the congestion and energy absorbing capability make it certain that a dropped operator will not punch through the floor. If a dropped operator managed to cause spalling after striking the floor, the concrete could hit one or more of the pipes in this area, or the torus itself. The pipes are associated with nuclear boiler instrumentation, liquid radwaste, RCIC, reactor water cleanup, core spray, fire protection, HPCI and primary containment instrument gas. None of the equipment below the load path is required to remove reactor decay heat. Therefore, decay heat removal ability would not be affected by a load drop from this hoist.

7. Inboard MSIV hoist (10H203)

The reactor is shut down when this hoist is used. There is no decay heat removal equipment located in the load path. The tops of the drywell radial structural steel and drywell floor framing cross beams are located at Elevation 100 feet, just below the main steam lines. All of the equipment above this structural steel network is associated with either the main steam, primary containment instrument gas, or breathing air systems. None is required for decay heat removal. If the operator were dropped, it would hit its own valve body or steam line, or one of the three other main steam pipes before it could contact the structural steel below, unless it were dropped in the removal space between main steam lines A and D. It would hit the steel

directly if it were dropped in the removal space. The steel would stop a dropped valve operator. It would not fall to the lower elevation (drywell floor). There is no decay heat removal equipment on this lower elevation.

8. CRD service hoist

There is no safe shutdown or decay heat removal equipment in the load path of this hoist. The torus is below the load path on the next lower elevation. It is doubtful whether a dropped load could punch through the Elevation 102 feet floor. Most loads actually weigh less than the 1200-pound heavy load limit. All loads are carried as close to the floor as is practical.

The following piping is located above the torus on the next lower elevation under the load path:

a. 18-inch RHR pump A discharge

b. 20-inch RHR shutdown cooling suction

c. 14-inch HPCI pump discharge

d. 12-inch HPCI turbine steam supply.

Three 1-inch channel A reactor vessel level, pressure and differential pressure instrument lines are also located in this area. If a dropped load during plant operation managed to penetrate the Elevation 102 feet floor, or cause concrete spalling, and disable the shutdown cooling line, cold shutdown could still be achieved. As discussed in Section 15.2.9 for this situation, an alternate method to achieve and maintain cold shutdown that involves the safety/relief valves, RHR suppression pool cooling, safety relief valve blowdown, and core spray return flow to the

reactor, could then be used. Therefore, this hoist satisfies guideline 5.1.5(1)(c) of NUREG-0612.

9. Vacuum breaker valve removal hoist (10H207)

   This hoist does not handle heavy loads.

10. Main steam relief valve removal hoist (10H202)

   This hoist does not handle heavy loads.

11. Turbine Building bridge crane (10H102)

   There is no safe shutdown or decay heat removal equipment beneath the load path of this crane or on the next lower elevation, but there are safety-related instruments, cables, or conduits of the Reactor Protection System (RPS) on both elevations. The safety-related function of the RPS is to initiate reactor scram after certain abnormal operational transients. The stator lift beam is intended to only be used during construction. If an unforeseen problem requires that the stator be lifted after plant startup, the lift will only be made when the reactor is shut down. The RPS is not required to function then. Therefore, a stator lift beam load drop will not compromise the safety function of the RPS.

   The main and auxiliary hoists are used mainly during reactor shutdown, but they are also used during reactor operation. Because the RPS is a fail safe system, main or auxiliary hoist load drop could cause a reactor scram but would not affect safe shutdown or decay heat removal capability.

12. Feedwater heater removal hoist (1AH103, 1BH103)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

13. Heating and ventilating equipment removal hoist (10H104)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

14. Motor generator set hoist (0AH105)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

15. Secondary condensate pump hoist (10H106)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

16. Reactor feed pump hoist (1AH107, 1BH107, 1CH107)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

17. Water box removal hoist (10H109, 10H110)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

18. Steam packing exhauster hoist (10H115)

    There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

19. Water box removal hoist (10H111, 10H112)

    There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

20. Chiller tube removal hoist (10H118)

    There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

21. Emergency air compressor hoist (10H114)

    There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

22. Main air compressor hoist (00H113, 10H113)

    There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

23. Vacuum pump water cooler hoist (10H116)

    There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

24. Heating and cooling coil removal hoist (1AH119, 1BH119)

There is no safe shutdown or decay heat removal equipment beneath the load path of these hoists or on the next lower elevation.

25. Turbine generator auxiliary crane (00H100)

A load drop from this crane could damage RPS equipment, but it would not affect safe shutdown or decay heat removal.

26. Demineralizer removal hoist (00H302)

Figure 9.1-39 shows the safe load path. There is no safe shutdown or decay heat removal equipment in the load path or on the next lower elevation, but there are two RPS cables on the lower elevation. Because the RPS is a fail-safe system, a load drop could cause a reactor scram but would not prevent safe shutdown or decay heat removal or cause unacceptable radioactivity release.

27. Decontamination evaporator hoist (00H305)

There is no safe shutdown or decay heat removal equipment in the load path. There is no lower floor elevation.

28. Equipment decontamination room hoist (00H314)

There is no safe shutdown or decay heat removal equipment beneath the load path or on the next lower elevation.

29. Machine shop underhung crane (0AH301, 0BH301, 0CH301, 0DH301)

There is no safe shutdown or decay heat removal equipment beneath the load path or on the next lower elevation (87 feet).

30. Water evaporator recirculation pump hoist (00H309, 00H310)

There is no safe shutdown or decay heat removal equipment beneath the load path. There is no lower floor elevation.

31. Waste evaporator hoist (00H312, 00H313)

There is no safe shutdown or decay heat removal equipment beneath the load path or on the next lower elevation (54 feet).

32. Diesel generator underhung crane (AH400, 1BH400, 1CH400, 1DH400)

Each diesel generator crane services only one diesel and cannot travel over another. The diesel generators are the plant's emergency ac power source in the event of a loss of offsite power (LOP). The diesel generators are safety-related and are required for safe shutdown and decay heat removal if there is an LOP. The diesel generators are in individual compartments that are separated by concrete walls to prevent failure of one diesel, because of a fire or other damage, from causing failure of the diesel generator in an adjacent compartment. The mechanical and electrical systems are designed so that a single failure will affect the operation of only a single diesel generator. Each of the four diesels serves a separate Class 1E electrical channel system. Three of the four diesels are required to be operable to ensure safe shutdown of the plant following a loss-of-coolant accident (LOCA) or LOP. The crane travels on the bottom flanges of two structural beams that have

mechanical stops to halt the movement of the bridge before it hits the diesel exhaust piping. There are safety-related electrical panels and fuel tanks on the sides of the rooms, away from the crane load paths. Each crane is intended for use during diesel maintenance, when that particular diesel generator would be inoperable. Administrative control is used to ensure that only one of the cranes is in service at any time to prevent the possibility that load drops could damage two diesels.

Because of the mechanical stops, separation and redundancy, and maintenance sequencing, it is concluded that a load drop would not prevent safe shutdown or decay heat removal.

33. Intake structure gantry crane (00H500)

The main hoist has mechanical stops to prevent it from traveling north past column C and south past the outer gantry leg of the crane. All the equipment in the load path is safety-related.

There are four service water pumps. A different one of the four Class 1E electrical channels powers each pump. The pumps share a common intake structure, with two pumps located in one of two cells that are separated by walls and covered by concrete hatch covers. Two pumps are required for normal plant operation. Four pumps will be used for plant shutdown, although two of the four are sufficient for safe shutdown and decay heat removal. Because of the mechanical stops, redundancy, physical separation, and maintenance sequencing, it is concluded that a load drop will not affect safe shutdown or decay heat removal.

34. Reactor Building personnel lock shield removal hoist (1AH218, 1BH218)

There is no safe shutdown equipment directly below the hoist's load path. A portion of the primary containment suppression pool is located below the load path on the next lower elevation. Removal of the T-shaped upper shield block is administratively limited to reactor shutdown periods. As discussed in the evaluation for the personnel air lock hoist (item 1.), if the shield block were to drop, it could punch through the floor and hit the suppression pool. There is a very low probability that the impact could cause water loss. However, water loss would not prevent decay heat removal.

35. Solid radwaste monorail (00H316)

The hoist is remotely controlled with the aid of closed circuit television from the drum handling control panel located in the radwaste control room. If the hoist becomes inoperable, a mechanical retrieval device permits removal and/or repair as necessary, while keeping operator exposure as low as reasonably achievable.

There is no safe shutdown or decay heat removal equipment in the load path or on the next lower floor elevation. The drop of a drum could require implementation of isolation and decontamination procedures, but could not affect safe shutdown of the plant.

36. Solid radwaste bridge crane (00H317)

The hoist is remotely controlled with the aid of closed circuit television from the drum handling control panel located in the radwaste control room. Independent motors control low and high speed crane movement. Eyelets

on the bridge provide attachment points for a winch type retrieval hoist in the event of a loss of crane electrical power.

There is no safe shutdown or decay heat removal equipment in the load path or on the next lower floor elevation. The drop of a drum could require implementation of isolation and decontamination procedures, but could not affect safe shutdown of the plant.

37. SACS pumps hoist

One monorail serves the two pumps associated with Safety Auxiliaries Cooling System (SACS) loop A, and the other serves the two pumps associated with loop B. A pump motor (6160 pounds) is only removed when the SACS cooling loop associated with that pump is shutdown and completely isolated (physically separated) from the other (redundant) loop. This is not a normal maintenance lift. It would be done infrequently, if at all, and would be subject to administrative control procedures. The heaviest anticipated maintenance load is the upper half of the pump casing (825 pounds), which is not a heavy load.

Above Elevation 102 feet, a dropped SACS pump A or C motor (SACS loop A) would not affect safe shutdown capability because loop A will not be operating when the lift is made. If no credit is taken for the Elevation 102 feet floor, a dropped pump A or C motor could possibly disable one of the following SACS loop B pipes above the next lower floor elevation (Elevation 77 feet):

- o 30 inch TACS supply

- o 20 inch SACS loop B discharge to diesels

- o 30 inch TACS return

Loss of any one of these pipes could cause loss of the decay heat removal function of SACS loop B, which in turn could cause loss of safe shutdown capability. To preclude the possibility that a dropped loop A motor could punch through the Elevation 102 feet floor, the motor lift height will be mechanically restricted to the minimum necessary distance above the floor, and energy absorbing material will be placed beneath the load path.

The pump A motor is lifted vertically until it is approximately 8 feet above the floor so it will clear spring can pipe support EG-123-H01 when it is moved horizontally south approximately 10 feet past the pump A discharge line, EG-123-HBC-20", before it is lowered between building column lines 21R and 20R. The load handling procedure for the pump A motor requires that a sling long enough to permit the motor to be lifted only as high as is necessary to clear the pipe support be used. The procedure also requires that energy absorbing material, sufficient to prevent the dropped motor from punching through the floor or causing spalling, be verified in place by the hoist operator before the lift is made.

The pump C motor is lifted vertically until it is approximately 4 feet above the floor so it will clear the lip of the pump baseplate when it is moved horizontally north approximately 6 feet before it is lowered between column lines 21R and 20R. The load handling procedure for the pump C motor requires that a sling long enough to permit the motor to be lifted only as high as is necessary

to clear the baseplate lip be used. The procedure also requires that energy absorbing material sufficient to prevent the dropped motor from punching through the floor or causing spalling, be verified in place by the hoist operator before the lift is made.

Above Elevation 102 feet, a dropped SACS pump B or D motor (SACS loop B) would not affect safe shutdown capability because loop B will not be operating when the lift is made. If no credit is taken for the elevation 102 feet floor, a dropped pump B or D motor could possibly disable the 6 inch RHR post-LOCA containment flooding crosstie line from the station service water system that runs above Elevation 77 feet. This line is not required for safe shutdown or decay heat removal. However, it is used for long term decay heat removal (containment flooding) after a LOCA. Therefore, the load handling procedure for the pump B and D motors requires that a sling long enough to permit the motor to be lifted only as high as is necessary to clear the baseplate lip be used. It also requires that energy absorbing material sufficient to prevent the dropped motor from punching through the floor or causing spalling, be verified in place by the hoist operator before the lift is made.

Therefore, these hoists satisfy Guideline 5.1.5(1)(c) of NUREG-0612.

SACS motor removal may be implemented using alternate methods with the associated SACS loop in service provided an approved engineered rigging plan satisfies Guideline 5.1.5 of NUREG-0612.

38. SACS heat exchanger hoist

Two hoists, one mounted on each monorail, work in tandem to remove a SACS heat exchanger return end cover. The configuration includes a separate sling and lifting point for each hoist.

There is no safe shutdown or decay heat removal equipment beneath the load paths on elevation 102 feet or on the next lower elevation (77 feet). But the 18-inch RHR heat exchanger A inlet line, three Channel A Class 1E cable trays, and some Channel A, Class 1E conduits are located in the northwest corner of the RHR heat exchanger A compartment below Elevation 77 feet and beneath a portion of the SACS heat exchanger A hoist load path. The 18-inch RHR heat exchanger B inlet line and two Channel B Class 1E cable trays are located beneath the load path on elevation 77 feet. Three additional Channel B Class 1E cable trays and some Channel B Class 1E conduits are located in the southwest corner of the RHR heat exchanger B compartment below Elevation 77 feet and beneath a portion of the SACS heat exchanger B hoist load path.

To preclude the possibility that a dropped SACS heat exchanger end cover could penetrate the Elevation 102 feet floor, the cover lift height will be mechanically restricted to the minimum necessary distance above the floor, and energy absorbing material will be placed beneath the load path, or another load handling system that satisfies the four evaluation criteria of Section 5.1 of NUREG-0612 will be used.

Therefore, these hoists satisfy guideline 5.1.5(1)(c) of NUREG-0612.

39. Recombiner system hoists (00H318, 10H318)

This hoist does not handle heavy loads.

40. CRD transfer cask jib crane (10H205)

There is no safe shutdown or decay heat removal equipment in the load path on either the 102 feet or 132 feet elevation. The torus and RHR suction piping are located on the next lower floor elevation from the 102 feet load path. Based on calculations, if a load drop did occur from the maximum height equipment could be raised, the dropped load would not perforate the floor or cause spalling. Therefore, the load drop would not affect safe shutdown or decay heat removal equipment and the crane satisfies the Evaluation Criteria IV of NUREG-0612.

41. SW Strainers Trolley Beam Hoists

Each end of the trolley beams has a mechanical stop to prevent overtravel of the hoist trolley. All the equipment in the load path is safety-related.

Strainer rigging loads are enveloped by loads already evaluated for the SWIS Gantry Crane (00H500). Therefore, because of system redundancy, physical separation, maintenance sequencing, and load envelopment, it is concluded that a load drop will not affect safe shutdown or decay heat removal.

42. SW Bay A-frame Gantry (00H525)

This crane does not handle heavy loads.

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9.1.5.4 Inspection and Testing

9.1.5.4.1 Reactor Building Polar Crane

Final assembly and initial power operation of the bridge, both trolleys, and both hoists is done on site rather than in Paceco's shop. All crane parts subject to hoisting or seismic loads are nondestructively examined as described in Section 9.1.5.4.1.1.

9.1.5.4.1.1 Shop Tests

All butt welds are ultrasonically examined in accordance with AWS D1.1, Section 6, Part C, Ultrasonic Testing of Groove Welds, and Section 9, Paragraph 9.25.3, Design of New Bridges.

Structural plates thicker than 3/4-inch are ultrasonically examined in accordance with ASTM A 578 to meet A 578, Level 1 acceptance criteria.

Structural steel butt welds 3/4-inch thick and less that can not be ultrasonically examined are radiographically examined in accordance with AWS D1.1, Section 6, Part B, Radiographic Testing of Welds, and Section 9, Paragraph 9.25, Design of New Bridges. Cast steel components are examined in accordance with ASTM A 27, Paragraph 12, Radiographic Inspection, with acceptance criteria in accordance with ASTM E 71.

All load carrying mechanical components subject to repeated stress or fatigue, including the drum, are examined by the liquid penetrant method in accordance with AWS D1.1, Section 6, Paragraph 6.7.6, and Section 9, Paragraph 9.25, Design of New Bridges. Structural steel plates thicker than 1/4 inch joined by butt welds are examined at the welds in accordance with ASTM E 165.

The yoke method of magnetic particle examination in accordance with AWS D1.1, Section 6, Paragraph 6.7.5 and Section 9, Design of New

Bridges, is used in approximately 30 percent of the stress carrying structural fillet and plug welds.

Visual examination of all welds is in accordance with AWS D1.1, Paragraph 9.25.1.

The main hook, shank, and nut are given a magnetic particle examination after final machining. Both hooks are ultrasonically examined in accordance with ASTM A 388 after forging. They are then given a proof load test at 200 percent of their rated load in accordance with ANSI B30.10. Dimensions are checked before and after the load test. After the test, the alloy steel main hook is given a dry powder magnetic particle examination in accordance with ASTM A 275 with acceptance criteria per ASTM 654-73, Paragraph 18.1.3. The stainless steel auxiliary hook is given a liquid penetrant examination in accordance with ASTM E 165 and an ultrasonic examination after the load test. The hooks are accepted if no surface or subsurface discontinuities or permanent deformation is produced by the testing.

To help ensure safe operation and minimize potential field repairs during final assembly and initial power operation, the polar crane is shop assembled to the maximum practical extent to ensure proper fit. Permanent wiring, control panels, and conduit are permanently installed. The girders and end ties are bolted together. The drive and idler truck equalizer trunnions are rough bored, fitted, and welded to the frame. The drive and idler trucks are assembled into two wheel units. Earthquake restraints are fitted but not welded. The cab is fitted and shipped as a completely wired subassembly. The hook blocks are completely assembled. Power collector supports and zone limit switches are fitted. The trolleys, including bumpers and limit switches, are rolled along the girder rails. Machinery on all motions is manually turned and checked for fit, clearance, gear mesh, and free operation. Concentricity of bridge and trolley wheels is checked by dial gauge.

9.1.5.4.1.2 Preoperational Tests

After installation the crane, including both the main and auxiliary hoists, is static load tested at 125 percent of the maximum critical load (MCL). After satisfactory completion of the 125 percent load test, the polar crane is given a 100 percent MCL performance test for all speeds and motions for which it is designed. Proper operation of all limiting and safety control devices is verified. Manual lowering of the MCL for both hoists, and manual movement of the bridge and trolleys, is verified.

After construction use the crane is inspected and recertified by Paceco for an extended 12-month warranty period. Recertification is accomplished in three phases as follows:

1. Paceco inspects and identifies items needing adjustment and repair.

2. Identified items are repaired or replaced in accordance with Paceco's direction.

3. Paceco inspects repaired and replaced items and witnesses crane operation under load.

The following steps are used to determine which items must be repaired or replaced after construction operation:

1. A review of maintenance logs to be aware of any crane operation difficulties and any special or unusual lifts that were accomplished during the construction program

2. A thorough visual inspection of all load bearing members

3. Crane is operated to clock speeds and motion smoothness

4. Maintenance personnel remove safety guards and access covers and clean the gears. Gears are then examined, relubricated, and replaced as necessary

5. Motor coupling reducer is checked for proper operation

6. Limit switches are checked for proper operation

7. Crane electrical control system is checked for proper sequencing and operation.

Preoperational tests of the polar crane include operating the crane through all of the heavy load handling path areas.

9.1.5.4.1.3 Operational Tests

In compliance with NUREG-0612, Section 5.1.1(6), the crane is inspected, tested, and maintained in accordance with Chapter 2-2 of ANSI B30.2-1976, Overhead and Gantry Cranes.

9.1.5.4.2 Other OHLHS Cranes

Shop, preoperational, and operational tests on OHLHS cranes other than the polar crane are discussed in this subsection.

9.1.5.4.2.1 Shop Tests

All of the OHLHS cranes listed in Table 9.1-10, except items 1 (Reactor Building polar crane), 11 (Turbine Building bridge crane), 27 (solid radwaste monorail), 28 (solid radwaste bridge crane), and 38 (intake structure gantry crane) are functionally tested without load and at 150 percent of rated capacity. Each hoist brake is tested to confirm ability to brake the load from rated speed and hold it without slipping.

Shop testing of the Reactor Building polar crane is discussed in Section 9.1.5.4.1.1.

The turbine Building crane is shop assembled, except for the rope and blocks, to check fit. The trolley is powered along the bridge to check tracking. The hoist, trolley, and bridge drives are operated in the shop for 15 minutes.

The intake structure gantry crane is shop tested at rated load. Each hoist brake is tested to confirm ability to brake the load from rated speed and hold it without slipping.

The solid radwaste monorail and solid radwaste bridge cranes are shop tested at 125 percent of rated load.

9.1.5.4.2.2 Preoperational Tests

Each of the OHLHS cranes listed in Table 9.1-10 is given an operational performance test, a rated load test, and preoperational inspection in accordance with ANSI B30.2-1976, Chapter 2-2.

Preoperational testing of the Reactor Building polar crane is discussed further in Section 9.1.5.4.1.2.

After preoperational performance and rated load testing, per ANSI B30.2-1976, the Turbine Building bridge crane is operationally and rated load tested in accordance with Paragraph 1910.179(K) of OSHA. Each hoist brake is tested to confirm ability to brake the load from rated speed and hold it without slipping.

9.1.5.4.2.3 Operational Tests

All the OHLHS cranes listed in Table 9.1-10 that carry heavy loads over safety-related equipment (those not identified by exclusion criteria A, B, or C) are inspected, tested, and maintained in accordance with ANSI B30.2-1976.

9.1.5.5 Instrumentation

Instrumentation and controls for the Reactor Building polar crane are described in Sections 9.1.5.2.1 and 9.1.5.3.1 and Table 9.1-13. Supplemental information is presented below in Section 9.1.5.5.1.

9.1.5.5.1 Reactor Building Polar Crane

Bridge and trolley controls are the variable speed, reversing, magnetic, five-step type. Cab control handles are deadman type with spring return. Hoist controls are A.C. static stepless type in accordance with NEMA Industrial Control Standard ICS-3-442 Class III and OSHA. Release of a hoist controller stops the motion and sets the brakes.

The hoist control system limits lowering speed to 120 percent of full load hoist speed. Each hoist holding brake system includes and overspeed switch that stops the motor and applies the brakes at 120 percent of maximum no load hoist speed. The hoists limit hook movement when starting from a standstill to 1/32 inch for the main hook and 5/16 inch for the auxiliary hook in either the hoist or lower direction.

Simultaneous motion of the bridge, trolleys, and hoists is possible whether control is from the cab or the remote control system. Cab control includes a maintained contact, master on-off switch. Cab control is not possible unless the master control switch is set to “Cab” control. The master control switch is provided to prevent simultaneous operation from the cab and remote control system. All remote control switches have spring return to neutral configurations. Additionally, the system includes a push-to-operate lever, which is required to be activated prior to commanding any movement. A deadman foot switch must be held down during crane operation from the cab. In addition, a Main Hoist Unbalanced Load Bypass Switch is mounted in the cab to permit the operator to lower a load if there is a rope failure or unbalanced load.

For both the main and auxiliary hoists, a rotary limit switch coupled to the drum trips at the normal up and extreme low hook position. A block operated overhoist limit switch backs up the normal "up" limit switch by stopping the drive and setting the brakes. Hoist overload switches shut off hoist power and set the brakes if the design loads (150 or 10 tons) are exceeded.

End of travel limit switches stop the main and auxiliary trolleys and the bridge at their normal stop positions.

The bridge, trolley, and hoist motors include overtemperature protection.

9.1.5.5.2 Other OHLHS Cranes

All cranes include a drum overspeed system to automatically set the load brake when hoist drum speed exceeds motor synchronous speed. A phase loss protection system automatically stops the hoist and sets the holding brakes when hoist power is lost.

The Turbine Building bridge crane (item 11 in Table 9.1-10) control system includes redundant 125 percent capacity hoist holding brakes that are automatically applied upon loss of power. The bridge drive brakes are automatically applied upon loss of power. The 125 percent trolley brakes are also automatically applied upon loss of power. The design includes hoist raising or lowering overtravel limit switches. Trolley travel limit switches cut power at the trolley travel limits. All crane motion control switches and pushbuttons are momentary contact return to off type.

The intake structure gantry crane (item 36 in Table 9.1-10) design includes automatic application of the mechanical hoist load brake and electrical hoist holding brake upon loss of power. Trolley end of travel limit switches cut motor power when the travel limits are reached.

9.1.5.6 <u>SRP Rule Review</u>

In SRP Section 9.1.5, Acceptance Criterion 2 refers to Regulatory Guide 1.13, Position C.3, which requires that interlocks be provided to prevent cranes from passing over stored fuel when fuel handling is not in progress.

At HCGS, only the main hoist of the polar crane is physically prevented from traveling over the spent fuel pool. The auxiliary

hoist has no travel restriction. Preventing its travel over the fuel pool is not an auxiliary hoist design basis. Instead, the alternative basis of a single-failure proof hoist described in Section 9.1.5.3.1 is used. No loads are required to be routinely handled over the fuel pool when fuel handling is not in progress. The fuel pool gates are the only heavy loads routinely handled over the pool when fuel handling is in progress. A single failure proof handling system lifts the gates, and any other nonroutine heavy loads that must be carried over the spent fuel pool.

Acceptance Criterion 2 also refers to NUREG-0612, which, in Paragraph 5.1.1(1), states that load paths should be clearly marked on the floor in the areas where heavy loads are to be handled.

At HCGS, load paths are not painted on the floor. They are omitted to avoid possible operator confusion in areas such as the refueling floor where multiple paths would cross. The paths are defined in the specific load handling procedures and shown on equipment layout load path drawings that are incorporated in the procedures. Deviations from defined load paths require written alternative procedures approved by the plant safety review committee.

Because opaque plastic sheets may be taped to the floor where the potential for radioactive contamination exists, polar crane load paths painted on the refueling floor (Elevation 201 feet) may not be visible. The alternative method that is used at HCGS for the polar crane is to make a person other than the crane operator (i.e., a signalman) responsible for assuring that the load path is followed. The signalman inspects the load path before the lift to ensure that it is clear, reviews the specific load handling procedure before the lift, and provides direction to the crane operator to ensure that the prescribed path is followed. The specific load handling procedures clearly define the duties and responsibilities of the operator, the signalman, and any other members of the load handling party.

The appropriate polar crane load path is temporarily marked with rope or pylons to provide a visual reference for the operator. If it is not possible to temporarily mark the load path, permanent or temporary match marks are used to assist in positioning the bridge and/or trolley for the lift. The method of marking the load path is defined in each specific load handling procedure.

The Reactor Building polar crane is the only non-exempt cab-operated crane at HCGS. Other non-exempt cranes, except for the main steam tunnel underhung crane, are simple hoists on monorails where the load path cannot vary. Most lifts are short lifts where movement is limited to one coordinate axis in addition to the vertical. As described in Section 9.1.5.2.2(6), each of the monorails for the main steam tunnel underhung crane is mounted on end trucks that provide the capability for load movement in both coordinate axes in addition to the vertical. For these non-exempt, non-cab operated monorail hoists the specific load handling procedures define whether a signalman is used and whether the load path will be marked.

Acceptance Criterion 2 also refers to ANS 57.1, which in Paragraph 6.2.1.1(a) requires that the auxiliary fuel handling crane be provided with an underload interlock that is actuated upon a reduction in load while lowering, to prevent any further downward travel.

At HCGS, the polar crane functions as the auxiliary fuel handling crane. It does not have an underload interlock since it was purchased before ANS 57.1 was issued. The fuel pool gates are the only heavy loads normally handled over the fuel pool. A single failure proof handling system lifts the gates, and any other nonroutine heavy loads that must be carried over the spent fuel pool.

9.1.6 References

9.1-1 Deleted

9.1-2 AISC Manual of Steel Construction

9.1-3 AGMA Gear Classification Manual

9.1-4 Aluminum Construction Manual, Aluminum Association

9.1-5 AWS D1.1, Structural Welding

9.1-6 NEMA MG-1, Motor and General Standards

9.1-7 National Electric Code

9.1-8 OSHA 1910.179

9.1-9 OSHA, Vol. 37, No. 202, Part 191 ON

9.1-10 Deleted

9.1-11 UAI 84-42, Revision 0, Summary Report of Nuclear Criticality Analysis for the Spent Fuel Racks of Hope Creek Generating Station.

TABLE 9.1-1

FUEL POOL COOLING AND CLEANUP SYSTEM AND
TORUS WATER CLEANUP SYSTEM DESIGN PARAMETERS

Skimmer Surge Tanks

Type	Vertical, cylindrical
Quantity	2
Design pressure, psig	0
Design temperature, °F	212
Capacity, gallons	4062

Fuel Pool Cooling and Cleanup System Pumps

Type	Horizontal, centrifugal, single stage
Quantity	2
Design pressure, psig	200
Design temperature, °F	212
Rated flow per pump, gpm	700
Developed head (TDH) at rated flow, feet	257
Motor horsepower, each	75

Fuel Pool Heat Exchangers

Type	Plate
Quantity	2
Design pressure, psig	
Cold side	175 + Full Vacuum
Hot side	175 + Full Vacuum
Design temperature, °F	212
Design flowrate, gpm	
Cold side	1000
Hot side	700
Heat transfer rate, Btu/h (at 95°F SACS and 135°F Fuel Pool)	9.515 x 10E6

FPCC Filter Demineralizers

Quantity	2
Design pressure, psig	175
Design temperature, °F	150
Design flow rate, gpm per vessel	700

FPCC System Resin Tank

Quantity	1
Design pressure, psig	0

<u>FPCC System Resin Tank</u>	
Design temperature, °F	150
Capacity, gallons	188
<u>FPCC System Resin Eductor</u>	
Quantity	1
Design pressure, psig	500
Design temperature, °F	250
<u>FPCC System Holding Pumps</u>	
Type	Horizontal, centrifugal, single stage
Quantity	2
Design pressure, psig	400
Design temperature, °F	150
Rated flow per pump, gpm	645
Developed head (TDH) at rated flow, feet	40
Motor horsepower, each	10

Torus Water Cleanup System Pump

Type	Horizontal, centrifugal, single stage
Quantity	1
Design pressure, psig	200
Design temperature, °F	210
Rated flow, gpm	700
Developed head (TDH) at rated flow, feet	230
Motor horsepower	75

TABLE 9.1-2

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TABLE 9.1-3

FUEL POOL COOLING AND CLEANUP SYSTEM AND TORUS WATER CLEANUP SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Normal	FPCC system	System leak	Increased makeup water requirement and fuel pool cooling pump trip	Visual observation in MCR of higher frequency of normal makeup valve cycling (if leak is less than normal makeup rate). Low-low surge tank level alarm in MCR (if leak is more than normal makeup rate)	None
Normal	Normal makeup valve	Normal makeup valve fails to open on initial low skimmer surge tank level during normal operation	Automatic trip of fuel pool pump	Low-low alarm in MCR	Temporary loss of normal makeup. The makeup valve is manually opened to restore normal make-up
Normal	Normal makeup valve	Normal makeup valve fails to close on high initial skimmer surge tank level during normal operation	The operator will manually close the normal makeup valve	High-high alarm in the MCR	None
Normal	Fuel pool cooling pumps	Failure of one fuel pool cooling pump to provide sufficient flow during normal operation.	Temporary decrease in system flow. FPCC system operation can be continued with the other fuel pool cooling pump	FPCC system pump trip and low discharge flow alarm in the MCR and automatic or manual isolation of pump.	None
Accident	Non-Seismic Category I FPCC system purification loop piping	Through wall leakage crack	Temporary loss of inventory. Termination of purification loop operation. The fuel pool F/D system can be bypassed	Surge tank low-low level alarm and automatic or manual isolation of the fuel pool F/D system isolation	None

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Accident	Seismic Category I FPCC system cooling loop	Line break (through-wall leakage crack)	Operate the FPCC system using the redundant cooling loop if available or termination of FPCC system operation	Surge tank low-low level alarm (if leak is more than normal makeup rate)	Operate the FPCC system using the redundant cooling loop if available or shut down plant and use RHR system to provide fuel pool cooling
Accident	Fuel pool cooling pump and fuel pool heat exchanger	Loss of one fuel pool cooling pump and heat exchanger concurrent with loss of offsite power (LOP)	In the event of loss of normal power, FPCC system pumps are powered from the standby diesel generators. The redundant cooling loop is available to continue fuel pool cooling and maintain fuel pool temperature within safe limits	Alarm in the MCR	None
Accident	FPCC system	Loss of system function due to seismically induced damage	Loss of normal makeup. Emergency makeup water is supplied from the Seismic Category I hose fill connection in the Auxiliary Building, to permit continuation of fuel pool cooling and prevent boiling	Skimmer Surge tank low-low level alarm in the MCR	None, because plant is already tripped
Accident	FPCC system	Loss of fuel pool cooling loop and emergency (fresh) makeup water	Loss of normal makeup and emergency (fresh) makeup water. If fresh makeup water unavailable, operator can remotely open the emergency SSWS makeup supply valves from the MCR to connect the SSWS to loops A and B.	Skimmer Surge tank low-low level alarm	None, Plant remains shut down

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Normal	RHR crosstie loop	Failure of operating RHR loop	Temporary loss of fuel pool cooling by the RHR system	RHR system alarm in the MCR	The RHR pump loop associated with the other RHR heat exchanger that services the fuel pool is started to restore cooling flow to the fuel pool
Normal	Fuel pool heat exchanger	Loss of one cooling water (SACS) loop	Temporary loss of fuel pool cooling	SACS alarm in the MCR	The other SACS loop will provide cooling water to continue fuel pool cooling

TABLE 9.1-4

TABLE DELETED

TABLE 9.1-5

FUEL SERVICING EQUIPMENT

Component Number & Identification		Essential Classification[1]	Code Classification[2]	Seismic Category[3]
1	Fuel preparation machine[4]	PE	E	I
2	New fuel inspection stand	NE	E	NA
3	Deleted			
4	Channel handling tool	NE	E	NA
5	Fuel pool sipper	NE	E	NA
6	Fuel inspection fixture	NE	E	NA
7	Channel gauging fixture	NE	E	NA
8	General purpose grapple[4]	PE	E	I
9	Jib crane[4]	PE	E	II/I
10	ABB J-Hook[4][5]	PE	E	I

(1) NE - Nonessential (not essential to safety).
PE - Essential item that has a passive safety function.

(2) E - Industrial codes apply.

(3) NA - Not Seismic Category I.

(4) See Table 3.2-1 for additional design criteria.

(5) Used for moving GE and ABB new fuel bundles and assemblies between the upending stand and the fuel preparation machine (includes various intermediate locations)

TABLE 9.1-6

REACTOR VESSEL SERVICING EQUIPMENT

Component Number & Identification		Essential Classification[1]	Code Classification[2]	Seismic Category[3]
1	Reactor vessel service tools	NE	E	NA
2	Main Steam line plug Assembly	PE	E	NA
3	Deleted			
4	Deleted			
5	Deleted			
6	Head nut and washer racks	NE	E	NA
7	Head stud rack	NE	E	NA
8	Dryer and separator sling[5]	PE	E	NA[4]
9	RPV and drywell head strongback[5]	PE	E	NA[4]
10	Service platform	NE	E	NA
11	Service platform support	NE	E	NA
12	Service Pole Caddy System	PE	E	NA
13	GE 360 Degree Scorpion II Service Platform	NE	E	NA

---

(1) NE - Nonessential (not essential to safety).
PE - Essential item that has a passive safety function.

(2) E - Industrial codes apply.

(3) NA - Not Seismic Category I.

(4) Dynamic analysis methods for seismic loading are not applicable, because this equipment is supported by the reactor building crane when it performs its function. It is designed with a minimum safety factor of five and is proof tested after fabrication.

(5) See Table 3.2-1 for additional design criteria.

TABLE 9.1-7

IN-VESSEL SERVICING EQUIPMENT

Component Number & Identification		Essential Classification[1]	Code Classification[2]	Seismic Category[3]
1	Deleted			
2	Control rod grapple[5]	PE	E	NA[4]
3	Control rod guide tube grapple	NE	E	NA
4	Fuel support grapple	NE	E	NA
5	Control rod latch tool	NE	E	NA
6	Deleted			
7	Deleted			
8	Control rod guide tube seal	NE	E	NA
9	Deleted			
10	Deleted			
11	Deleted			
12	Deleted			
13	Fuel bundle sampler	NE	E	NA
14	Grid guide	NE	E	NA
15	Combined CRB/FSP grapple[5]	PE	E	NA[4]

---

(1) NE - Nonessential (not essential to safety).
PE - Essential item that has a passive function.

(2) E - Industrial standards apply.

(3) NA - Not Seismic Category I.

(4) Dynamic analysis methods for seismic loading are not applicable, because this equipment is supported by the refueling platform when it performs its function.

(5) See Table 3.2-1 for additional design criteria.

TABLE 9.1-8

REFUELING AND STORAGE EQUIPMENT

Component Number & Identification		Essential Classification[1]	Code Classification[2]	Seismic Category[3]
1	Refueling platform[4]	PE	E,J	I
2	Channel storage rack	NE	E	NA
3	In-vessel rack[4]	PE	E	I
4	Defective fuel storage container[4]	PE	E	I
5	Shielded fuel transfer chute [4]	PE	E	II/I
6	Shielded fuel transfer chute strongback	PE	E	NA[5]

(1) NE - Nonessential (not essential to safety).
PE - Essential item that has a passive function.

(2) E - Industrial standards apply.
J - Electrical standards apply.

(3) NA - Not Seismic Category I.

(4) See Table 3.2-1 for additional design criteria.

(5) Dynamic analysis methods for seismic loading are not applicable because this equipment is supported by the Reactor Building crane when it performs its function. It is designed with a minimum safety factor of six and is prooftested after fabrication in accordance with ANSI N14.6-1978.

TABLE 9.1-9

UNDER REACTOR VESSEL SERVICING EQUIPMENT AND TOOLS

Component Number & Identification		Essential Classification[1]	Code Classification[2]	Seismic Category[3]
1	CRD handling equipment	NE	E,J	NA
2	Equipment handling platform	NE	E,J	NA
3	Deleted			
4	Deleted			
5	In-core flange seal test plug	NE	E	NA
6	Deleted			
7	CRD servicing tools	NE	E	NA
8	CRD hydraulic system tools	NE	E,J	NA

---

(1) NE - Nonessential (not essential to safety).

(2) E - Industrial standards apply.
J - Electrical standards apply.

(3) NA - Not Seismic Category I.

TABLE 9.1-10

OVERHEAD HEAVY LOAD HANDLING SYSTEMS DATA SUMMARY

Item Number	Crane or Hoist	Tag Number	Building	Floor Elev (ft)	Equipment Loc Fig Number	Column Area
1	Reactor building polar crane	10H200	Reactor	201	1.2-32	N-V;14R-23R
2	Personnel air lock hoist	10H217	Reactor	102	1.2-28	P-R;20R-23R
3a	'A' Recirculation pump motor Dual hoists	1AH201	Reactor	102 (Drywell)	1.2-28	Sa-O;19R-20R
3b	'B' Recirculation pump motor hoist	1BH201	Reactor	102 (Drywell)	1.2-28	Sa-T;18.9-17R
4	Reactor water clean-up filter/ demineralizer hoist	1AH220 1BH220	Reactor	178-6	1.2-31	R-Q;15R-17R
5	HPCI pump and turbine hoist	1AH211 1BH211	Reactor	54	1.2-26	W-V;18R-21R
6	RCIC pump and turbine hoist	10H212	Reactor	54	1.2-26	W-V;17R-18R
7	Main steam tunnel underhung crane	10H214 10H223	Reactor	102	1.2-28	P-Q;17R-20R
8	Inboard MSIV hoist	10H203	Reactor	102 (Drywell)	1.2-28	Q-R;17R-20R
9	Vacuum breaker valve removal hoist	10H207	Reactor	54 (Torus)	1.2-27	N-V;15R-22R
10	Main steam line relief valve removal hoist	10H202	Reactor	135-6 (Drywell)	1.2-29	Q-T;17R-20R
11	Turbine building bridge crane	10H102	Turbine	137	1.2-16	E-F;12-29
12	Feedwater heater removal hoist	1AH103 1BH103	Turbine	102	1.2-14	E-Eg;18-22
13	H&V equipment removal hoist	1OH104	Turbine	171	1.2-17	H-F;12-13
14	Motor-generator set hoist	OAH105 OBH105	Turbine	137	1.2.-16	Eu-H;26-29

TABLE 9.1-10 (cont)
OVERHEAD HEAVY LOAD HANDLING SYSTEMS DATA SUMMARY

Item Number	Capacity (tons)	Max Vert Lift (ft in)	Seismic Cat I	Design Standard(2)	Is Load Over Safety-Related(5) Equipment	Is Load Over Safety-Related(5) Equipment on Next Lower Elev.	Exclusion Criterion(1)
1	150 main 10 aux	129-0	Yes	a, b	Yes	Yes	None
2	30	16-3	No(3)	c, d	No	Yes	None
3a	30(dual)	12-0	No-(3)	d	Yes	Yes	None
3b	24	12-0	No-(3)	c, d	Yes	Yes	None
4	10	26-0	No	d	No	No	B
5	4	9-10	No(3)	c, d	Yes	NA	None
6	3	9-0	No(3)	c, d	Yes	NA	C
7	2-1/2	16-0(1OH214) 36-0(1OH223)	No(3)	a, d(4)	Yes	Yes	None
8	2	16-0	No(3)	d	Yes	Yes	None
9	2	7-0	No	d	Yes	No	C
10	1	32-2	No(3)	c, d	No	Yes	C
11	220 main 45 aux	72-3 main 122-0 aux	No	a, b	No	No	B
12	24	12-6	No	d	No	No	B
13	15	37-0	No	c, d	No	No	B
14	15	16-5	No	c, d	No	No	B

Item Number	Crane or Hoist	Tag Number	Building	Floor Elev (ft)	Equipment Loc Fig Number	Column Area
15	Secondary condensate pump hoist	10H106	Turbine	54	1.2-12	E-F;12-13
16	Reactor feed pump hoist	1AH107 1BH107 1CH107	Turbine	137	1.2-16	F-H;17-22
17	Water box removal hoist	10H109 10H110	Turbine	81	1.2-13	E-Eq;17-23
18	Steam packing exhauster hoist	10H115	Turbine	77	1.2-13	F-G;16-17
19	Turbine generator auxiliary crane	00H100	Turbine	137	1.2-16	Eg-Eq;13-26
20	(DELETED)					
21	Water box removal hoist	10H111 10H112	Turbine	81	1.2-13	Ep-Et;17-23
22	Chiller tube removal hoist	10H118	Turbine	171	1.2-17	F-H;17-21
23	Emergency air compressor hoist	10H114	Turbine	123	1.2-15	F-Fd;14-16
24	Main air compressor hoist	00H113 10H113	Turbine	123	1.2-15	F-Fd;11-14
25	Vacuum pump water cooler hoist	10H116	Turbine	77	1.2-13	G-F;14-16
26	Heating and cooling coil removal hoist	1AH119 1BH119	Turbine	171	1.2-17	G-H;13-18
27	Solid radwaste monorail	00H316	Service and radwaste	102	1.2-20	Ka-M;36.9-42.6
28	Solid radwaste bridge crane	00H317	Service and radwaste	126-6	1.2-21	Ha-Md;44.2-45.4
29	Demineralizer removal hoist	00H302	Service and radwaste	102	1.2-21	L-MC 25.9-34.6
30	Demineralizer evaporator hoist	00H305	Service and radwaste	54	1.2-18	J-K;30.3-33.1

TABLE 9.1-10 (cont)

Item Number	Capacity (tons)	Max Vert Lift (ft in)	Seismic Cat I	Design Standard(2)	Is Load Over Safety-Related(5) Equipment	Is Load Over Safety-Related(5) Equipment on Next Lower Elev	Exclusion Criterion(1)
15	15	12-9	No	c, d	No	No	B
16	15	19-9	No	c, d	No	No	B
17	12	17- 4	No	d, e	No	No	B
18	10	14-11	No	c, d, e	No	No	B
19	10	26-1/2	No	b, c, d(4)	No	No	B
20	(DELETED)						
21	8	17-4	No	d, e	No	No	B
22	5	14-4	No	d, e	No	No	B
23	4	7-0	No	d, e	No	No	B
24	3	7-1	No	d, e	No	No	B
25	2	6-9	No	d, e	No	No	B
26	1-1/2	13-0	No	c, d	No	No	B
27	1-1/2 ton	13-0	No	c, e	No	No	B
28	7.5 ton	39-6	No	a, b	No	No	B
29	10 ton	21-8	No	c, d	No	No	B
30	7-1/2	21-3	No	c, d	No	NA	B

TABLE 9.1-10 (Cont)

Item Number Crane or Hoist	Tag Number	Building	Floor Elev (ft)	Equipment Loc Fig Number	Column Area
31 Equipment decontamination room hoist	00H314	Service and radwaste	102	1.2-20	Ha-K;28.8-33.1
32 Machine shop underhung crane	0AH301 0BH301 0CH301 0DH301	Service and radwaste	102	1.2-20	Ha-Md; 13.6-25.9
33 Waste evaporator recirculation pump hoist	00H309 00H310	Service and radwaste	54	1.2-18	Ha-K;15.8-19.9
34 Waste evaporator hoist	00H312 00H313	Service and radwaste	87	1.2-19	Ha-K;15.8-19.9
35 Diesel generator underhung crane	1AH400 1BH400 1CH400 1DH400	Control and diesel gene-rator	102	1.2-35	S-W;24.3-34.6
36 Intake structure gantry crane	00H500	Intake struc-ture	122, 128	1.2-41	A_c-C;5-9
37 Personnel lock shield removal hoist	1AH218 1BH218	Reactor	102	1.2-28	P-R;20R-22R
38 Recombiner system hoist	10H318 00H318	Control and diesel gene-rator	67-3	1.2-24	Ha-K;34.6-39.1
39 CRD service hoist	(6)	Reactor	102	1.2-28	T-U;21R-22R
40 SACS pumps hoist	(6)	Reactor	102	1.2-28	V-W;15R-17R 20R-22R
41 SACS heat exchanger hoists	(6)	Reactor	102	1.2-28	V-W;13.6-15R 22R-24.2R
42 Feedwater flow straightener hoists	10H225 10H226 10H227 10H228	Turbine	137	1.2-16	H-Ga;16.5-18.1
43 CRD Transfer cask jib crane	10H205	Reactor	132	1.2-29	U-Ud;17R-19R
44 SW strainers trolley beam hoists	(7)	Intake Structure	93	1.2-40	Aj; 5-6 7-8
45 Crane	00H525	Service Water Intake Structure	102	1.2-40	C; 4.8-9.2

TABLE 9.1-10 (cont)

Item Number	Capacity (tons)	Max Vert Lift (ft-in)	Seismic Cat I	Design Standard (2)	Is Load Over Safety-Related Equipment?	Is Load Over Safety-Related Equipment on Next Lower Elev?	Exclusion Criterion
31	5	10-2	No	c, d, e(4)	No	No	B
32	5	11-1	No	d, e(4)	No	No	B
33	2	9-3	No	d, e	No	NA	B
34	1	27-0	No(3)	d, e	No	No	B
35	2	19-6	No (3)	c, d, e	Yes	Yes	None
36	30 main 15 aux	65-0 main 88-0 aux	No	b, d, e	Yes	Yes	None
37	15	23-0	No(3)	b, c, d	No	Yes	None
38	2.5(10H318) 1.5(00H318)	18-8	No	d	No	No	C
39	(6)	(6)	(6)	a, b, d	No	Yes	None
40	(6)	(6)	(6)	a, b, d	Yes	Yes	None
41	(5), (6)	(6)	(6)	a, b, d	No	Yes	None
42	(4)	12-0	No	e	No	No	B
43	1	37'-0"	No	c,d	No	Yes	None
44	(7)	(7)	No	c,d	Yes	Yes	None
45	1.1	8'-0"	No	b	Yes	No	C

NOTES:

(1) Exclusion criteria:

A. This crane is located in a building or structure that contains no safety-related or safe shutdown equipment.

B. This crane's load path does not pass over any safety-related or safe shutdown equipment on the floor below or on the next lower elevation.

C. Although this crane's capacity is greater than 1200 pounds, its dedicated load is lighter than 1200 pounds.

(2) Design standards:

a. ANSI B30.2.0 Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

b. CMAA 70 Electric Overhead Traveling Cranes

c. HMI 100 Electric Wire Rope Hoists

d. ANSI B30.16 Overhead Hoists (Underhung)

e. ANSI B30.11 Monorail Systems and Underhung Cranes

(3) Seismically secured (designed so that all parts remain in place under 7g horizontal and vertical seismic accelerations, and equipped with positive restraints and locking devices)

(4) The design also uses ANSI B30.17 (Overhead and Gantry Cranes-Top Running Bridge, Single Girder Underhung Hoist) as a guide.

(5) For the purposes of this table safety related is defined as "required for plant shutdown or decay heat removal".

(6) This hoist will be borrowed from another location when needed. The monorail capacity is shown. The rated capacity of each Item 41 hoist will not be less than 5 tons. The hoist design standards will include ANSI B30.16 and the applicable criteria of Chapter 2.1 of ANSI B30.2-1976 and CMAA-70.

(7) This hoist will be borrowed from another location when needed. The trolley beam capacity is 4 tons. The rated capacity of the hoist will not be less than 4 tons. Hoist design will comply with ANSI B30.16.

TABLE 9.1-11

REACTOR BUILDING POLAR CRANE DATA

BRIDGE

Bridge span	159 ft 0 in.
Bridge weight	488,000 lb
Number of trucks	4
Number of wheels per truck	2
Type of wheels	Parallel tread
Wheel size	36 in.
Number of drive motors	2
Drive motor power	7.5 hp at 1200 rpm
Maximum travel speed	40 ft/min.
Minimum travel speed	16 ft/min.
Minimum incremental movement	1/4 in.
Number and type of brakes	2 dual actuated (auto electric, manual hydraulic) shoe type
Type of bumpers	polyurethane
Type of control	5-step reversing

MAIN TROLLEY

Length of trolley travel	90 ft 6 in.
Trolley span	24 ft 0 in.
Trolley weight	156,000 lb
Number of wheels	4
Type of wheels	Parallel tread
Wheel size	24 in.
Drive motor power	1.5 hp at 900 rpm
Maximum travel speed	10 ft/min.
Minimum travel speed	3 ft/min.
Minimum incremental movement	1/8 in.
Number and type of brakes	2 electric disc type

MAIN TROLLEY

Type of bumpers	Polyurethane
Type of control	5-step reversing

AUXILIARY TROLLEY

Length of trolley travel	132 ft 9 in.
Trolley span	24 ft 0 in.
Trolley weight	39,000 lb
Number of wheels	4
Type of wheels	Parallel tread
Wheel size	18 in.
Drive motor power	1 hp at 900 rpm
Maximum travel speed	50 ft/min.
Minimum travel speed	15 ft/min.
Minimum incremental movement	3/8 in.
Number and type of brakes	2 electric disc type
Type of bumpers	Polyurethane
Type of control	5-step reversing

HOISTS

	Main	Auxiliary
Rated lifting capacity	150 tons	10 tons
Drum size (pitch diameter)	65.625 in.	26.375 in.
Upper sheave size (pitch diameter)	39.5	13 in.
Lower sheave sizes (pitch diameter)	45 in., 39.5 in.	17 in.
Equalizer sheave size (pitch diameter)	39.5 in, 19.5 in.	None

TABLE 9.1-11 (Cont)

HOISTS

	Main	Auxiliary
Rope type	6x37 IWRC, EIPS, right regular lay preformed	6x37 IWRC, oil free stainless steel, right regular lay, preformed
Rope diameter	1.5 in.	1 in.
Reeving type	8 part	2 part
Number of reeving systems	2	2
Hoist motor power	60 hp	30 hp
Maximum hook speed	5 ft/min.	35 ft/min.
Minimum hook speed	0.5 ft/min.	1.25 ft/min.
Minimum incremental hook movement	1/32 in.	5/16 in.
Maximum travel of hook	129 ft 0 in.	129 ft 0 in.
Number and type of load brakes	1 eddy current type	1 eddy current type
Number and type of holding brakes	2 magnetic shoe type	2 magnetic shoe type
Type of control	Static stepless	Static stepless

TABLE 9.1-12
OHLHS LOADS SAFETY-RELATED EQUIPMENT

Heavy Load	Load Weight	Lifting Device	First Elevation: Feet	First Elevation: Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation: Hazard Elimination Criterion(1)	Second Elevation: Feet	Second Elevation: Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation: Hazard Elimination Criterion
Crane/Hoist: Reactor Building Polar Crane (Item 1, Table 9.1-10)								
a. Reactor well shield plugs	107-1/2 tons	Shield plug sling	201	RPV	d	178	B&F FRVS Recirc. Units	d
b. Drywell head	65 tons	RPV head strongback	201	RPV	d	178	B&F FRVS Recirc. Units	d
c. Reactor vessel head	97 tons	RPV head strongback	201	RPV	d	162	Standby Liquid Control (SLC)	d
						162	`A' H_2 Recombiner	d
						162	H_2O_2 Analyzers	d
d. Moisture separator	73-1/4 tons	Dryer/ separator sling	201	RPV	d	162	H_2 Recombiners	d
e. Steam dryer	45 tons	Dryer/ separator sling	201	RPV	d	162	H_2 Recombiners	d
f. Dryer/separator pool plugs	53 tons (upper plug)	Shield plug sling	201	None	NA	178	B&F FRVS Recirc. Units	d
	38 tons (3 lower plugs)	Shield plug sling						
ff.	38 tons (3 lower plugs)	Shield plug strongback						
g. Spent fuel shipping cask	110 tons	Fuel cask yoke	201	None	NA	162	Fuel Pool Cooling System	d
h. Auxiliary hoist load block	1 ton	(None required)	201	A&B SACS Exp. Tank	d	178	B&F FRVS Recirc. Units	d
						162	SLC	d
			201	RPV	d	162	H_2O_2 Analyzers	d
			201	Spent Fuel Pool	d	162	H_2 Recombiners	d
						162	Fuel Pool Pumps & Heat Exch.	d

TABLE 9.1-12 (Cont)

Heavy Load	Load Weight	Lifting Device	First Elevation Feet	First Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation Hazard Elimination Criterion(1)	Second Elevation Feet	Second Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation Hazard Elimination Criterion
i. Main hoist load block	10 tons	(None required)	201	A&B SACS Exp. Tank	d	178	B&F FRVS Recirc. Units	d
			201	RPV	d	162	SLC	d
						162	H_2O_2 Analyzers	d
						162	H_2 Recombiners	d
						162	Fuel Pool Pumps & Heat Exch.	d
j. Spent fuel pool slot plugs	7.2 tons	Single failure proof sling	201	Spent Fuel Pool	d	178	'F' FRVS Recirc. Unit	d
			201	RPV	d			
k. Spent fuel pool gates & cask pool gates	5.0 tons	Single failure proof sling	201	Spent Fuel Pool	d	162	Spent Fuel Pool	d
l. RPV service platform	5 tons	Service platform sling	201	RPV	d	178	'B' FRVS Recirc. Unit	d
m. Head stud rack	2.1 tons	Single failure proof sling	201	RPV	e	178	B&F FRVS Recirc. Units	e
						162	H_2 Recombiners	e
						162	H_2 O_2 Analyzers	e
						162	SLC	e
						162	Fuel Pool Pumps & Heat Exch.	e
n. Vessel head insulation and frame	7.5 tons	RPV head strong back or single failure proof sling	201	RPV	d	178	B&F FRVS Recirc. Units	d
o. Flux monitor shipping crate	2.5 tons	Single failure proof sling	201	None	NA	162	'A' H_2 Recombiner	e
						162	SLC	e
						162	'A' H_2 O_2 Analyzer	e

TABLE 9.1-12 (Cont)

Heavy Load	Load Weight	Lifting Device	Feet	First Elevation: Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation: Hazard Elimination Criterion(1)	Feet	Second Elevation: Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation: Hazard Elimination Criterion
q. Head strongback Stud tensioner Frame (carousel)	11 tons	(None required) Sht.1&2	201	RPV	d	178	B&F FRVS Recirc. Units	d
						162	SLC	d
						162	'A' H_2 Recombiner	d
						162	'A' H_2O_2 Analyzer	d
r. Spent fuel cask yoke	6 tons	(None required)	201	None	NA	162	'A' H_2 O_2 Analyzer	d
						162	SLC	d
						162	Fuel Pool Pumps & Heat Exch.	d
s. Hatch cover 4' x 4'-6"	2.4 tons	Single failure proof sling	201	None	NA	162	None	NA
t. Hatch cover 10' x 10'	7.5 tons	Single failure proof sling	201	None	NA	162	'B' FRVS Recirc. Unit	d
u. Refueling bellows guard ring	10 tons	Single failure proof sling	201	RPV	e	162	'A' H_2 Recombiner	e
						162	'A' H_2 O_2 Analyzer	e
						162	SLC	e
v. Jib crane	1.6 tons	Single failure proof sling	201	RPV	d	178	'F' FRVS Recirc. Unit	d
						162	None	NA
w. Channel handling boom crane	0.8 ton	Single failure-proof sling	201	None	NA	178	B&F FRVS Recirc. Units	e
						162	SLC	
						162	H_2 O_2 Analyzers	e
						162	H_2 Recombiners	e
						162	Fuel Pool Pumps & Heat Exch.	e

TABLE 9.1-12 (Cont)

Heavy Load	Load Weight	Lifting Device	First Elevation Feet	First Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation Hazard Elimination Criterion(1)	Second Elevation Feet	Second Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation Hazard Elimination Criterion
x. Dryer Separator sling	2 tons	(None required)	201	RPV	d	178	B&F FRVS Recirc. Units	d
						162	SLC	d
						162	H_2 Recombiners	d
						162	H_2 O_2 Analyzers	d
						162	Fuel Pool Pumps & Heat Exch.	d
y. Spent fuel rack modules	10 tons	Fuel rack lifting fixture	201	RPV	d	162	'B' Fuel Pool Pump & Heat Exch.	d
			201	Spent fuel pool	d			
z. Fuel rack lifting fixture	1.1 tons	Single failure proof sling	201	RPV	d	162	'B' Fuel Pool Pump & Heat Exch.	d
			201	Spent fuel pool	d			
aa. Reactor well shield plug sling	4.5 tons	(None required)	201	RPV	d	178	B&F FRVS Recirc. Units	d
						162	SLC	d
						162	H_2 Recombiners	d
						162	H_2O_2 Analyzers	d
						162	Fuel Pool Pumps & Heat Exch.	d
bb. (DELETED)								
cc. New fuel inner box	0.97 ton	Inner box lifting sling	201	None	NA	162	Fuel Pool Pumps & Heat Exch.	d
dd. New fuel inner box	0.96 ton	Inner box tilting sling	201	None	NA	162	Fuel Pool Pumps & Heat Exch.	e
ee. Shielded fuel transfer chute	23 tons	Transfer chute strong-back	201	RPV	d	162	SLC	d
ff. Head nut and washer rack	3.6 tons	Single failure proof slings	201	RPV	d	178	B&F FRVS Recirc. Units	d
						162	SLC	d
gg. Dryer Separator Staircases	2.0 tons	Single failure proof slings	201	None	d	162	H_2 Recombiners	d
hh. New fuel inner box	5.85 tons	Inner box multibox lifting rig	201	None	NA	162	Fuel Pool Pumps & Heat Exch.	d
ii. Dry Cask Storage Sys. transfer cask with Loaded MPC	100 tons	Transfer cask lifting trunnions and lift yoke	201	None	NA	162	Fuel Pool Cooling System	d
						102	None	N/A
						77	Torus	d
jj. Dry Cask Storage Sys. transfer cask Lift yoke	2.35 tons	None	201	RPV	d	162	Fuel Pool Cooling System	d
kk. Dry Cask Storage Sys. MPC lid	5 tons	Lift yoke, single failure proof slings	201	None	d	162	MPC loaded with spent fuel	d
							Fuel Pool Cooling System	d

	Heavy Load	Load Weight	Lifting Device	First Elevation Feet	First Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation Hazard Elimination Criterion(1)	Second Elevation Feet	Second Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation Hazard Elimination Criterion
ll.	Dry Cask Storage Sys. transfer cask top lid	0.650 tons	Single failure proof slings	201 201	MPC loaded with spent fuel RPV	d d	162	Fuel Pool Cooling System	d
mm.	Dry Cask Storage Sys. transfer cask pool lid	4 tons	Single failure proof slings	201	None	N/A	162	Fuel Pool Cooling System	d
nn.	Dry Cask Storage Sys. mating device	13.75 tons	Single failure proof slings	201	None	N/A	102	MPC loaded with spent fuel	d
oo.	Dry Cask Storage Sys. AWS base plate shield	1.270 tons	Single failure proof slings	201	MPC loaded with spent fuel	d	162	Fuel Pool Cooling System	d
pp.	Dry Cask Storage Sys. MPC transfer into Storage overpack	45 tons	Lift yoke, single failure proof slings and MPC lift cleats	102	None	N/A	77	Torus	d
qq.	Dry Cask Storage Sys. empty MPC	14.7 tons	Single failure proof slings	201	None	N/A	162 102 77	Fuel Pool Cooling System None Torus	d N/A d
rr.	Dry Cask Storage Sys. hanging work platform	1.05 tons	Single failure proof slings	201 201	MPC loaded with spent fuel RPV	d d	162	Fuel Pool Cooling System	d
	Crane/Hoist: Personnel Air Lock Hoist (Item 2, Table 9.1-10)								
a.	Air lock	30 tons	Air lock strongback	102	None	NA	77 77 77 77	Torus HPCI disch. piping SRV disch. piping Core spray disch. piping	c b,c b,c b,c
b.	Upper shield block	21 tons	(None required)	102	None	NA	77 77 77 77	Torus HPCI disch. piping SRV disch. piping Core spray disch. piping	c b b,c b,c
c.	Lower shield blocks (8)	17 tons	(None required)	102	None	NA	77 77 77 77	Torus HPCI disch. piping SRV disch. piping Core spray disch. piping	c b,c b,c b,c

Heavy Load	Load Weight	Lifting Device	First Elevation Feet	First Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation Hazard Elimination Criterion(1)	Second Elevation Feet	Second Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation Hazard Elimination Criterion
Crane/Hoist: Recirculation Pump Motor Hoist (Items 3a and 3b, Table 9.1-10)								
Recirculation pump motor	24 tons	(None required)	102 (inside drywell)	Recircu-lation pumps (1AP201, 1BP201) and asso-ciated piping and conduit	b, c	87 (bottom of drywell)	None	NA
Crane/Hoist: HPCI Pump and Turbine Hoist (Item 5, Table 9.1-10)								
HPCI pump and turbine parts (turbine case)	3.75 tons	Conventional slings	54	Pumps (10P204, 10P217) turbine (10S211) & HPCI piping	b, c	(No lower elevation)		NA
Crane/Hoist: Main Steam Tunnel Underhung Crane (Item 7, Table 9.1-10)								
Valve Operators:								
Main steam Iso. valve	1.8 tons	Conven-tional slings	102	MSIVs (HV F028A-D)	c	54	Torus	c
						54	Containment ins-trument gas piping	b,c
Main steam stop valve	0.9 tons		102	main steam piping	c	54	RCIC piping	b,c
M.O. feedwater check valve	0.9 tons		102	feedwater piping	c	54	HPCI piping	b,c
						54	Nuclear boiler sys. instrumentation	b,c
						54	Core Spray piping	b,c
Crane/Hoist: Inboard MSIV Hoist (Item 8, Table 9.1-10)								
Main steam isolation valve operators	1.8 tons	Conventional slings	102	MSIVs (HV F022 A-D)	c	87 (bot-tom of dry-well)	Main steam piping	c,e
							Containment instrument gas piping	c,e
			102	main steam piping	c		Breathing air piping	c,e
Crane/Hoist: Diesel Generator Underhung Crane (Item 35, Table 9.1-10)								
Diesel generator parts, e.g., combustion air cooling water heat exchanger tube bundle	3540 lb	Conventional slings	102	Diesel generators (1AG400-1DG400) and assoc cooling piping	b,c	77	Associated cooling piping	b,c

Heavy Load	Load Weight	Lifting Device	First Elevation: Feet	First Elevation: Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation: Hazard Elimination Criterion(1)	Second Elevation: Feet	Second Elevation: Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation: Hazard Elimination Criterion
Crane/Hoist: Intake Structure Gantry Crane (Item 36, Table 9.1-10)								
Traveling screen, S.W. pump, and misc equipment	19 tons	Conventional slings	123	Screens (S501)	b, c	93	Strainers (F509)	b, c
			123	heaters (VE507)				
			123	S.W. pumps (P502)				
Crane/Hoist: Reactor Building Personnel Lock Shield Removal Hoist (Item 37, Table 9.1-10)								
T-shaped upper shield block	21 tons	(None required)	102	None	NA	54	Torus	c
						54	Core spray piping	b,c
						54	HPCI piping	b,c
						54	SRV discharge piping	b,c
Crane/Hoist: CRD Service Hoist (Item 39, Table 9.1-10)								
CRD maintenance equipment	1 ton (maximum)	Conventional slings	102	None	NA 77	77	Torus RHR pump A discharge piping	e
						77	RHR shutdown cooling suction	e
						77	HPCI pump discharge line	e
						77	HPCI turbine steam supply	e
						77	RPV instrument lines	e
Crane/Hoist: SACS Pumps A and C Hoist (Item 40, Table 9.1-10)								
Motor	3.1 tons	Conventional sling	102	SACS loop A pumps, remaining motor, associated piping	b,d,e	77	SACS Loop B piping (TACS & diesel supply & return)	e

Heavy Load	Load Weight	Lifting Device	First Elevation Feet	First Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	First Elevation Hazard Elimination Criterion(1)	Second Elevation Feet	Second Elevation Safety-Related, Safe Shutdown, or Decay Heat Removal Equipment	Second Elevation Hazard Elimination Criterion
Crane/Hoist: SACS Pumps B and D Hoist (Item 40, Table 9.1-10)								
Motor	3.1 tons	Conventional sling	102	SACS Loop B pumps, remaining motor, associated piping	b	77	RHR Post-LOCA containment flooding line	e
Crane/Hoist: SACS Heat Exchanger A Hoists (Item 41, Table 9.1-10)								
Return end cover	9.2 tons	Conventional sling	102	None	NA	77	RHR loop A piping	e
						77	Channel A Class 1E cable trays	e
						77	Channel A Class 1E conduit	e
Crane/Hoist: SACS Heat Exchanger B Hoists (Item 41, Table 9.1-10)								
Return end cover	9.2 tons	Conventional sling	102	None	NA	77	RHR loop B piping	e
						77	Channel B Class 1E cable trays	e
						77	Channel B Class 1E conduit	e
Crane/Hoist: CRD Transfer Cask Jib Crane (Item 43, Table 9.1-10)								
CRD transfer cask	1 ton	CRD cask load leveler	132	None	NA	77	torus	e
							RHR suction piping	e

(1) Hazard elimination criteria:

a. Crane travel for this area/load combination is prohibited by electrical interlocks or mechanical stops.

b. System redundancy and separation precludes the loss of the capability of the system to perform its safety-related function following this load drop in this area.

c. Site-specific considerations, such as maintenance sequencing, eliminate the need to consider this load/equipment combination.

d. The likelihood of a handling system failure for this load is extremely small; i.e., Section 5.1.6 of NUREG-0612 is satisfied, the OHS is single-failure-proof.

e. Analysis demonstrates that crane failure and load drop will not prevent safe shutdown or decay heat removal, or cause unacceptable radiation release.

f. Deleted.

(2) Deleted

(3) Deleted

(4) Deleted

TABLE 9.1-13

REACTOR BUILDING POLAR CRANE DESIGN COMPARISON
WITH NUREG 0554, SINGLE FAILURE PROOF
CRANES FOR NUCLEAR POWER PLANTS
(MAY 1979)

NUREG Section	Complies	Does Not Comply	Notes
1. INTRODUCTION	X		
2. SPECIFICATION AND DESIGN CRITERIA			
2.1 Construction and Operating Periods	X		(1)
2.2 Maximum Critical Load	X		(2)
2.3 Operating Environment	X		(3)
2.4 Material Properties	X		(4)
2.5 Seismic Design	X		(5)
2.6 Lamellar Tearing	X		(6)
2.7 Structural Fatigue	X		(7)
2.8 Welding Procedures	X		(8)
3. SAFETY FEATURES			
3.1 General	X		(9)
3.2 Auxiliary Systems	X		(10)

NUREG Section	Complies	Does Not Comply	Notes
3.3 Electric Control System	X		(11)
3.4 Emergency Repairs	X		(12)
4. HOISTING			
4.1 Reeving System	X		(13)
4.2 Drum Support	X		(14)
4.3 Head and Load Blocks	X		(15)
4.4 Hoisting Speed	X		(16)
4.5 Design Against Two Blocking	X		(17)
4.6 Lifting Devices	X		(18)
4.7 Wire Rope Protection	X		(19)
4.8 Machinery Alignment	X		(20)
4.9 Hoist Braking System	X		(21)
5. BRIDGE AND TROLLEY			
5.1 Braking Capacity	X		(22)
5.2 Safety Stops	X		(23)

NUREG Section	Complies	Does Not Comply	Notes
6. DRIVERS AND CONTROLS			
6.1 Driver Selection	X		(24)
6.2 Driver Control Systems	X		(25)
6.3 Malfunction Protection	X		(26)
6.4 Slow Speed Drives	X		(27)
6.5 Safety Devices	X		(28)
6.6 Control Stations	X		(29)
7. INSTALLATION INSTRUCTIONS			
7.1 General	X		(30)
7.2 Construction and Operating Periods	X		(31)
8. TESTING AND PREVENTIVE MAINTENANCE			
8.1 General	X		(32)
8.2 Static and Dynamic Load Tests	X		(33)
8.3 Two Block Test	X		(34)
8.4 Operational Tests	X		(35)

NUREG Section	Complies	Does Not Comply	Notes
8.5 Maintenance	X		(36)
9. OPERATING MANUAL	X		(37)
10. QUALITY ASSURANCE	X		(38)

Notes:

(1) Section 2.1 - The load lifts during construction were not greater than those for plant operation; therefore, no separate specifications were prepared.

(2) Section 2.2 - The Reactor Building polar crane main hoist is designed to handle a maximum critical load (MCL) of 130 tons. The MCL rating will be clearly marked on the main hoist. The design rated load (DRL) of 150 tons provides an overall increase of 15 percent in the crane's load handling ability above its MCL capacity to compensate for wear and exposure.

The Reactor Building polar crane auxiliary hoist is designed to handle a MCL of 8.5 tons. The MCL rating will be clearly marked on the auxiliary hoist. The design rated load (DRL) of 10 tons provides an overall increase of more than 15 percent in the crane's load handling ability above its MCL capacity to compensate for wear and exposure.

(3) Section 2.3 - All identified parameters, except maximum rate of pressure increase and emergency corrosive conditions, were specified. A maximum rate of pressure increase was not specified because it was judged not significant to safe design of the crane. Because it is in the Reactor Building, outside the drywell, the crane would not be subjected to the high accident pressure (62 psig) possible inside the drywell. The maximum pressure increase specified for crane design is -.25 in. wg minimum to +7 in. wg maximum. Emergency corrosive conditions were not specified because none were identified that would prevent safe crane operation.

(4) Section 2.4 - The minimum specified operating temperature is 60°F. Materials for structural members essential to structural integrity are impact tested unless exempted by the provisions of Paragraph AM-218 of the ASME Code, Section VIII, Division 2. All structural members, except the main hoist drums, are exempt under Paragraph AM-218.2, which withdraws the impact test requirement if stress intensity is less than 6000 psi. The main hoist drums are Charpy tested per ASTM A 370. The crane was not subjected to coldproof testing because low alloy steel, such as ASTM A 514, is not used. Cast iron is not used for any crane parts.

(5) Section 2.5 - The SSE design vertical acceleration is less than 1g. Therefore the bridge and trolley wheels will not jump up off their tracks during a seismic event. The bridge and trolley designs include horizontal seismic restraints that would prevent the wheels from leaving the tracks.

(6) Section 2.6 - Nondestructive examination (NDE) was done on all welds whose failure could cause a drop of a critical load. Section 9.1.5.4.1.1 describes the NDE in more detail. Lamellar tearing of these welds is not expected to occur.

(7) Section 2.7 - A structural fatigue analysis was not part of the design requirements for the Reactor Building polar crane. The crane is classified as a low use crane according to the guidelines of CMAA Specification 70. Structural fatigue analysis is not considered necessary in view of the low number of load cycles expected.

(8) Section 2.8 - Crane fabrication is in accordance with AWS D1.1, Structural Welding Code. The weld procedures that were used are qualified in accordance with AWS D1.1.

(9) Section 3.1 - The crane specification included provisions that addressed the design, fabrication and testing of the load bearing components, equipment, and subsystems. In addition, the provisions of withdrawn Regulatory Guide 1.104, Overhead Crane Handling Systems for Nuclear Power Plants, that pertain to crane design, fabrication and testing were invoked in an appendix of the crane specification.

(10) Section 3.2 - As stated in Design Basis Section 9.1.5.1.c, the design basis for the auxiliary hoist is that it be single failure proof. It is described in Section 9.1.5.3.1.

(11) Section 3.3 - Cab controls are deadman type with spring return. A deadman foot switch in the cab must be held down during crane operation. Release of the switch will stop the crane and set the brakes. Overspeed switches on the hoist drives stop the motors and set the brakes at 120 percent of no load speed. All remote control switches have spring return to neutral configurations. Additionally, the system includes a push-to-operate lever, which is required to be activated prior to commanding any movement. The remote control system includes an emergency stop pushbutton that stops power to all drivers. Also, a Main Hoist Unbalanced Load Bypass Switch is added to permit the operator to lower a load if the Main Hoist experiences a rope failure or unbalanced load.

(12) Section 3.4 - The crane design basis is to safely hold the load in the event of a control or component failure. The design permits the load to be manually lowered.

(13) Section 4.1 - The maximum fleet angle from drum to lead sheave in the load block or between individual sheaves does not exceed 3-1/2 degrees at any one point during hoisting. Reverse bends are not used in the reeving system. Each main hoist rope is reeved through block and upper sheave assemblies so that its eight parts provide two parts in each quadrant of the load block about the vertical axis of the hook. With both ropes effective, the load is supported by sixteen parts at an effective static factor of safety of 10. If one rope loses its effectiveness, the load is supported by the eight parts of the remaining rope at a static factor of safety of 5. The extra improved plow steel main hoist wire ropes, with independent wire rope center are 1-1/2 inches in diameter with an ultimate breaking strength of 228,000 pounds each. With both auxiliary hoist ropes effective, the load is supported by four parts at an effective static factor of safety of 15. If one rope loses its effectiveness, the load is supported by two parts of the remaining rope at a static factor of safety of 5. The stainless steel auxiliary hoist wire ropes, with independent wire rope center, are 1 inch in diameter with an ultimate breaking strength of 77,200 pounds each.

(14) Section 4.2 - The main hoist and auxiliary hoist drum assemblies, each with its shafts and bearings, are designed at factors of safety not less than 10. Safety lugs are provided inside each trolley truck to sustain the drum assembly hubs in the event of drum shaft failure at either end. Upper sheave shafts and block swivel assemblies are provided with safety retainers and block housings capable of sustaining the load in

case of shaft or swivel failure. Drum movement in this event is mechanically limited so that the gears and holding brakes remain engaged.

(15) Section 4.3 - As described in Section 9.1.5.2.1.2, both the main and auxiliary hoists are provided with dual reeving systems, and each load block assembly is provided with dual load attachment points. The parts of the vertical hoisting system, including the head block, reeving system, load block, and hook for both the main and auxiliary hoists are designed to support a static load of 200 percent of the design rated load (DRL), instead of the maximum critical load (MCL) as required by NUREG-0554. For the main hoist, the DRL is 150 tons and the MCL is 130 tons. For the auxiliary hoist, the DRL is 10 tons and the MCL is 8.5 tons. Each load path of each dual path hook was given a 200 percent static load test. Geometric configuration measurements of the hook were made before and after each test, and were followed by both volumetric and surface non-destructive examination. The examination results are documented and recorded.

(16) Section 4.4 - As given in Table 9.1-11, the maximum main hoist raising speed is 5 ft/min under load and the maximum auxiliary hoist speed is 35 ft/min. The "slow" column of Figure 70-6 of CMAA-70 suggests speeds of 5 and 20 ft/min for the main and auxiliary hoists, respectively. The static stepless magnetorque control provides smooth hoist acceleration and deceleration, and precise spotting of the load. The auxiliary hoist speed is only 17 percent above the slow speed (30 ft./min.) recommended for cab operated cranes in Table 2 of the Whiting Crane Handbook, 4th Edition, and is well below the recommended medium speed of 60 ft/min.

(17) Section 4.5 - Dual upper limit switches of diverse design in series, and an overload cutoff switch on each hoist stop the hoist motor and set the brakes. Motor overtemperature switches activate warning lights in the cab and on the remote control system. Each limit switch allows the hoist motor to be operated in reverse after it has opened.

(18) Section 4.6 - As described in Section 9.1.5.2.1.2, the main hoist sister hook and lifting eye bolt are independently supported by their respective crosshead and bearings that are in turn supported by the load block. The auxiliary hoist hook and shackles are independently supported by the load block.

(19) Section 4.7 - Side loads are not planned. The main and auxiliary hoist reeving systems do not include wire rope guards.

(20) Section 4.8 - The main and auxiliary hoists employ redundant holding brakes. Each brake is coupled to the drum via a separate gear train.

(21) Section 4.9 - As described in Section 9.1.5.2.1.2, the mechanical holding brakes are automatically activated on loss of electric power. The torque rating of each brake is 150 percent of rated full load hoist motor torque. Each hoist also includes one dc-actuated eddy current, power control type load brake.

(22) Section 5.1 - As described in Section 9.1.5.2.1.2, the trolley and bridge brakes are automatically applied on loss of power. They are rated at 125 percent of drive motor full load torque. Drag brakes are not used. The reversing static stepless controls provided for the main and auxiliary trolleys and the bridge permit minimum incremental movements of 1/8 inch for the

main trolley, 3/8 inch for the auxiliary trolley, and 1/4 inch for the bridge. The maximum speeds of the bridge (40 ft/min), main (10 ft/min), and auxiliary (50 ft/min) trolleys are within the limits of 50, 30, and 125 ft/min, respectively, recommended in the "slow" column of Figure 70-6 of CMAA 70.

(23) Section 5.2 - Section 9.1.5.2.1.5 describes the bridge and trolley limit switches, bridge rail stops, and trolley bumpers.

(24) Section 6.1 - An emergency breaker switch located at the refueling floor level cuts power to the crane independently of the crane controls.

(25) Section 6.2 - The crane does not lift spent fuel assemblies.

(26) Section 6.3 - Malfunction protection that includes sensing and response to excessive current, motor temperature, speed, load, and travel is provided for the hoists, trolleys, and bridge. Indication that the Main Hoist has experienced a rope failure or unbalanced load is provided in the cab with a red beacon.

(27) Section 6.4 - Jogging and plugging are considered in the crane controls design. Drift point is not provided for bridge or trolley movement.

(28) Section 6.5 - The crane safety devices are separate from the control devices.

(29) Section 6.6 - Manual controls for hoisting and trolley movement are not provided on the trolley. Manual controls for the bridge are not located on the bridge.

(30) Section 7.1 - The manufacturer provided installation instructions.

(31) Section 7.2 - Separate construction specifications were not prepared because the construction duty was expected to be enveloped by the specified design requirements. After construction use the crane will be thoroughly inspected and preoperationally tested as described in Section 9.1.5.4.1.2.

(32) Section 8.1 - Mechanical and electrical system checks were done after initial installation. The shop testing records are available at the jobsite.

(33) Section 8.2 - Static and dynamic preoperational load tests were performed as described in Section 9.1.5.4.1.2.

(34) Section 8.3 - The crane design does not include an energy controlling device between the load and head blocks. Therefore, the two-block test is not done. Instead, the two-block test consists of verification that the two uptravel limit switches on each hoist function as designed.

(35) Section 8.4 - The operational tests are performed in accordance with Chapter 2-2 of ANSI B30.2-1976.

(36) Section 8.5 - See Note (2).

(37) Section 9 - An operating and maintenance manual was provided by the manufacturer. It includes operating requirements for all travel movements.

(38) The crane is procured under a QA program that complies with the applicable provisions of ANSI N45.2-1971. Field installation, testing, operator qualification, and crane operation comply with ANSI B30.2.

TABLE 9.1-14
HOPE CREEK SPECIAL LIFTING DEVICE FACTORS OF SAFETY

Item	Special Lifting Device	Rated Capacity tons	Maximum Load Weight tons	Lifting Device Weight tons	Maximum Static Load tons	Dynamic Load Factor(2)	Maximum Combined Static and Dynamic Load tons	Stress Design Factor vs. Yield(3)	Stress Design Factor vs. Ultimate(3)	NUREG-0612(2) Section 5.1.1 Factor of Safety Compliance
1.	RPV head strongback	130	122.4	Note 5	Note 5	0.15	Note 5	Note 5	Note 5	Yes(4)
2.	Dryer separator sling	200	73.3	Note 5	Note 5	0.15	Note 5	Note 5	Note 5	Yes(4)
3.	RPV service platform sling	7.2	5.9	Note 5	Note 5	0.175	Note 5	Note 5	Note 5	Yes(4)
4.	Spent fuel shipping cask yoke	110	110	Note 1	Note 1	0.15	Note 1	Note 1	Note 1	Note 1
5.	Reactor well shield plug sling(6)	107.5	107.5	5.5	113	0.15	130.0	6	10	Yes(4)
6.	Deleted									
7.	RPV stud tensioner sling	5.3	5.3	0.2	5.5	0.175	6.5	14.2	14.7	Yes(4)
8.	Personnel air lock strongback	30	30	0.7	30.7	0.15	35.3	2.3	3.9	No
9.	Fuel rack lifting fixture	10	10	1.1	11.1	0.175	13.0	6	10	Yes
10.	New fuel inner box lifting sling	3.4	1.10	0.01	1.11	0.175	1.30	10.2	10.6	Yes(4)
11.	New fuel inner box tilting sling	2.1	0.98	0.02	1.00	0.175	1.17	5.6	5.9	Yes
12.	Shielded fuel transfer chute strongback and slings	23.0	22.6	0.6	23.2	0.15	26.7	6	10	Yes(4)
13.	Dryer/separator lower pool plug strongback	40.0	38	2	40.0	0.15	46.0	11.3	18.3	Yes
14.	New fuel inner box multibox lifting rig	5.85	5.47	0.15	5.62	0.175	6.60	6	10	Yes (4)

HOPE CREEK SPECIAL LIFTING DEVICE FACTORS OF SAFETY

Item	Special Lifting Device	Rated Capacity tons	Maximum Load Weight tons	Lifting Device Weight tons	Maximum Static Load tons	Dynamic Load Factor (2)	Maximum Combined Static and Dynamic Load tons	Stress Design Factor vs. Yield (3)	Stress Design Factor vs. Ultimate (3)	NUREG-0612 (2) Section 5.1.1 Factor of Safety Compliance
15.	Dry cask storage transfer cask lift yoke	125.0	100	2.35	100	0.15	146.5	Note 8	10.7	Yes (4)
16.	MPC Lift Cleats	45	45	0.0625	45	0.15	129.4	Note 8	10.9	Yes (4)

Notes:

(1) The spent fuel shipping cask and yoke are not yet known for HCGS. The cask weight and dimensions used for the HCGS design are based on the projected 125-ton NLI 26/32 rail cask. A 110-ton load is used here to acknowledge assumption of the NLI cask design responsibility by Nuclear Assurance Corporation (NAC) and subsequent development of the NAC 12/32 cask to replace the projected NLI cask.

(2) Dynamic load factor = 0.15 [lte] 0.005 (hoist speed, feet per minute) [lte] 0.50.

(3) NUREG-0612, Section 5.1.1(4) requires a factor of safety of 3 versus yield and 5 versus ultimate strength for the combined static and dynamic load. The static load includes the weight of the load plus the weight of the special lifting device.

(4) The lifting device satisfies the single-failure-proof requirements of NUREG-0612, Section 5.1.6(1)(a).

(5) Although the lifting device has been upgraded to meet the single-failure-proof guidelines of Section 5.1.6(1)(a) of NUREG-0612 in accordance with GE FDIs 117, 118, 120, and 127 as applicable, the as-built weight is not yet available. The factors of safety were determined from NUREG-0612 (1980) and ANSI N14.6-1986. The maximum load weight consists of the RPV Head, Strongback Carousel Frame, nut rack, tensioners (4), studs (6), Nuts/Washers (92) and miscellaneous equipment. (See Calc. 622-0070).

(6) The values identified for "Lifting Device Weight", "Maximum Static Load" and "Maximum Combined Static and Dynamic Load" on this Table correspond to the usage of wire rope slings. The values when kevlar and other equivalent synthetic fiber slings are used are as follows:

Lifting Device Weight (tons)	Maximum Static Load (tons)	Maximum Combined Static and Dynamic Load (tons)
4.3	111.8	128.6

All other values are unaffected.

(7) The lift yoke is analyzed for lifting either version of the Dry Cask Storage transfer cask weighing 100 or 125 tons. HC has selected the 100-ton version. The values reported in the table are for the 125-ton cask, which bound the values for the 100-ton cask.

(8) The design analysis used 1/10 of the ultimate strength for calculating the factor of safety. Using 1/10 of the ultimate strength bounds using the 1/6 of the yield strength, and therefore factors of safety against yield strength were not reported.

TABLE 9.1-15

REACTOR BUILDING POLAR CRANE FAILURE MODES AND EFFECTS ANALYSIS

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Power supply	Loss of offsite power	All crane movements stopped by setting crane holding brakes and tripping all drive motors	Crane operator	
Main hoist hook	Failure of hook or lifting eye	None. The redundant hook or eye supports the load	Periodic inspection, if not identified during crane use	
Auxiliary hoist hook	Failure of hook or both shackles	None. The redundant hook or shackles supports the load	Periodic inspection, if not identified during crane use	
Main hoist wire ropes	Failure of one rope	Spurious, dynamic, load transfer to the redundant rope. The load is supported by the remaining rope at a minimum static safety factor of 5. Minimum clearances maintained to preclude impact to structure	Crane operator, administrative Control per maintenance procedure	Proximity switch senses a rope break or unbalanced load and stops Main Hoist movement
Auxiliary hoist wire ropes	Failure of one rope	Spurious, dynamic, load transfer to the redundant rope. The load is supported by the remaining rope at a minimum static factor of safety of 5	Crane operator	
Main Hoist Bypass Switch Contact	Failure of contact open	None. Hoist downward movement is limited by PLS lower travel limit switch Opening	Crane operator can manually disengage brakes to lower unbalanced load	
	Failure of Contact Closed	Hoist downward Movement is limited By PLS lower travel Limit switch opening	Periodic testing	

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Main or auxiliary hoist drum	Failure of drum shaft	Possible load stalling, or noise and irregular hoist operation. Drum flange drops a fraction of an inch onto machined structural seats located so that the drum is supported. The remaining pinion and gear remain meshed and restrain the load. The crane operator stops hoist operation, resulting in setting of the holding brakes and the safe suspension of the load	Crane operator	The load can be positioned over its storage or laydown area and then lowered by manual operation of the hoist holding brakes
Main or auxiliary hoist holding brakes	Failure of one brake in the open position	None. The other holding brake stops the main hoist movement and holds the load	Periodic inspection	
Main or auxiliary trolley holding brakes	Failure of one brake in the open position	None. When the trolley drive motor is stopped, power to the holding brakes is also cut off, which sets the redundant brake	Crane operator	Two holding brakes are provided, both rated at 125 percent of the trolley drive motor torque at the point of application

TABLE 9.1-15 (Cont)

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Bridge holding brakes	Failure of one brake in the open position	None. The other bridge drive brake stops the bridge	Crane operator	Each bridge drive brake is actuated two ways, automatically and manually. Automatic electrical actuation occurs when the bridge controller returns to neutral. Backup manual hydraulic actuation occurs when the foot pedal in the cab is depressed. The holding brakes are rated at 125 percent of the bridge drive motor torque
Main and auxiliary hoist drive gear cases	Failure of one gear case, resulting in gear disengagement:	None. The other drive gear case maintains control of the load	Crane operator	Two gear cases are provided for each hoist
Auxiliary hoist upward movement limit switches (geared-type) Main Hoist upward movement limit switches (programmed type)	Failure of switch:			
	a) Open	Immediate power cut-off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes	Crane operator or periodic testing	
	b) Closed	None. If the hoist continues its upward travel it is stopped by action of the redundant upper limit switch	Periodic testing	

TABLE 9.1-15 (Cont)

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
Main and auxiliary hoist upward movement limit switches (contact-type)	Failure of switch:			Tripped by physical contact with moving load block as it moves upward
	a) Open	Immediate power cut-off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes	Crane operator or periodic testing	
	b) Closed	None. Hoist upward movement is limited by the redundant upper limit switch, before it reaches this limit switch	Periodic testing	
Auxiliary hoist downward movement limit switch (geared-type) Main Hoist downward Movement limit switches (programmed type)	Failure of limit switch:			
	a) Open	Immediate power cut-off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes	Crane operator or periodic testing	
	b) Closed	Hoist movement downward continues until terminated by the operator	Crane operator or periodic testing	
Bridge and trolley movement limit switches	Failure of one switch associated with a given bridge or trolley position:			
	a) Open	Immediate cutoff of power to respective drive motor(s) and holding brake(s) and stopping of all crane movements	Crane operator	

Component or Subsystem	Component or Subsystem Failure Mode	Effect of Failure on the System	Failure Mode Detection	Remarks
	b) Closed	None. The bridge or trolley bumpers prevent any crane movement into the restricted area	Crane operator	
Main Line Contactor	Open	None. No power to any of the crane motors or control circuits.	Crane Operator	
Main Line Contactor	Shorted	Power to all crane motors and control circuits. Isolation of power is compromised.	Crane Operator periodic inspection if not identified during crane use.	Use existing disconnect switch to remove power.
Main Hoist Programmable Limit Switch (PLS)	Loss of Power	None. If hoist continues upward, it is stopped by action of the redundant upper limit switch.	Crane Operator PLS controller local display indicates a fault.	PLS stays programmed positions are absolute settings are maintained.
		Hoist movement downward continues until terminated by the operator.	Crane Operator	
Main Hoist Programmable Limit Switch (PLS)	Detected Failure	None. No impact on operation of the main hoist.	Crane Operator PLS controller Local display indicates the fault.	PLS limit switches maintain programmed settings.
Main hoist Proximity switch (contact-type)	Failure of switch:			Tripped by physical contact with moving load block as it moves upward
	a) Open	Immediate power cut-off to the main hoist. As a result, the hoist is stopped through action of the hoist holding brakes	Crane operator or periodic testing	
	b) Closed	None. Hoist upward movement is limited by the redundant upper limit switch, before it reaches this limit switch	Periodic testing	

TABLE 9.1-16

SPENT FUEL POOL LINER DRAIN LINES

Fuel Pool Liner Drain Number (Ref. Figure 9.1-5)	Fuel Pool Leakage Area (Ref. Figure 1.2-32)
10	West wall (portion opposite new fuel vault)
11	North wall
12	East wall
13	South wall
14	West wall (portion opposite cask loading pit)
15	Floor (North area)
16	Floor (South area)

TABLE 9.1-17

DECAY HEAT AND EVAPORATION RATES FOR LOSS OF SPENT FUEL POOL COOLING

Description of the event		Normal heat load in the spent fuel pool (17.2×10^6 BTU/hr)	Maximum heat load in the spent fuel[5] pool (43.0×10^6 BTU/hr)
A	Time to reach 212°F	19.6 hrs[6]	6.9 hrs
B	Evaporation rate[1]	36.6 gpm	97.5 gpm
C	Time required to initiate makeup water	2 hrs[2] 1/2 hr[3] 20 hrs[4]	2 hrs[2] 1/2 hr[3]

Notes:

(1) SFP makeup is from the Seismic Category II condensate storage system with a capacity of 75 gpm, which is adequate for non-accident (nonOboiling) cases. In the unlikely even of a complete loss of SFP cooling capability, boil-off rates could exceed 75 gpm. Three Seismic Category I emergency makeup sources, low pressure coolant injection (LPCI/RHR), emergency fire makeup, and the service water system (SWS), each have makeup capabilities that exceed calculated boil-off rates..

(2) An estimated time of 2 hrs would be required to couple the fire hose fill connections to the Seismic Category I SSWS loops to provide fresh water makeup to the fuel pool.

(3) It has been conservatively estimated that the SSWS can be initiated within 1/2 hr by operator action in the MCR to provide makeup to the fuel pool.

(4) It has been conservatively estimated that after 20 hrs one RHR pump loop and the associated heat exchanger can be used for fuel pool cooling.

(5) Since the entire core is in the fuel pool, the RHR system can be made available for fuel pool cooling.

(6) This assumes a normal maximum heat load after 16 consecutive refuelings.

TABLE 9.1-18

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TABLE 9.1-19

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TABLE 9.1-20

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TABLE 9.1-21

SINGLE FAILUREPROOF POLAR CRANE LIFTING DEVICES AND ASSOCIATED HEAVY LOAD LIFT POINTS

	Lifting Device/Heavy Load Lift Point	Special Lifting Device[1]	Single Failure-proof	NUREG-0612 Applicable Criteria
1.	Spent Fuel Shipping Cask Yoke	Yes	Yes	Note 2
	- Spent Fuel Shipping Cask	NA	Yes	Note 2
2.	RPV Head Strongback	Yes	Yes	5.1.6(1)(a)
	- Drywell head	NA	Yes	5.1.6(3)(a)
	- RPV head	NA	Yes	5.1.6(3)(a)
	- RPV head insulation & frame	NA	Yes	5.1.6(3)(a)
	- RPV head, nut rack, nuts and washers	NA	Yes	5.1.6(3)(a)
3.	Shield Plug Sling	Yes	Yes	5.1.6(1)(a)
	- Reactor well shield plugs	NA	Yes	5.1.6(3)(a)
	- Dryer/Separator pool plugs	NA	Yes	5.1.6(3)(a)
3a.	Dryer/Separator Pool Plugs Strongback	Yes	Yes	5.1.6(1)(a)
4.	Dryer/Separator Sling	Yes	Yes	5.1.6(1)(a)
	- Steam dryer	NA	Yes	5.1.6(3)(a)
	- Moisture separator	NA	Yes	5.1.6(3)(a)
5.	Service Platform Sling	Yes	Yes	5.1.6(1)(a)
	- Service platform	NA	Yes	5.1.6(3)(a)

TABLE 9.1-21 (Cont)

Lifting Device/Heavy Load Lift Point		Special Lifting Device[1]	Single Failure Proof	NUREG-0612 Applicable Criteria
6.	Fuel Rack Lifting Fixture	Yes	Yes	5.1.6(1)(a)
	- Spent fuel rack module	NA	Yes	Note 3
7.	RPV Stud Tensioner Sling	Yes	Yes	5.1.6(1)(a)
	- RPV stud tensioner	NA	Yes	5.1.6(3)(a)
8.	Miscellaneous Slings (Note 5)	No	Yes	5.1.6(1)(b)
	- Spent fuel pool slot plugs	NA	Yes	5.1.6(3)(b)
	- Spent fuel pool & cask pool gates	NA	Yes	5.1.6(3)(a)
	- Head stud rack	NA	Yes	5.1.6(3)(b)
	- Flux monitor shipping crate	NA	No	NA
	- 4'x4'-6" Hatch cover	NA	Yes	5.1.6(3)(a)
	- 10'x10' Hatch cover	NA	Yes	5.1.6(3)(a)
	- Refueling bellows guard ring	NA	No	NA
	- Jib crane	NA	Yes	5.1.6(3)(b)
	- Channel handling boom crane	NA	Yes	5.1.6(3)(b)
	- RPV head insulation and frame	NA	Yes	5.1.6(3)(b)
	- Head nut and washer rack	NA	Yes	5.1.6(3)(a)
	- Dryer Separator Staircases	NA	Yes	5.1.6(3)(b)
9.	Polar Crane Main and Auxiliary Hoists	Note 4	Yes	5.1.6(2)

Lifting Device/Heavy Load Lift Point	Special Lifting Device(1)	Single Failure Proof	NUREG-0612 Applicable Criteria
10. New Fuel Inner Box			
Lifting Sling	Yes	Yes	5.1.6(1)(a)
- Inner New Fuel Container	NA	Yes	5.1.6(3)(a)
11. Shielded Fuel Transfer Chute Strongback and Slings	Yes	Yes	5.1.6(1)(a)
- Shielded Fuel Transfer Chute	NA	Yes	5.1.6(1)(a)
12. New Fuel Inner Box Multibox Lifting Rig	Yes	Yes	5.1.6(1)(a)
- Inner New Fuel Container	NA	Yes	5.1.6(3)(a)
13. Dry Cask Storage			
Transfer Cask Lift Yoke	Yes	Yes	5.1.6(1)(a)
- Transfer Cask Trunnions	Yes	Yes	5.1.6(1)(a)
Lift Cleats (loaded MPC)	Yes	Yes	5.1.6(1)(a)
- MPC lid	N/A	Yes	5.1.6(1)(a)
- MPC transfer Slings	N/A	Yes	5.1.6(1)(b)
Dry Cask Storage Slings	N/A	Yes	5.1.6(1)(b)
- MPC lid	N/A	Yes	5.1.6(1)(a)
- Transfer Cask Top Lid	N/A	Yes	5.1.6(3)(b)
- Transfer Cask Pool Lid	N/A	Yes	5.1.6(3)(b)
- Mating Device	N/A	Yes	5.1.6(3)(b)
- AWS Baseplate Shield	N/A	Yes	5.1.6(3)(b)
- Empty MPC	N/A	Yes	5.1.6(3)(b)
- Hanging Work Platform	N/A	Yes	5.1.6(3)(b)

TABLE 9.1-21 (Cont)

<u>Notes</u>:

(1) Special lifting device factors of safety are given in Table 9.1-14.

(2) The spent fuel shipping cask and yoke are not yet known for HCGS. A single failure proof shipping cask lifting device (yoke) and cask lift point design in accordance with NUREG-0612 Sections 5.1.6(1)(a) and 5.1.6(3) will be selected.

(3) The spent fuel rack modules have no lift points. The design of the fuel rack lifting fixture eliminates the need for lift points on the module.

(4) The polar crane main and auxiliary hoists are integral parts of the polar crane and are not considered special lifting devices.

(5) Miscellaneous slings that are not special lifting devices are selected as discussed in UFSAR Section 9.1.5.1.14.

TABLE 9.1-22
POLAR CRANE LOAD DROP ANALYSIS COMPARISON AGAINST NUREG-0612 EVALUATION CRITERIA

Heavy Load	NUREG-0612 EVALUATION CRITERIA I Releases of radioactive material	II Keff Less than 0.95	III No Fuel Uncovery	IV No Loss of Safe Shutdown Function	FSAR Section for Safety Evaluation
a. Reactor Well Shield Plugs	(1)	(1)	(1)	(1)	9.1.5.3.2.3
b. Drywell Head	(1)	(1)	(1)	(1)	9.1.5.3.2.2
c. Reactor Vessel Head	(1)	(1)	(1)	(1)	9.1.5.3.2.2
d. Moisture Separator	(1)	(1)	(1)	(1)	9.1.5.3.2.4
e. Steam Dryer	(1)	(1)	(1)	(1)	9.1.5.3.2.4
f. Dryer/Separator Pool Plugs	(1)	(1)	(1)	(1)	9.1.5.3.2.5
g. Spent Fuel Shipping Cask	(2)	(2)	(2)	(2)	9.1.5.3.2.1
h. Auxiliary Hoist Load Block	(3)	(3)	(3)	(3)	9.1.5.3.1
i. Main Hoist Load Block	(3)	(3)	(3)	(3)	9.1.5.3.1
j. Spent Fuel Pool Slot Plugs	(1)	(1)	(1)	(1)	9.1.5.3.2.9
k. Spent Fuel Pool Gates and Cask Pool Gates	(1)	(1)	(1)	(1)	9.1.5.3.2.9
l. RPV Service Platform	(1)	(1)	(1)	(1)	9.1.5.3.2.6
m. Head Stud Rack	(1)	(1)	(1)	(1)	9.1.5.3.2.9
n. Vessel Head Insulation and Frame	(1)	(1)	(1)	(1)	9.1.5.3.2.2
o. Flux Monitor Shipping Grate	(5)	(5)	(5)	(5)	9.1.5.3.2.9
p. Stud Tensioner Frame	(1)	(1)	(1)	(1)	9.1.5.3.2.8
q. Head Strongback	(1)	(1)	(1)	(1)	9.1.5.3.2.2
r. Spent Fuel Cask Yoke	(2)	(2)	(2)	(2)	9.1.5.3.2.1
s. Hatch Cover 4' x 4'-6"	(1)	(1)	(1)	(1)	9.1.5.3.2.9
t. Hatch Cover 10' x 10'	(1)	(1)	(1)	(1)	9.1.5.3.2.9
u. Dryer/Separator Lower Pool Plug Lifting Strongback	(1)	(1)	(1)	(1)	9.1.5.3.2.13

	Heavy Load	NUREG-0612 EVALUATION CRITERIA I Releases of Radioactive Material	II Keff Less than 0.95	III No Fuel Uncovery	IV No Loss of Safe Shutdown Function	FSAR Section for Safety Evaluation
u'.	Refueling Bellows Guard Ring	(4)	(4)	(4)	(4)	9.1.5.3.2 9.1.5.3.2.9
v.	Jib Crane	(1)	(1)	(1)	(1)	9.1.5.3.2.9
w.	Channel Handling Boom Crane	(1)	(1)	(1)	(1)	9.1.5.3.2.10
x.	Dryer-Separator Sling	(1)	(1)	(1)	(1)	9.1.5.3.2.4
y.	Spent Fuel Rack Modules	(1)	(1)	(1)	(1)	9.1.5.3.2.7
z.	Fuel Rack Lifting Fixture	(1)	(1)	(1)	(1)	9.1.5.3.2.7
aa.	Reactor Well Shield Plug Sling	(1)	(1)	(1)	(1)	9.1.5.3.2.3
bb.	*(DELETED)*					
cc.	New Fuel Inner Container	(6)	(6)	(6)	(6)	9.1.5.3.2.10 9.1.5.3.2.11 9.1.5.3.2.14
dd.	Shielded Fuel Transfer Chute	(1)	(1)	(1)	(1)	9.1.5.3.2.12
ee.	Dryer Separator Staircases	(1)	(1)	(1)	(1)	9.1.5.3.2.8
ff.	Dry Cask Storage Transfer Cask	(2)	(2)	(2)	(2)	9.1.5.3.2.1 9.1.5.3.2.15
gg.	Dry Cask Storage MPC Lid	(1)	(1)	(1)	(1)	9.1.5.3.2.15
hh.	Dry Cask Storage Transfer Cask Top Lid	(1)	(1)	(1)	(1)	9.1.5.3.2.15
ii.	Dry Cask Storage Transfer Cask Bottom Lid	(1)	(1)	(1)	(1)	9.1.5.3.2.15
jj.	Dry Cask Storage Mating Device	(1)	(1)	(1)	(1)	9.1.5.3.2.15
kk.	Dry Cask Storage AWS Base Plate	(1)	(1)	(1)	(1)	9.1.5.3.2.15
ll.	Dry Cask Storage MPC (stack-up)	(1)	(1)	(1)	(1)	9.1.5.3.2.15
mm.	Dry Cask Storage Empty MPC	(1)	(1)	(1)	(1)	9.1.5.3.2.15
nn.	Dry Cask Storage Hanging Work Platform	(1)	(1)	(1)	(1)	9.1.5.3.2.15

NOTES:

(1) The crane, lifting device, and lift points of the heavy load satisfy the single-failure-proof guidelines of NUREG-0612, Section 5.1.6. No load drop analysis is required.

(2) A single-failure-proof fuel cask lifting device (yoke) and cask lift point design in accordance with NUREG-0612 will be selected for HCGS. No load drop analysis is required.

(3) The polar crane and its main hoist load block and auxiliary hoist load block satisfy the single-failure-proof guidelines of NUREG-0612. No load drop analysis is required.

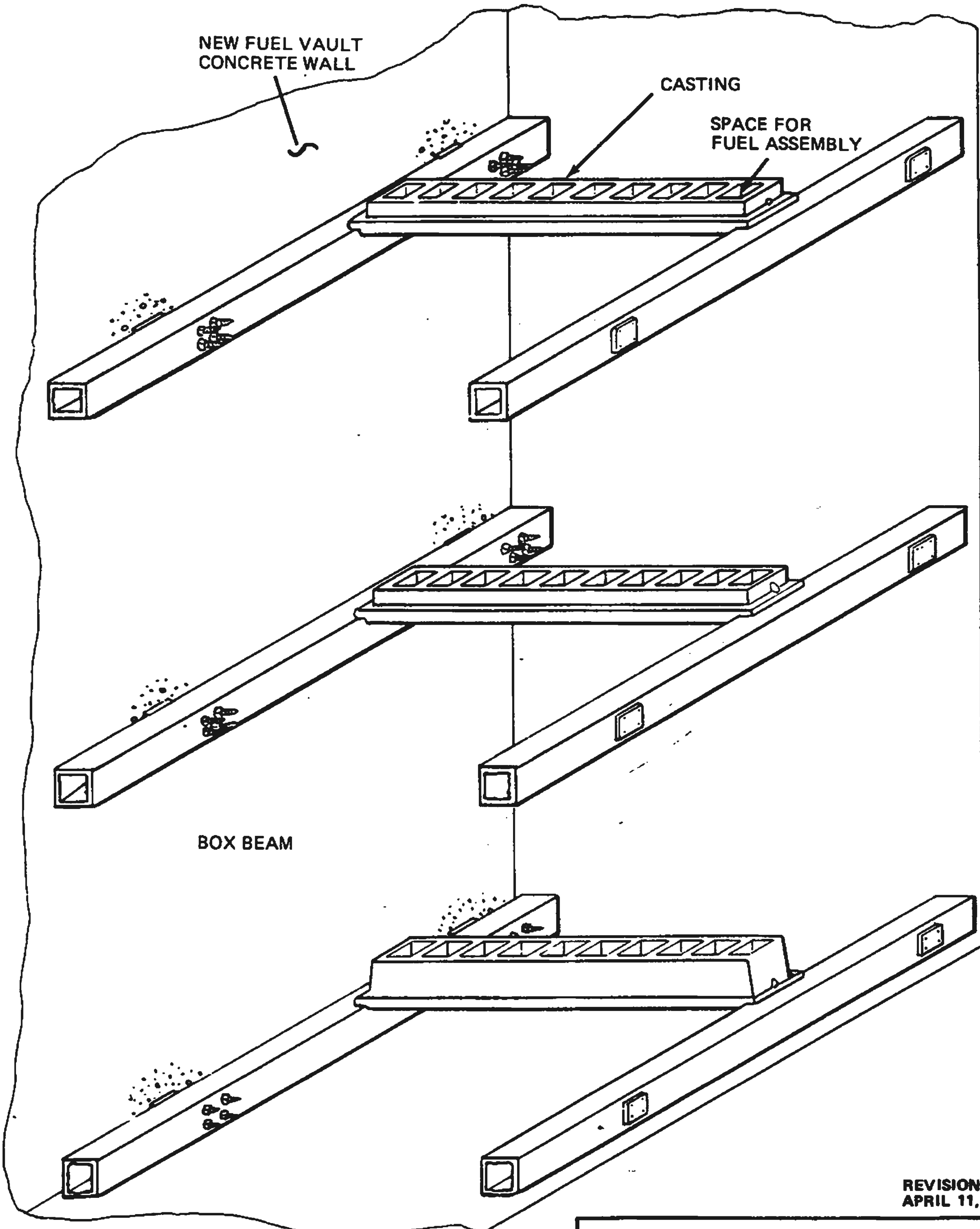
(4) The refueling bellows guard ring is lifted by a single-failure-proof sling selected in accordance with NUREG-0612, Section 5.1.6(1)(b). The 10-ton guard ring, if assumed to drop, would dissipate much of the energy through deformation of the circular guard ring. A postulated drop of the refueling bellows guard ring, while not considered likely, satisfies the four evaluation criteria of NUREG-0612, Section 5.1.

(5) The flux monitoring shipping crate is lifted by a single failure proof sling selected in accordance with NUREG-0612, Section 5.1.6(1)(b). Administrative controls will be used to ensure the lift height above the refueling floor is minimized. No safety-related, safe shutdown, or decay heat removal equipment is located at the refueling floor elevation within the load path for the shipping crate. The flux monitor shipping crate is not carried over the spent fuel pool or RPV.

A postulated drop of the shipping crate (2.5 tons) is not expected to penetrate the massive refueling floor, which is designed to support the heavier shield plugs, pool plugs, RPV head, etc. Concrete spalling is not expected as the heavy load being considered is relatively light, and the bottom of the refueling floor is steel decking, which would contain any concrete spalling. If local concrete spalling of the refueling floor were postulated along with impact and damage to equipment and piping on the elevation below, safe shutdown functions would not be affected as the equipment and piping are not required for safe shutdown, or redundant systems not affected by the postulated load drop are available.

In summary, an analysis of a postulated drop of the flux monitor shipping crate demonstrates that the four evaluation criteria of NUREG-0612, Section 5.1 are satisfied.

(6) The crane, lifting sling, multibox lifting rig, and lift points satisfy the single-failure-proof guidelines of NUREG-0612, Section 5.1.6, but the tilting sling does not. For the tilting sling, a drop of the inner new fuel container has been evaluated and satisfies the four evaluation criteria of NUREG-0612, Section 5.1, as described in Section 9.1.5.3.2.11.



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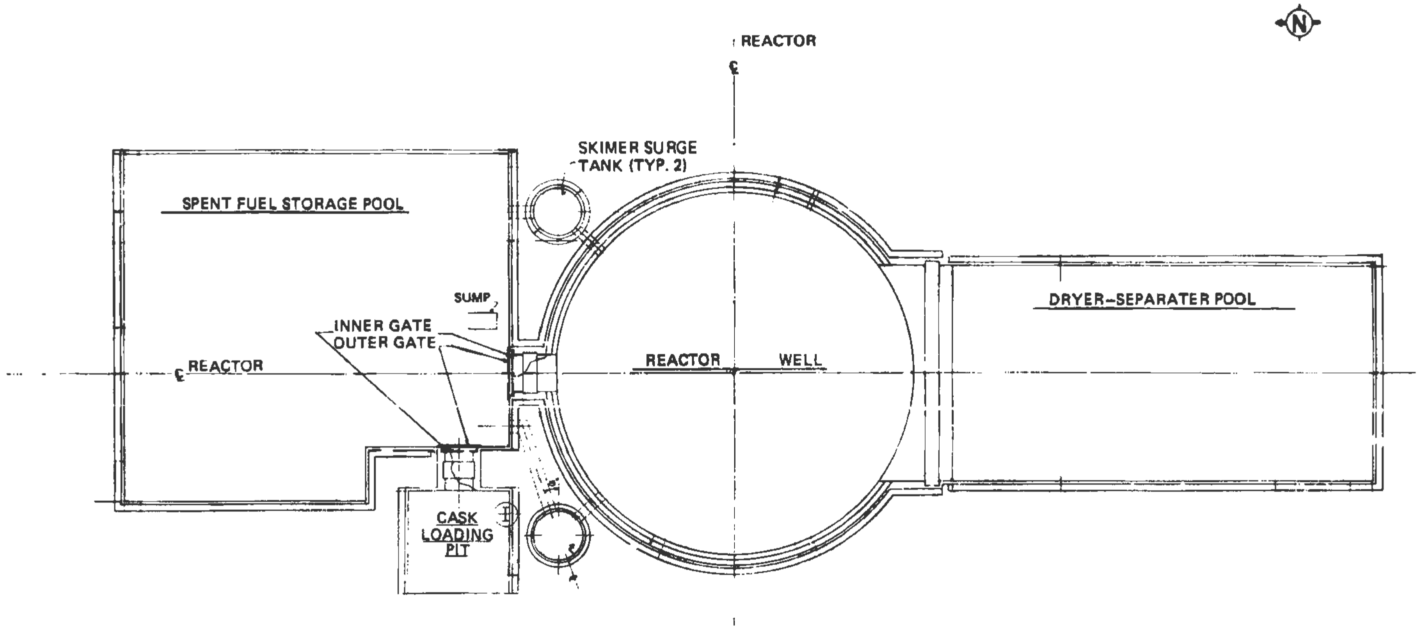
NEW FUEL RACK ARRANGEMENT

UPDATED FSAR

FIGURE 9.1-1



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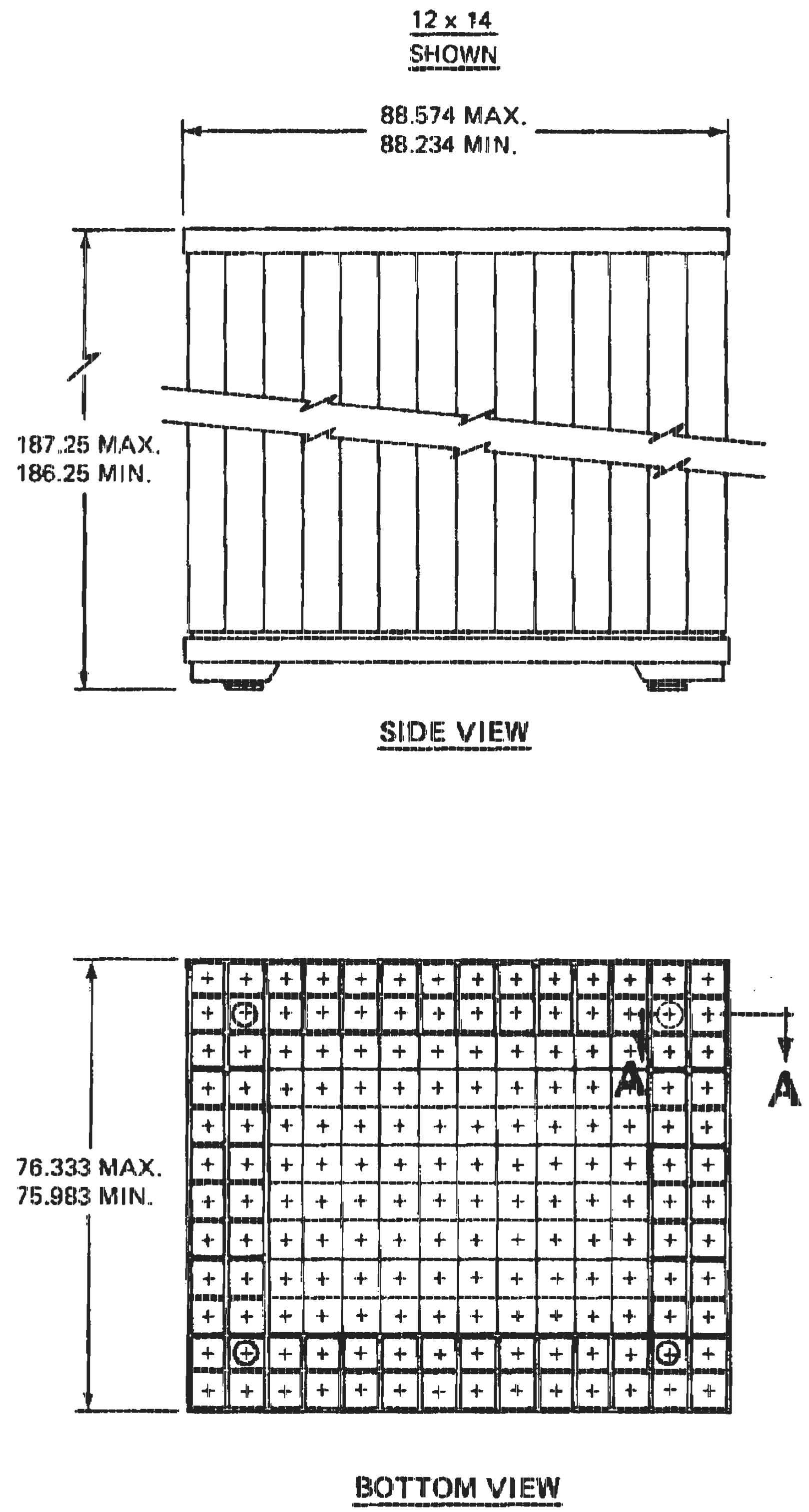
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

GENERAL ARRANGEMENT
OF SPENT FUEL STORAGE POOL

UPDATED FSAR

FIGURE 9.1-2



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NOTE:

ALL DIMENSIONS IN INCHES.

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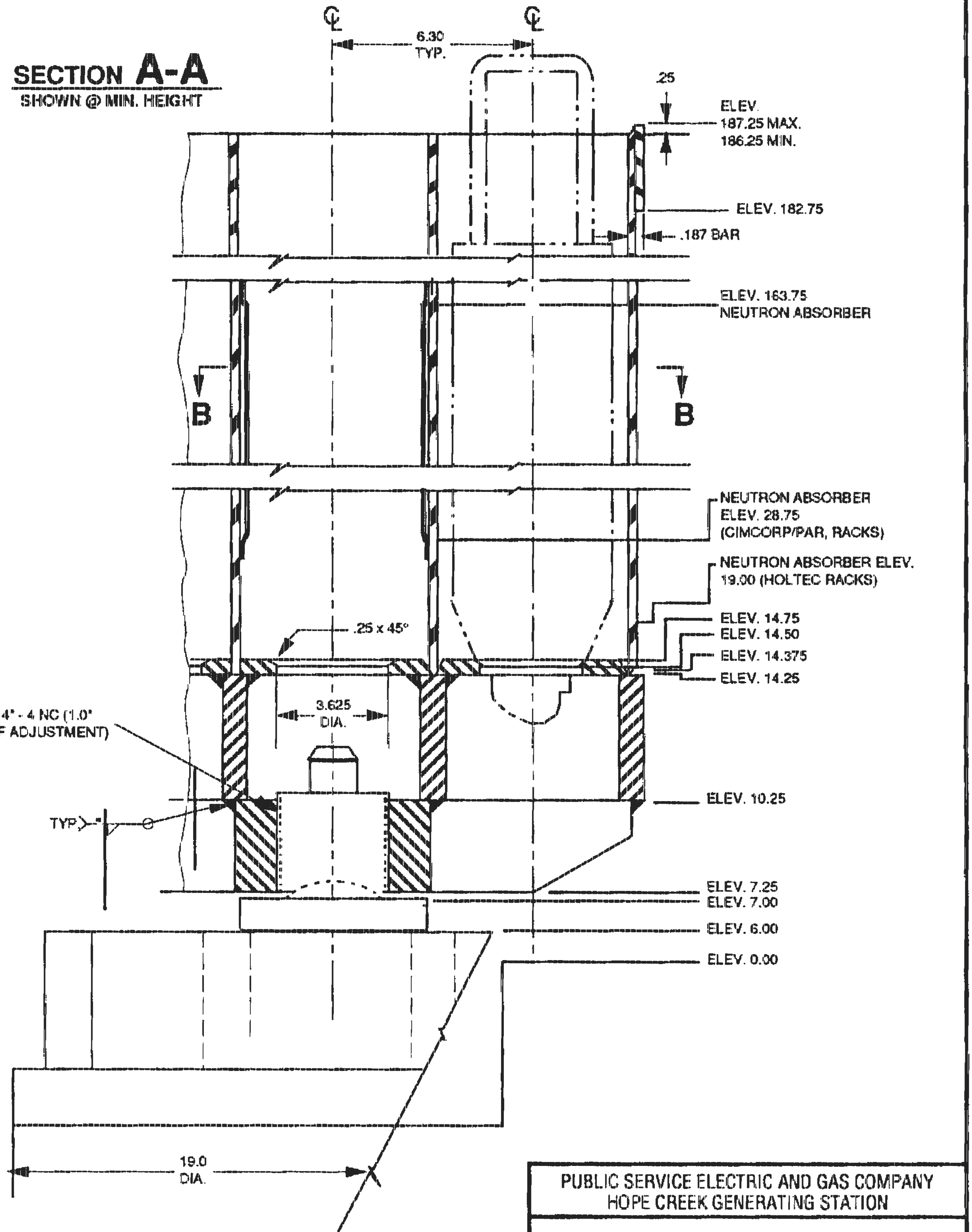
A TYPICAL SPENT FUEL RACK

UPDATED FSAR

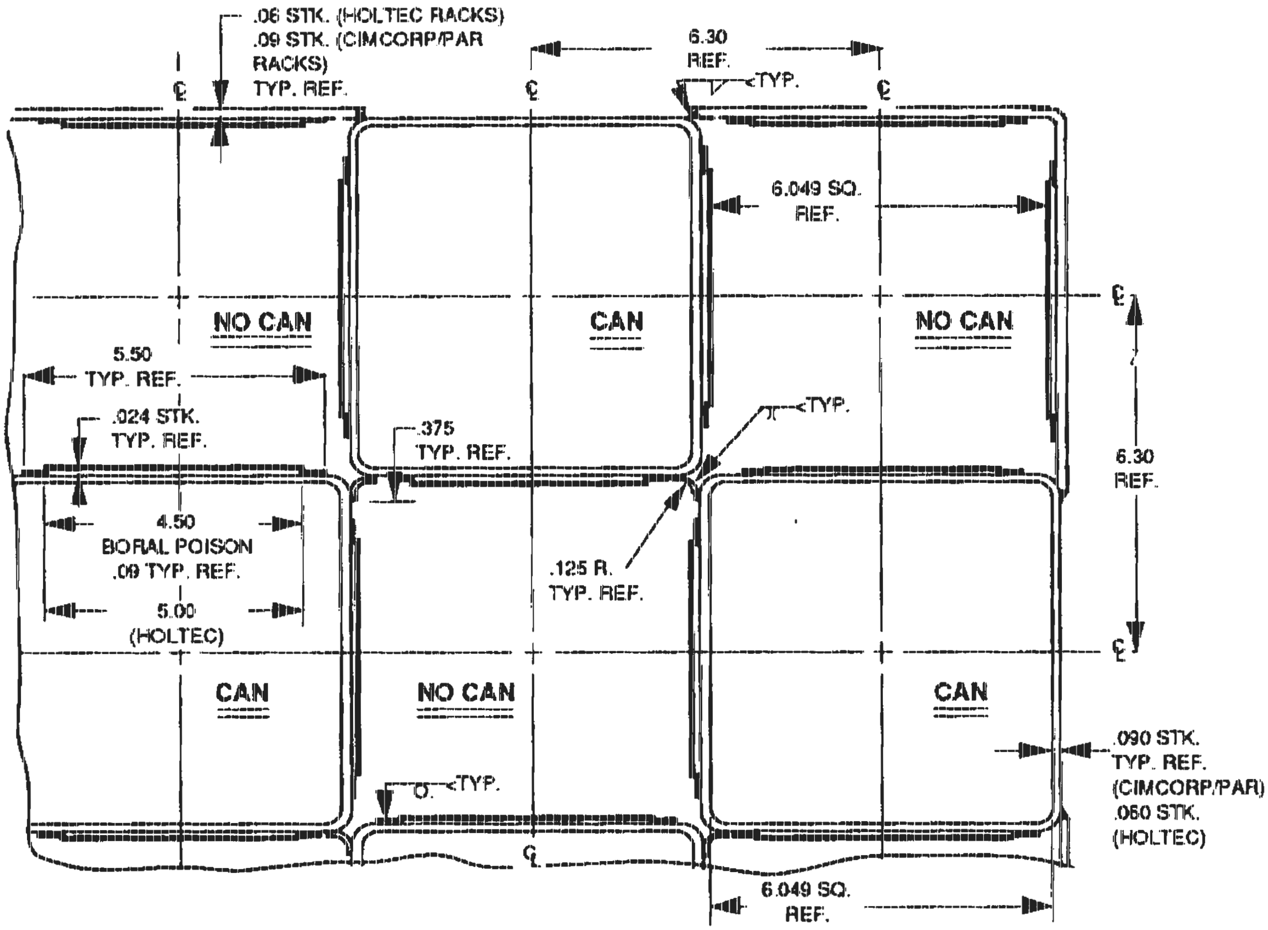
Sheet 1 of 4
FIGURE 9.1-3



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

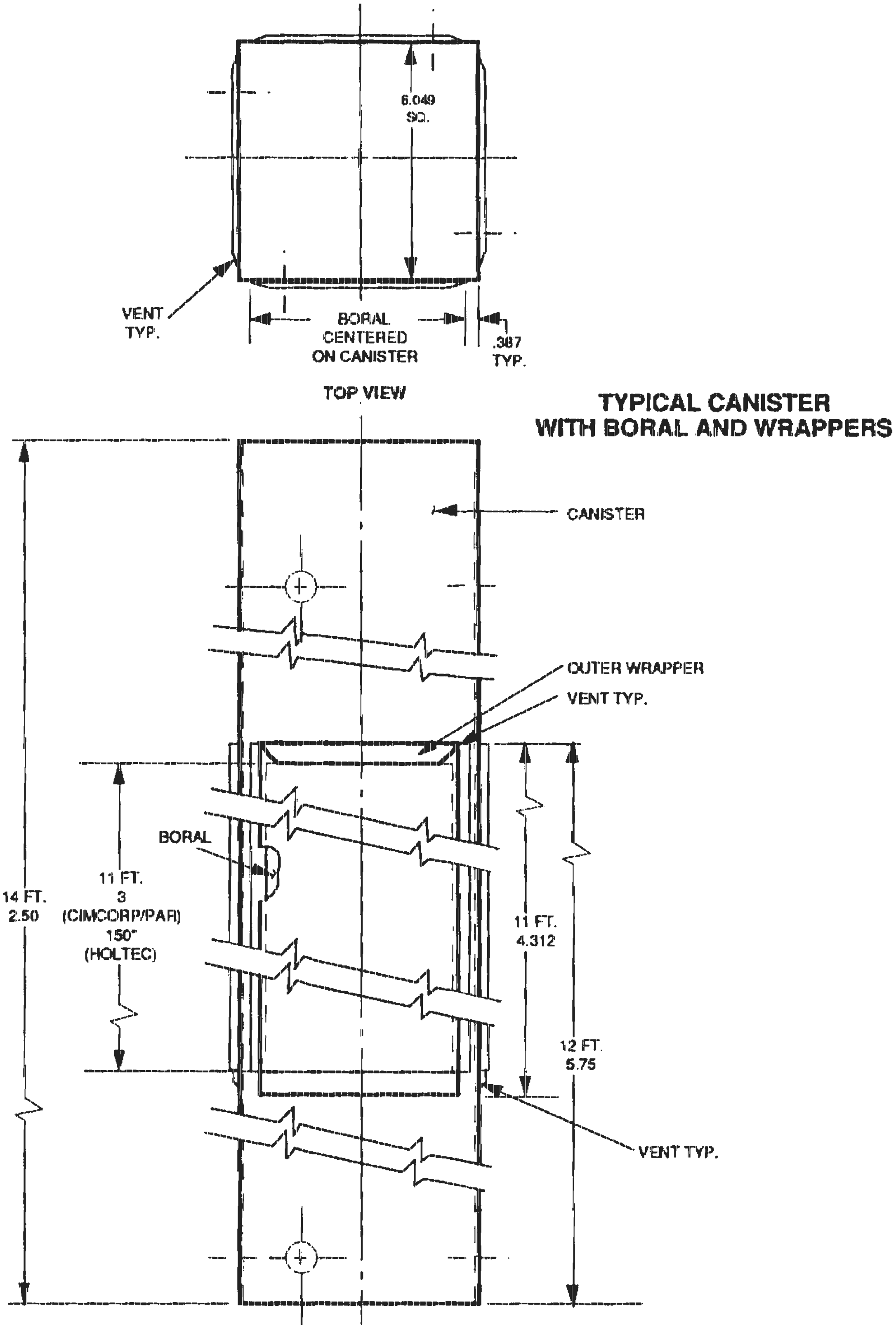
A TYPICAL SPENT FUEL RACK

Updated FSAR	Sheet 2 of 4
Revision 4, April 11, 1992	Figure 9.1-3



SECTION **B-B**

PUBLIC SERVICE ELECTRIC AND GAS COMPANY HOPE CREEK GENERATING STATION	
A TYPICAL SPENT FUEL RACK	
Updated FSAR Revision 4, April 11, 1992	Sheet 3 of 4 Figure 9.1-3

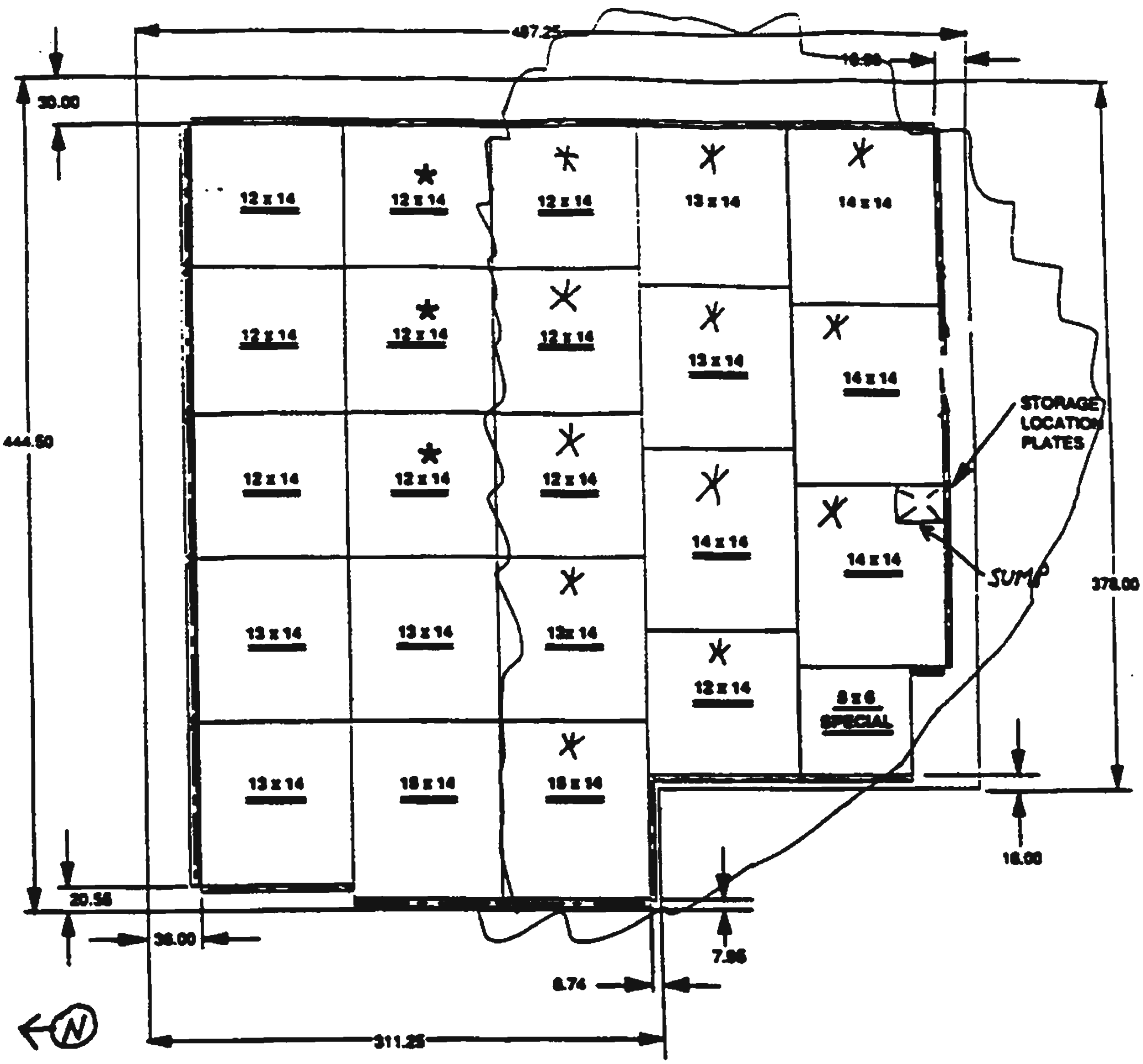


PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

A TYPICAL SPENT FUEL RACK

Updated FSAR
Revision 4, April 11, 1992

Sheet 4 of 4
Figure 9.1-3



TYPE OF MODULE	QTY OF MODULES	QTY OF CAVITIES	QTY OF SPECIAL CAVITIES
SPECIAL 5 X 6	1	–	30
12 x 14	10	1680	–
13 x 14	6	1092	–
14 x 14	4	784	
14 x 15	2	420	–
TOTAL	23	3976	30

NOTES:

1. 5 x 6 SPECIAL RACK IS FOR STORAGE OF CONTROL RODS, GUIDE TUBES AND DEFECTIVE FUEL CONTAINERS.
2. ALL DIMENSIONS IN INCHES.
3. ALL RACKS ARE CIMCORP/PAR RACKS UNLESS DENOTED WITH AN *

* DESIGNATES HOLTEC RACKS

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

SPENT FUEL RACK ARRANGEMENT IN FUEL POOL

Updated FSAR
Revision 5, May 11, 1993

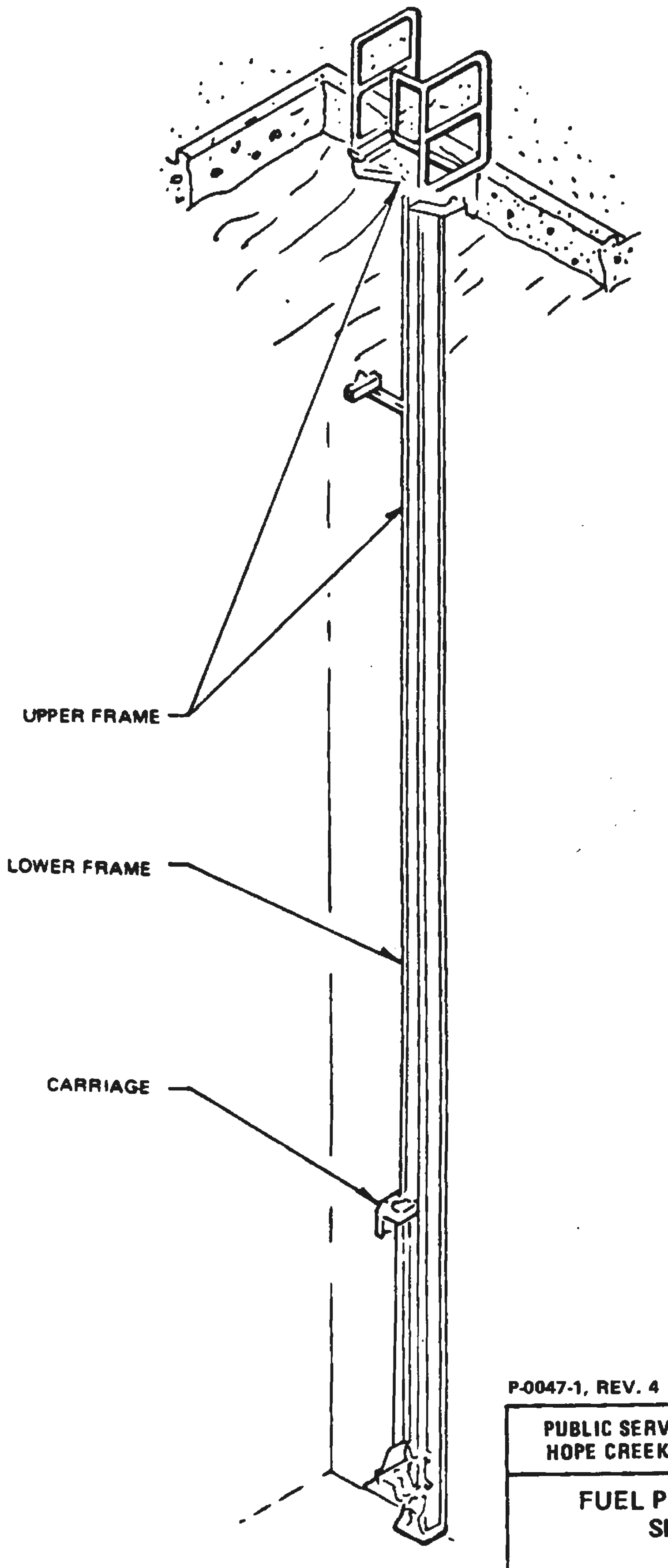
Sheet 1 of 1
Figure 9.1-4

Figure F9.1-5 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-53-1 for both sheets in DCRMS

Figure F9.1-6 intentionally deleted.

Refer to Plant Drawing M-54-0 in DCRMS



P-0047-1, REV. 4

REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

FUEL PREPARATION MACHINE
SHOWN INSTALLED
IN FUEL POOL

UPDATED FSAR

FIGURE 9.1-7

THIS FIGURE HAS BEEN DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

NEW FUEL INSPECTION STAND

UPDATED FSAR SHEET 1 OF 1
REVISION 10 SEPTEMBER 30, 1999 FIG 9.1-8

THIS FIGURE HAS BEEN DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CHANNEL BOLT WRENCH

UPDATED FSAR SHEET 1 OF 1
REVISION 10 SEPTEMBER 30, 1999 FIG 9.1-9

THIS FIGURE HAS BEEN DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CHANNEL HANDLING TOOL

UPDATED FSAR SHEET 1 OF 1
REVISION 10 SEPTEMBER 30, 1999 FIG 9.1-10

THIS FIGURE HAS BEEN DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

FUEL POOL SLIPPER

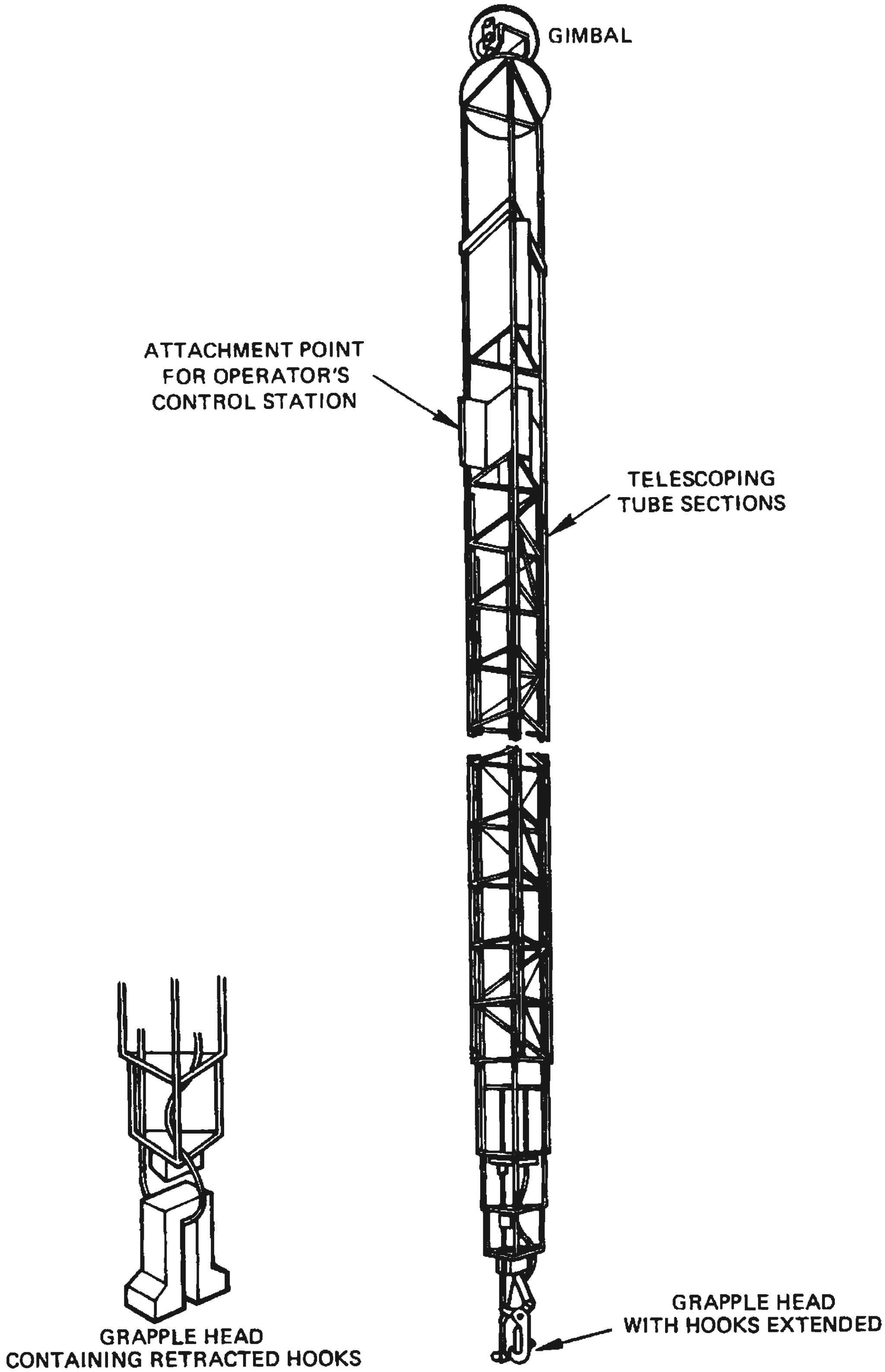
UPDATED FSAR SHEET 1 OF 1
REVISION 10 SEPTEMBER 30, 1999 FIG 9.1-11

THIS FIGURE HAS BEEN DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

CHANNEL GAUGING FIXTURE

UPDATED FSAR SHEET 1 OF 1
REVISION 10 SEPTEMBER 30, 1999 FIG 9.1-12



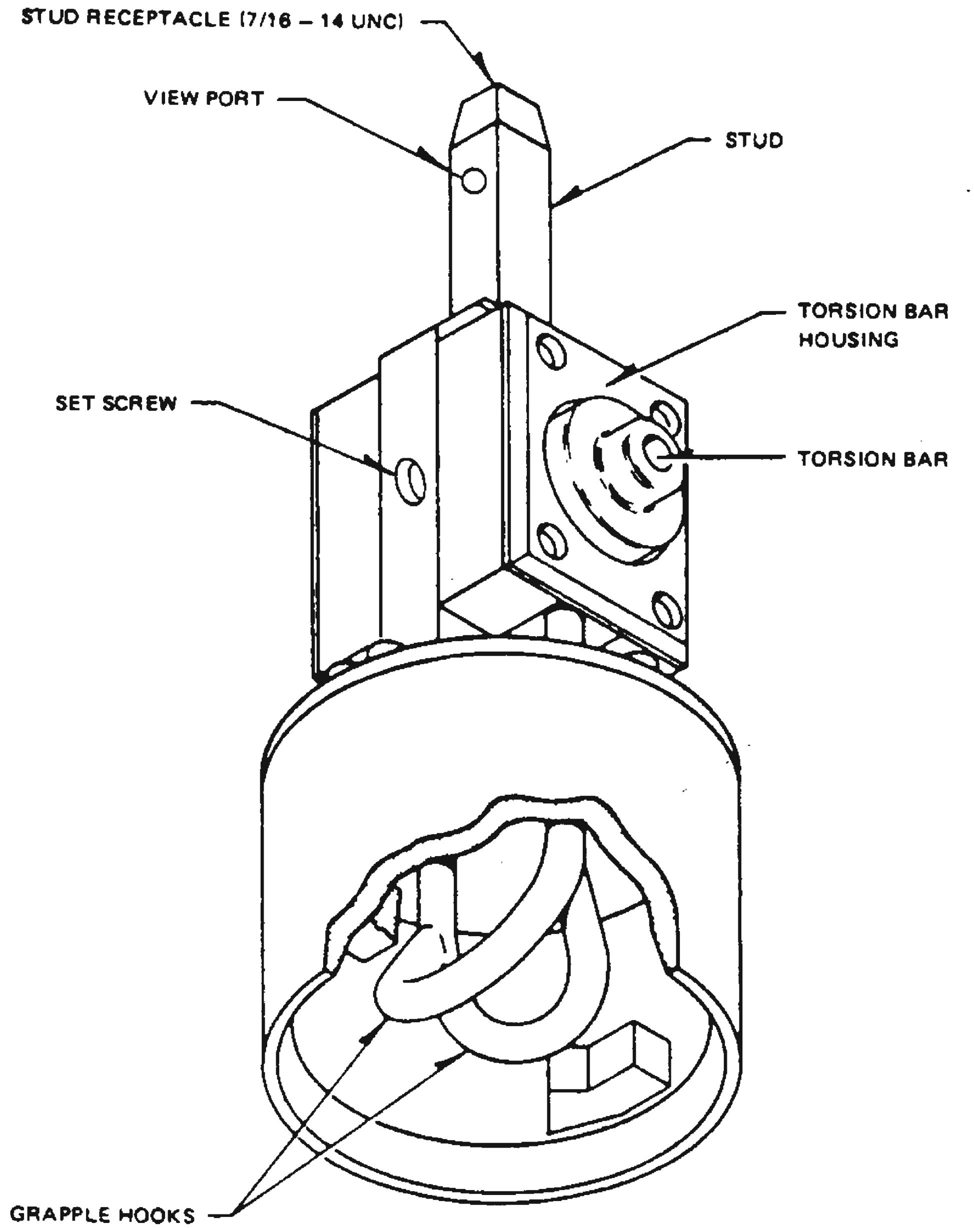
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

FUEL GRAPPLE

UPDATED FSAR

FIGURE 9.1-13



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

GENERAL PURPOSE GRAPPLE

UPDATED FSAR

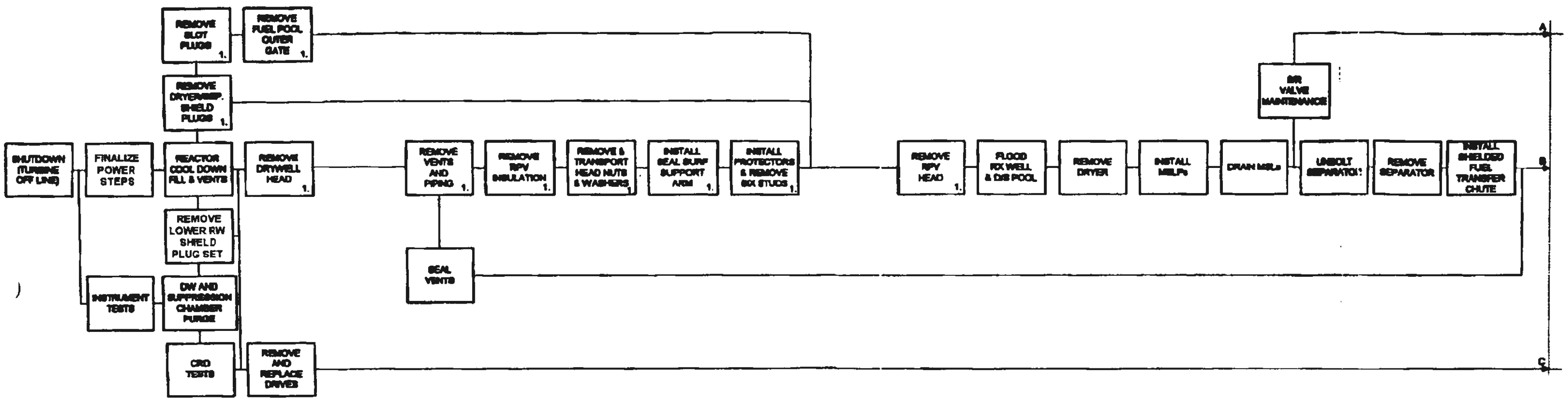
FIGURE 9.1-14

THIS FIGURE HAS BEEN DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

FUEL INSPECTION FIXTURE

UPDATED FSAR SHEET 1 OF 1
REVISION 10 SEPTEMBER 30, 1999 FIG 9.1-15

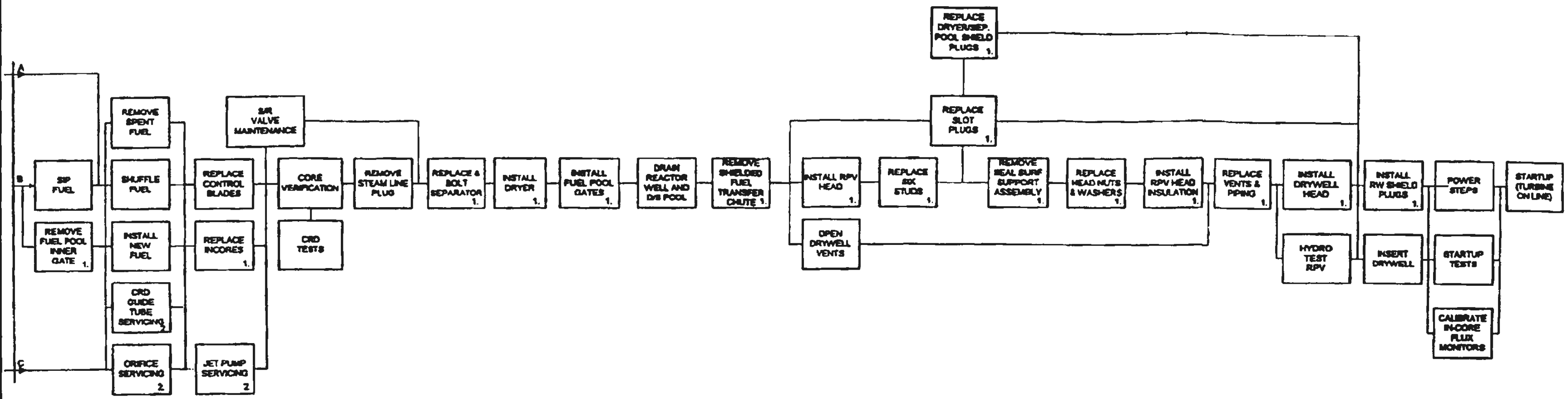


PSEG Nuclear, LLC
HOPE CREEK NUCLEAR GENERATING STATION

REFUELING OUTAGE
FLOW DIAGRAM

Updated FSAR
Revision 11, November 24, 2000

Sheet 1 of 2
Figure 9.1-15



NOTES:
1. REACTOR BLDG. CRANE REQ'D DURING OPERATION.
2. ADDITIONAL NON-ROUTINE OPERATION TO BE PERFORMED AS REQUIRED.
3. HEAVY LINE BETWEEN OPERATIONS INDICATES ANTICIPATED CRITICAL PATH DURING NORMAL OUTAGE.
4. THIS DIAGRAM SHOWS THE TYPICAL REFUELING ACTIVITIES. DEVIATIONS FROM THIS SEQUENCE ARE PERMISSABLE, AS CONSTRAINED BY OPERATING CONDITIONS, WHEN AUTHORIZED BY APPROVED STATION PROCEDURES.

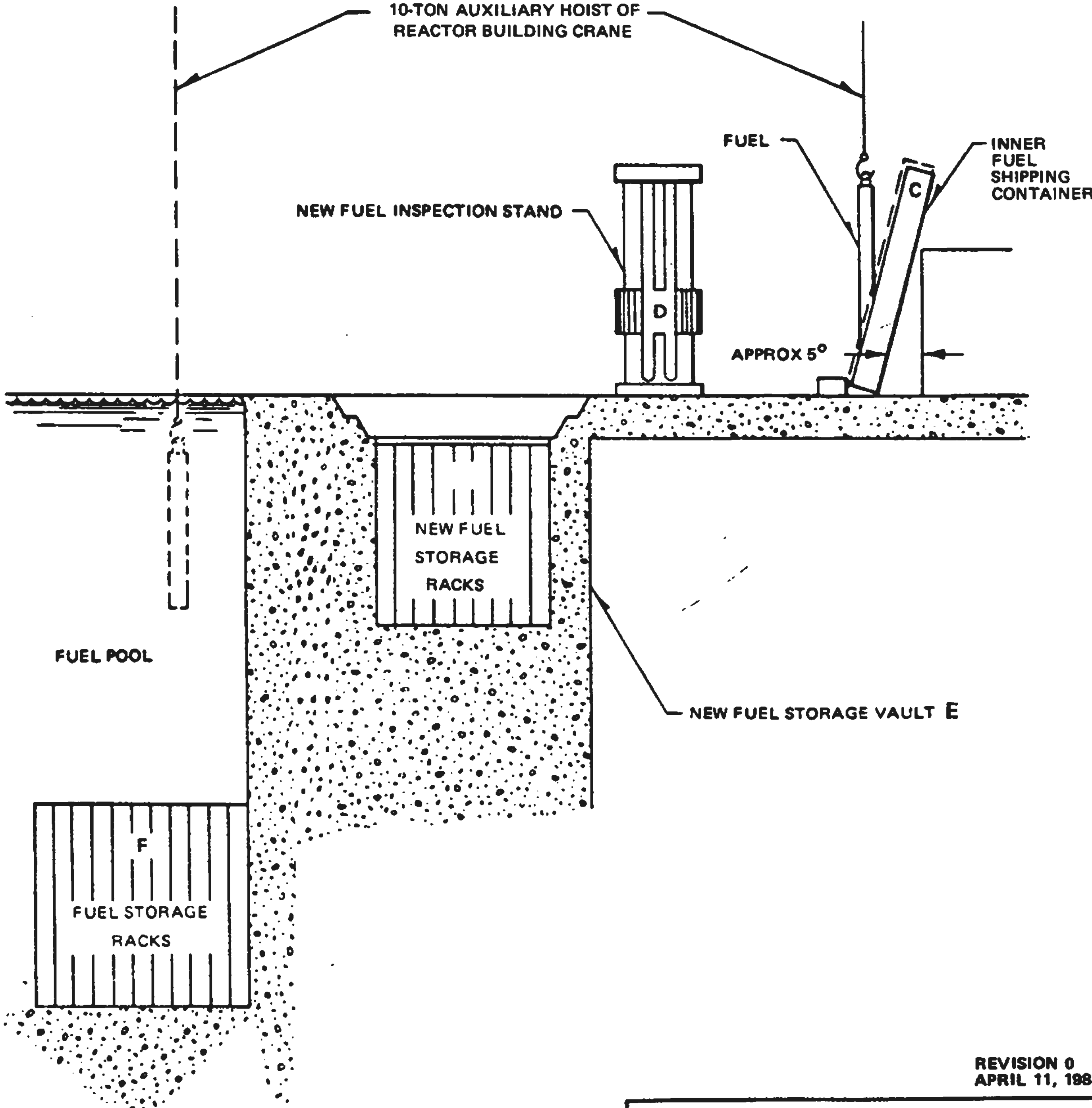
PSEG Nuclear, LLC
HOPE CREEK NUCLEAR GENERATING STATION

REFUELING OUTAGE
FLOW DIAGRAM

Updated FSAR — Sheet 2 of 2
Revision 11, November 24, 2000 — Figure 9.1-16

Figure F9.1-17 intentionally deleted.

Refer to Plant Drawing P-0047-1 in DCRMS



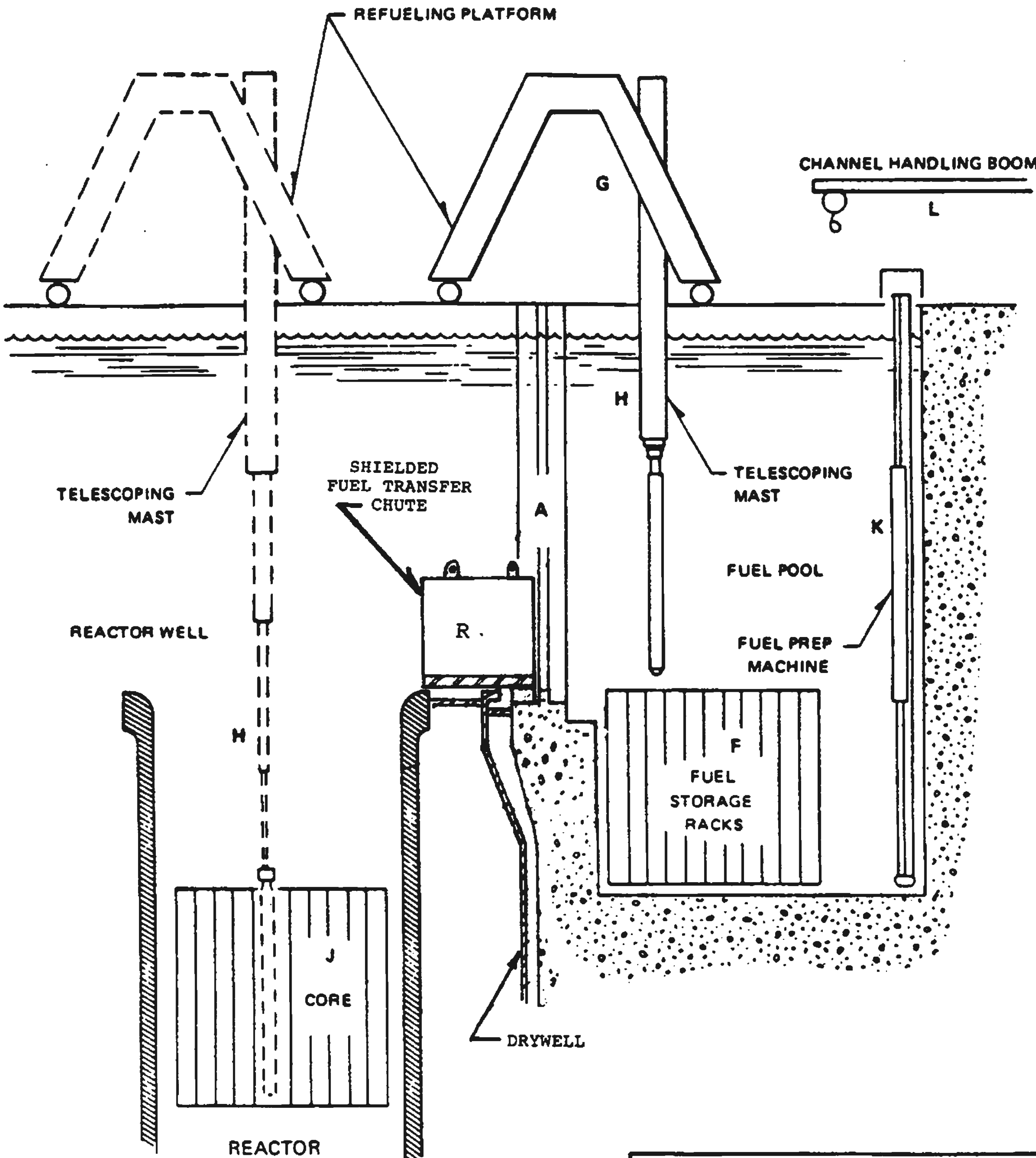
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

SIMPLIFIED SECTION OF NEW FUEL HANDLING FACILITIES SECTION X-X, FIGURE 9.1-17

UPDATED FSAR

FIGURE 9.1-18

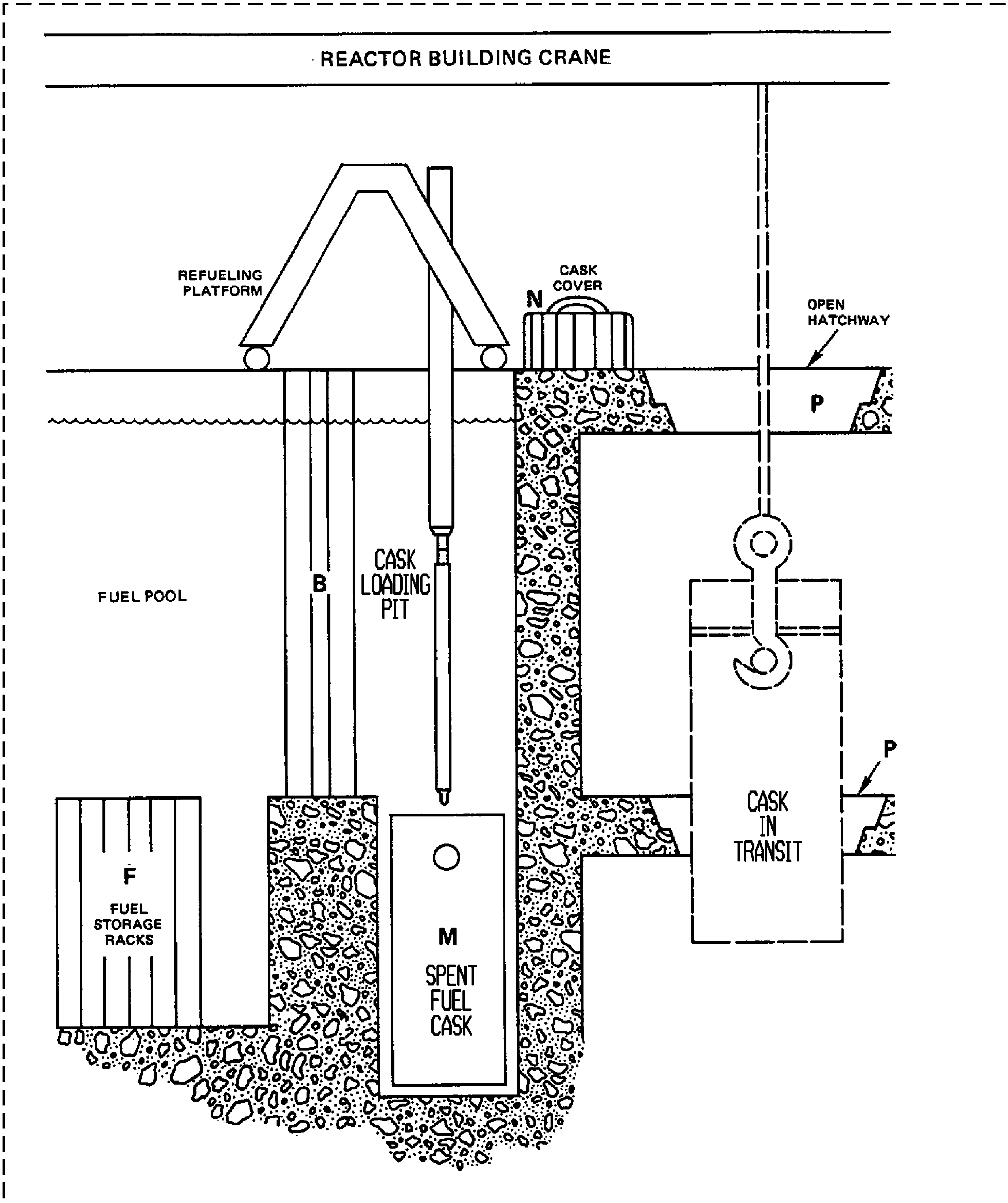


PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

SIMPLIFIED SECTION OF REFUELING FACILITIES
SECTION Y-Y, FIGURE 9.1-17

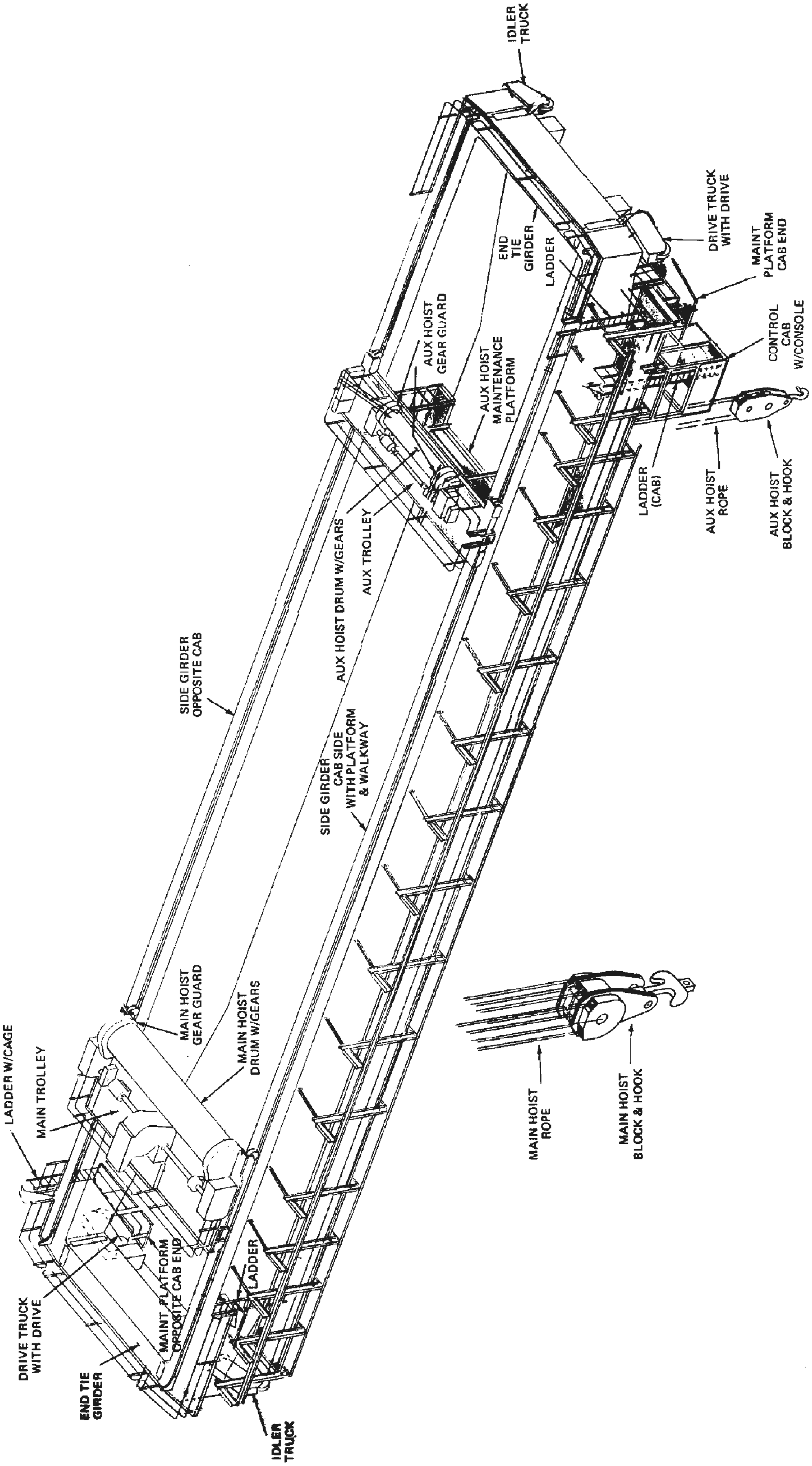
UPDATED FSAR
REVISION 1, APRIL 11, 1989

FIGURE 9.1-19



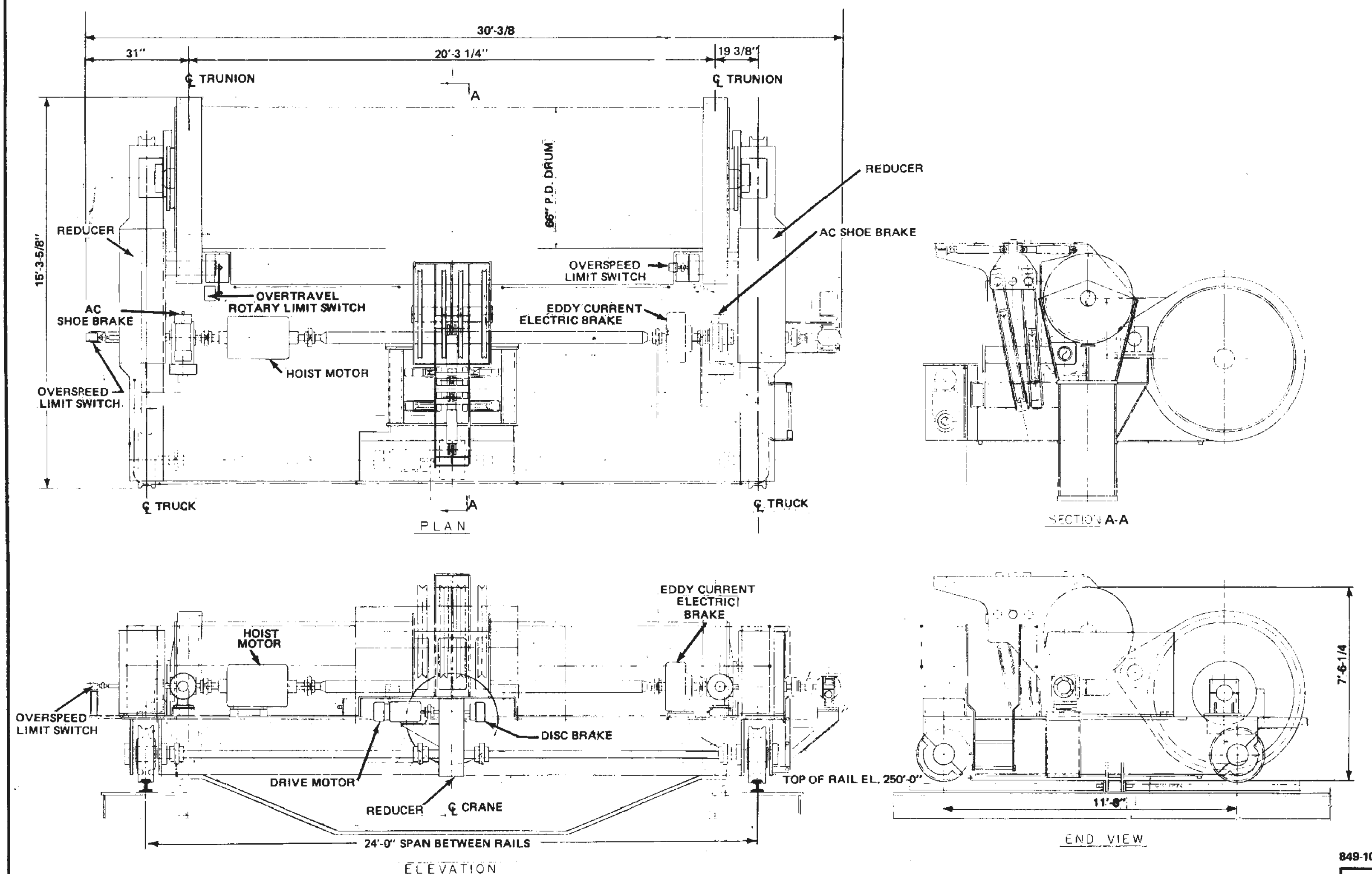
Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SIMPLIFIED SECTION OF SPENT FUEL CASK FACILITIES SECTION Z-Z, FIGURE 9.1-17
	Updated FSAR Figure 9.1-20



Revision 14, July 26, 2005

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station REACTOR BUILDING POLAR CRANE ARRANGEMENT - OUTLINE
	Updated FSAR Figure 9.1-21



849-100-02E, REV.4

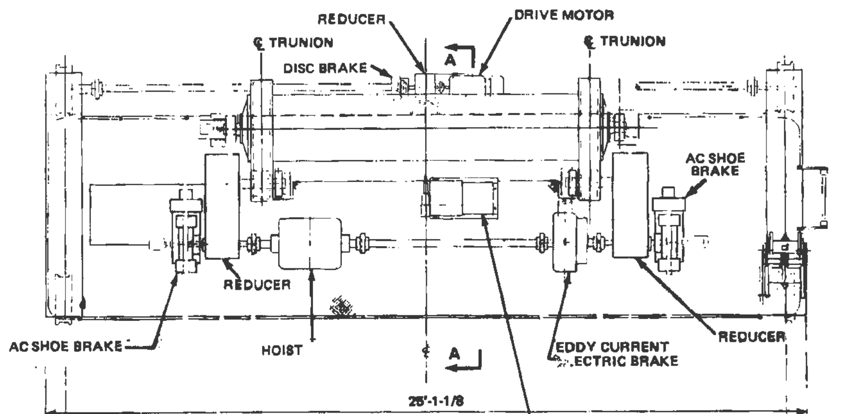
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

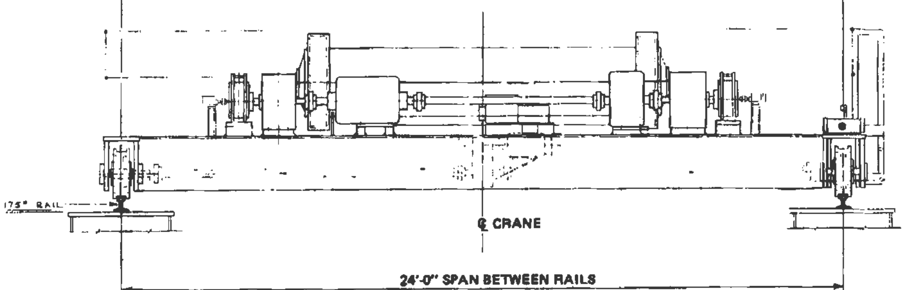
REACTOR BUILDING POLAR CRANE
MAIN TROLLEY LAYOUT

UPDATED FSAR

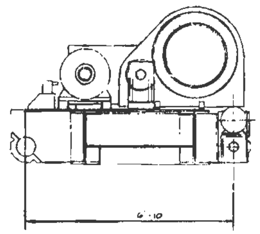
FIGURE 9.1-22



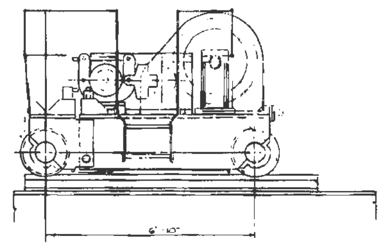
PLAN



ELEVATION



SECTION A–A



END VIEW

849-100-03E REV. 4

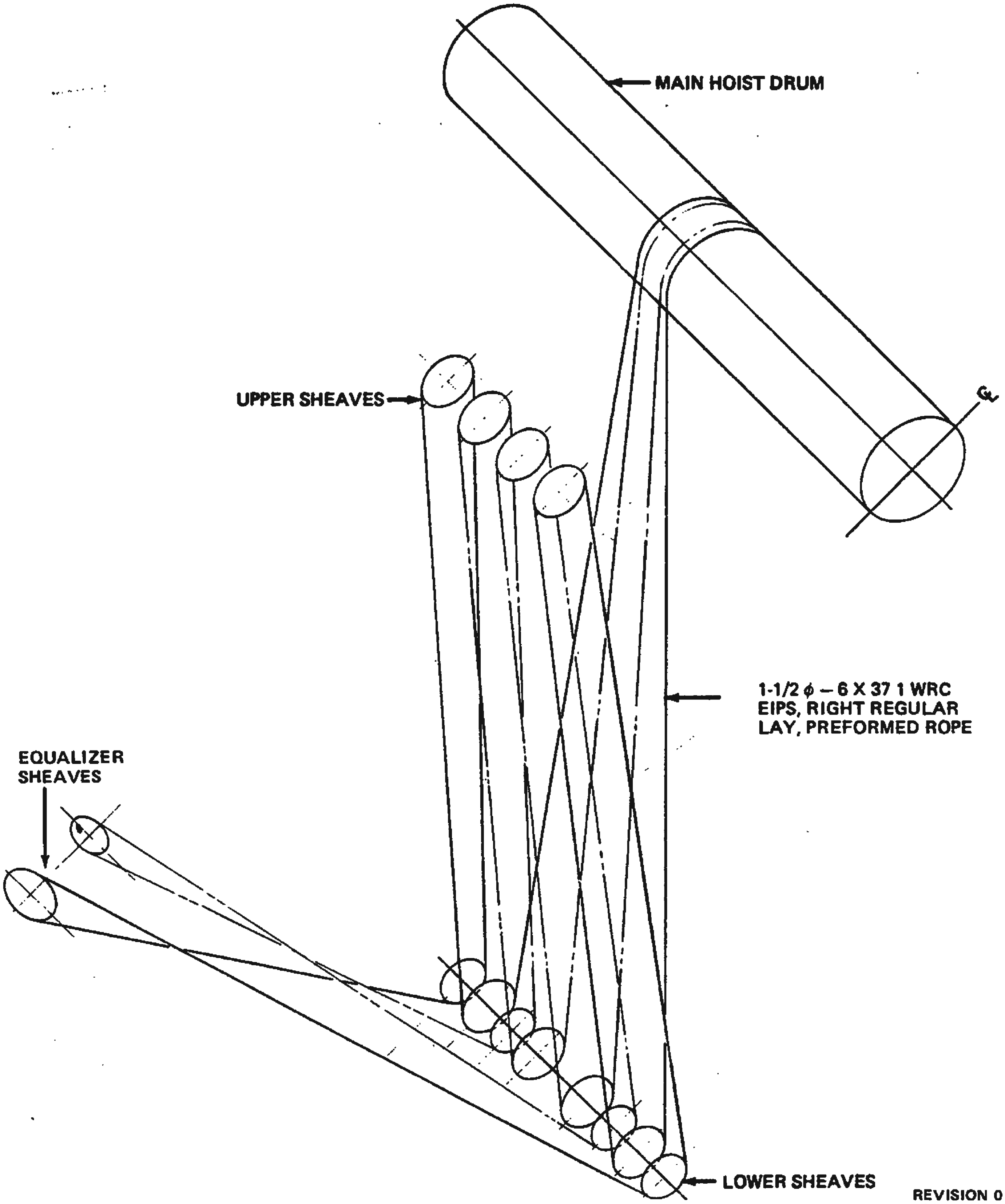
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE AUXILIARY TROLLEY LAYOUT

UPDATED FSAR

FIGURE 9.1-23



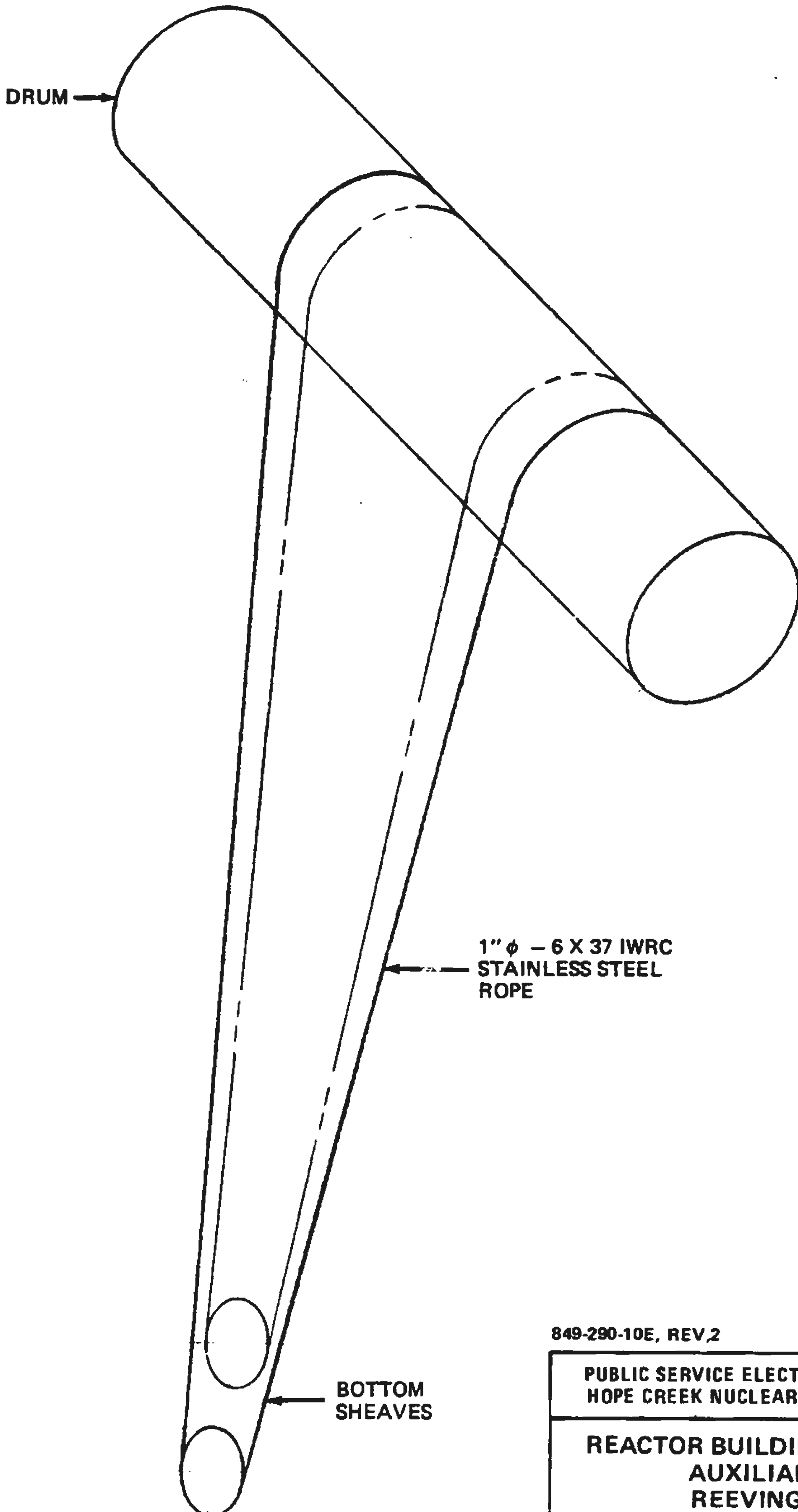
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
MAIN HOIST
REEVING SYSTEM

UPDATED FSAR

FIGURE 9.1-24



849-290-10E, REV.2

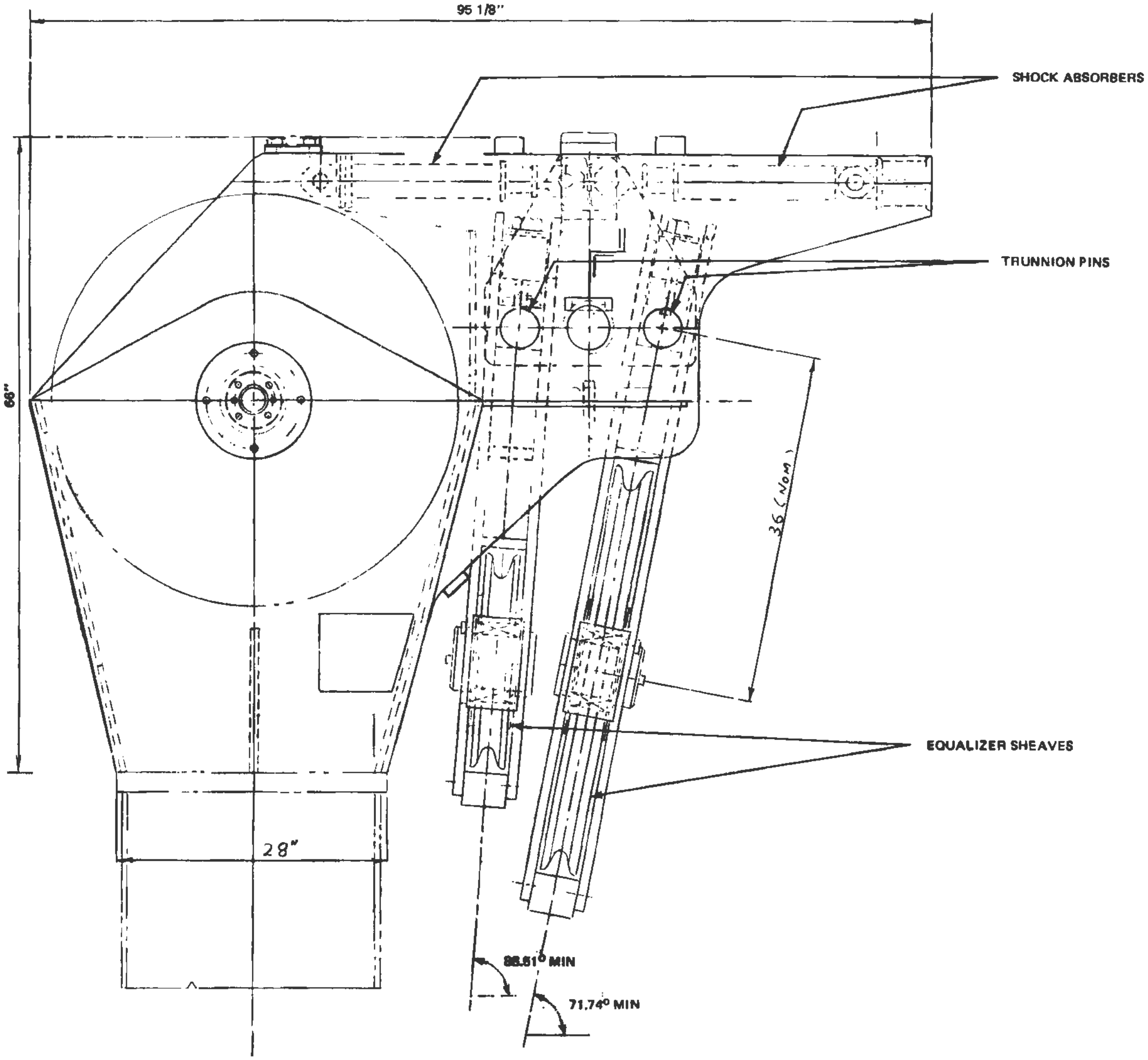
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
AUXILIARY HOIST
REEVING SYSTEM

UPDATED FSAR

FIGURE 9.1-25



849-100-51E

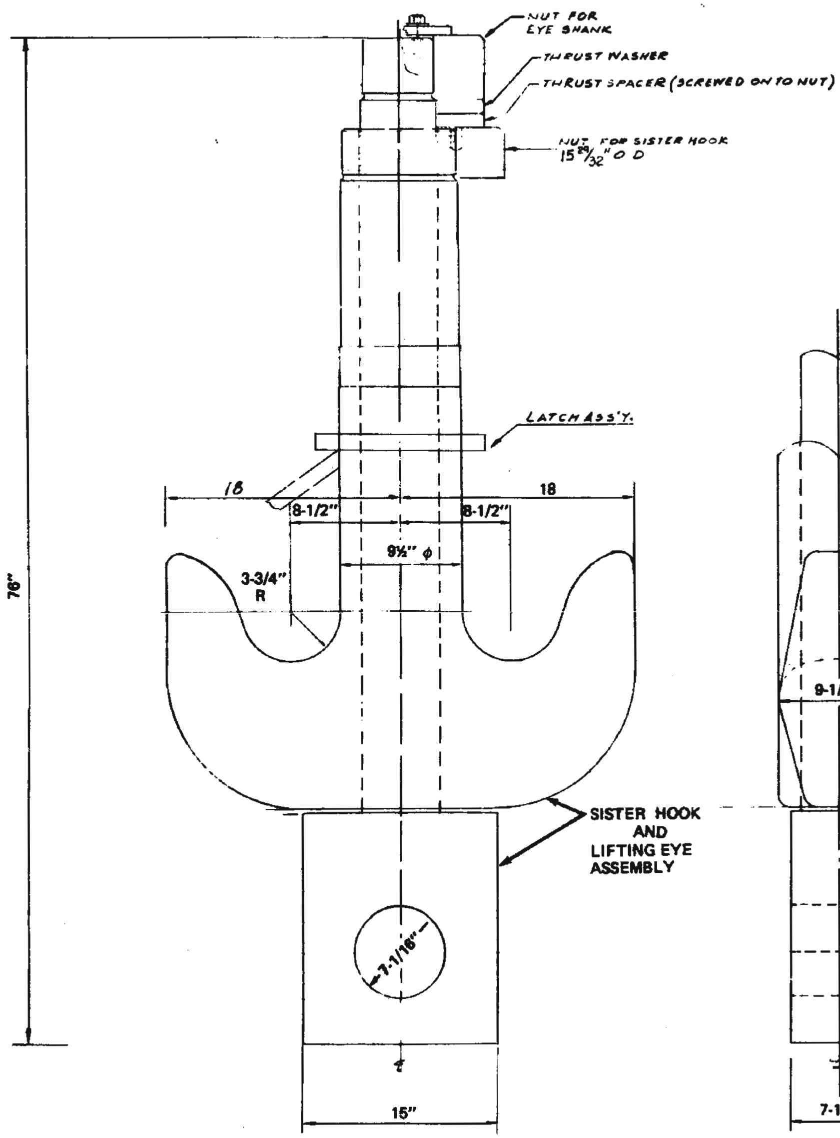
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
MAIN HOIST
EQUALIZER ASSEMBLY

UPDATED FSAR

FIGURE 9.1-26



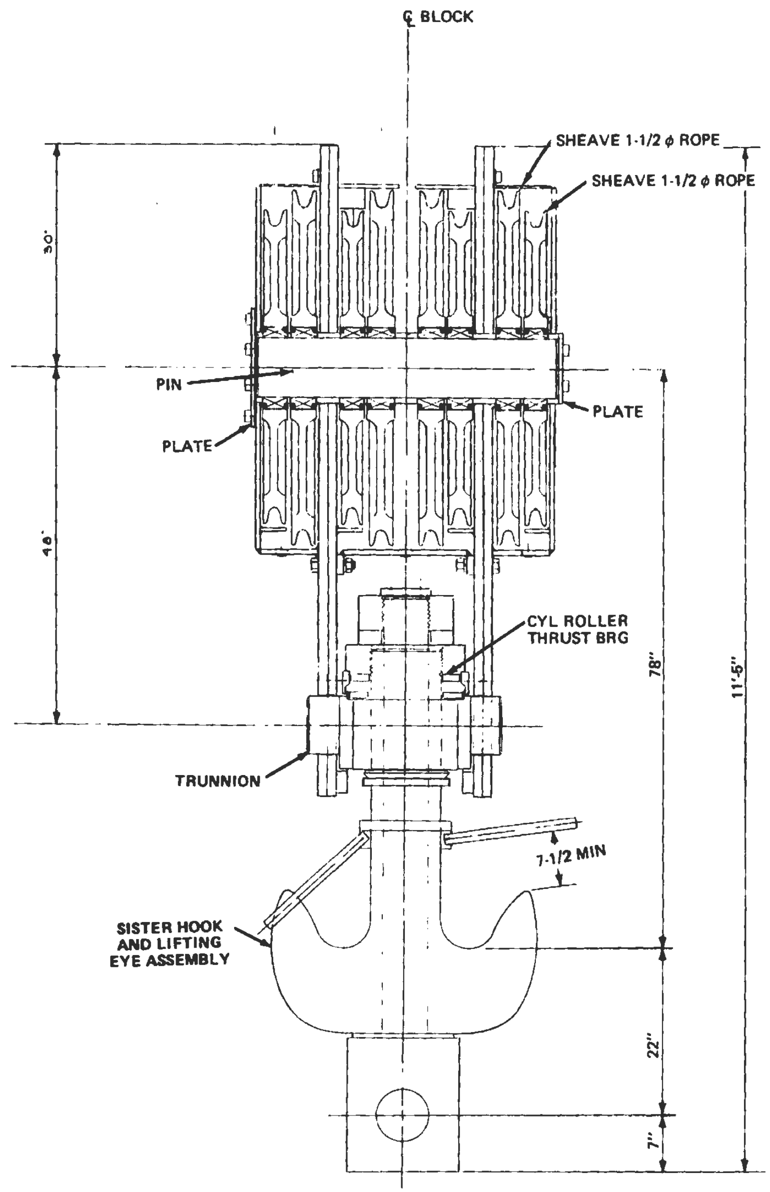
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
MAIN BLOCK HOOK

UPDATED FSAR

FIGURE 9.1-27



849-100-001E REV 3

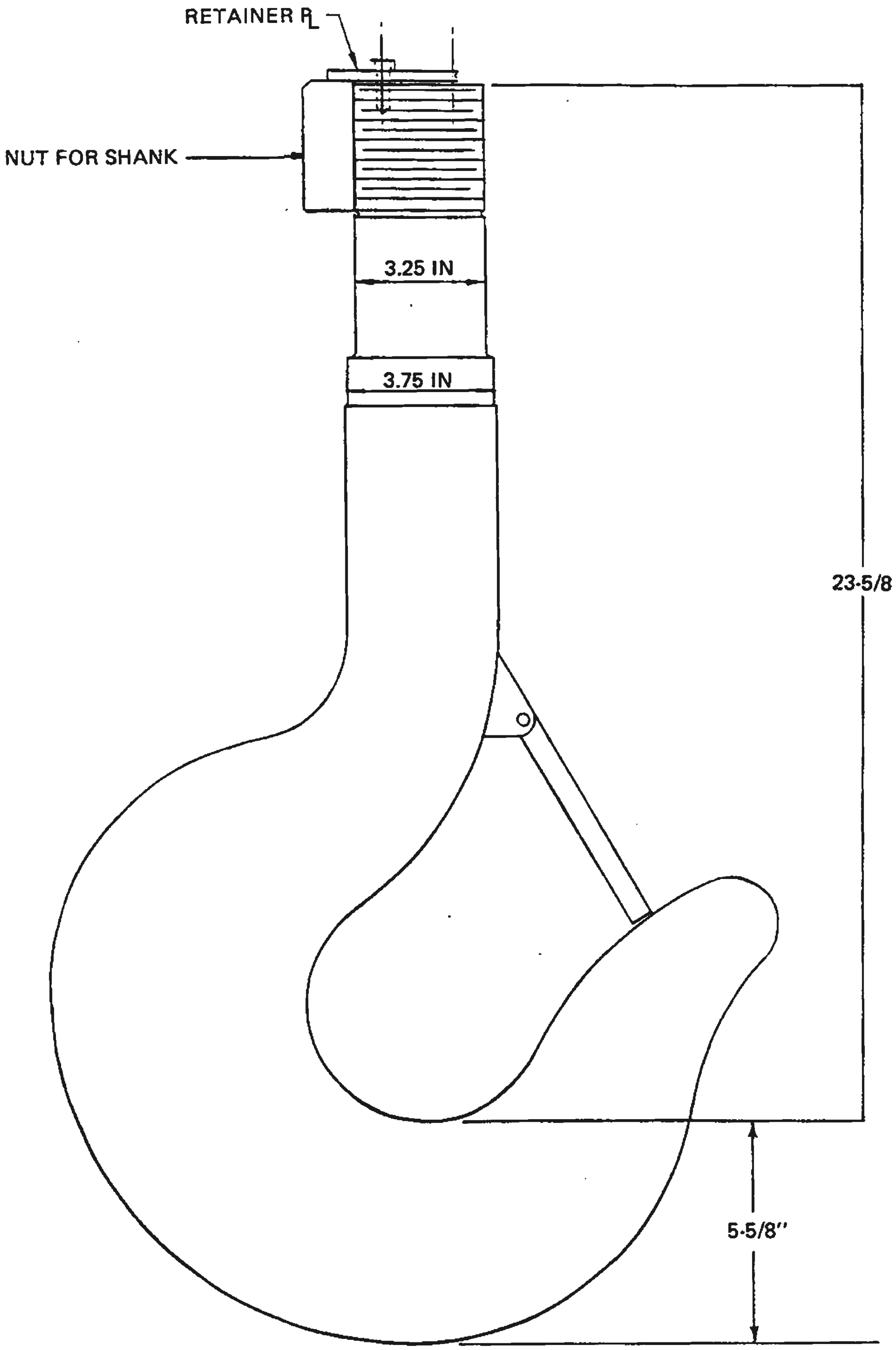
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
MAIN LOAD
BLOCK ARRANGEMENT

UPDATED FSAR

FIGURE 9.1-28



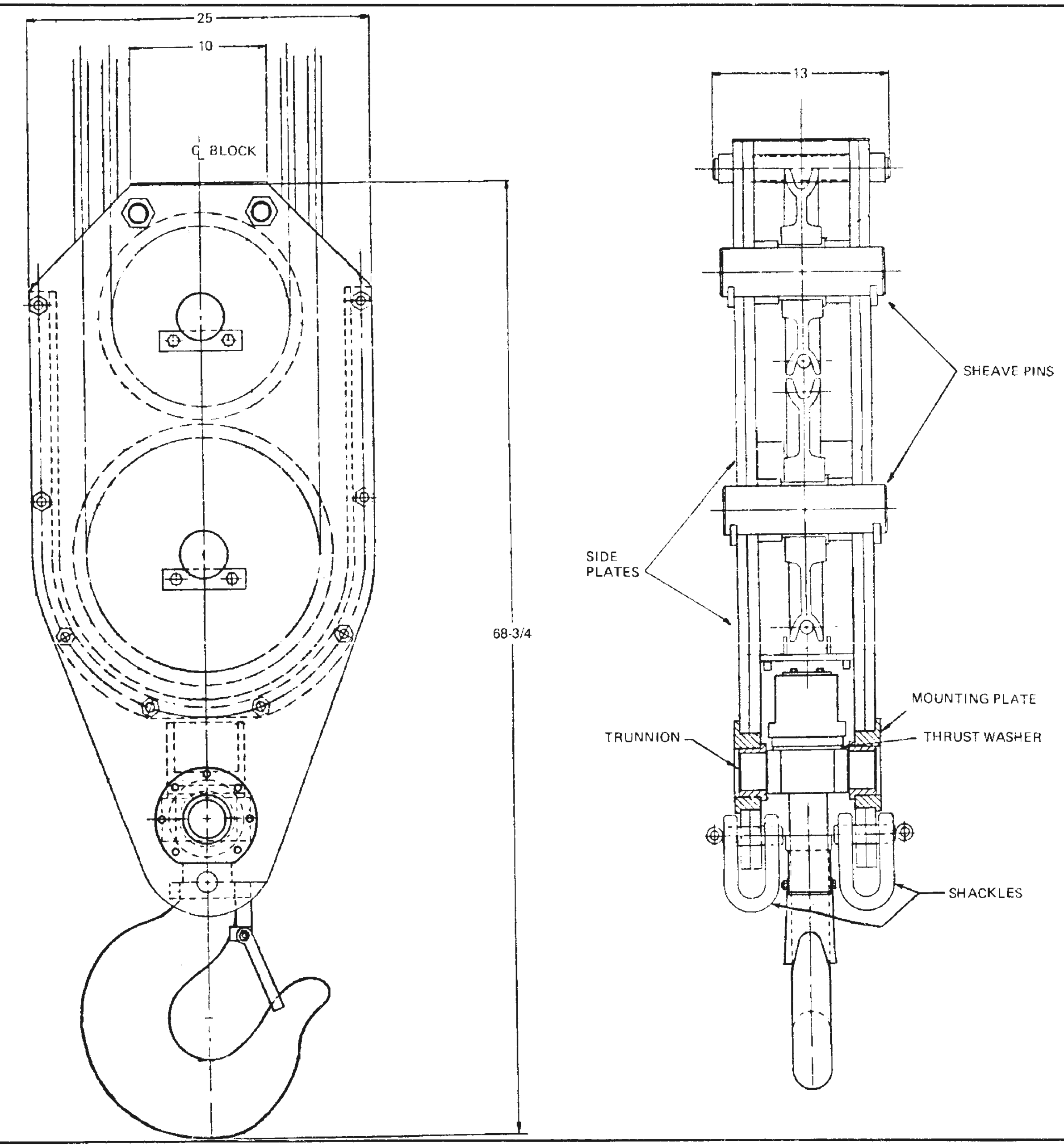
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
AUXILIARY HOIST HOOK

UPDATED FSAR

FIGURE 9.1-29



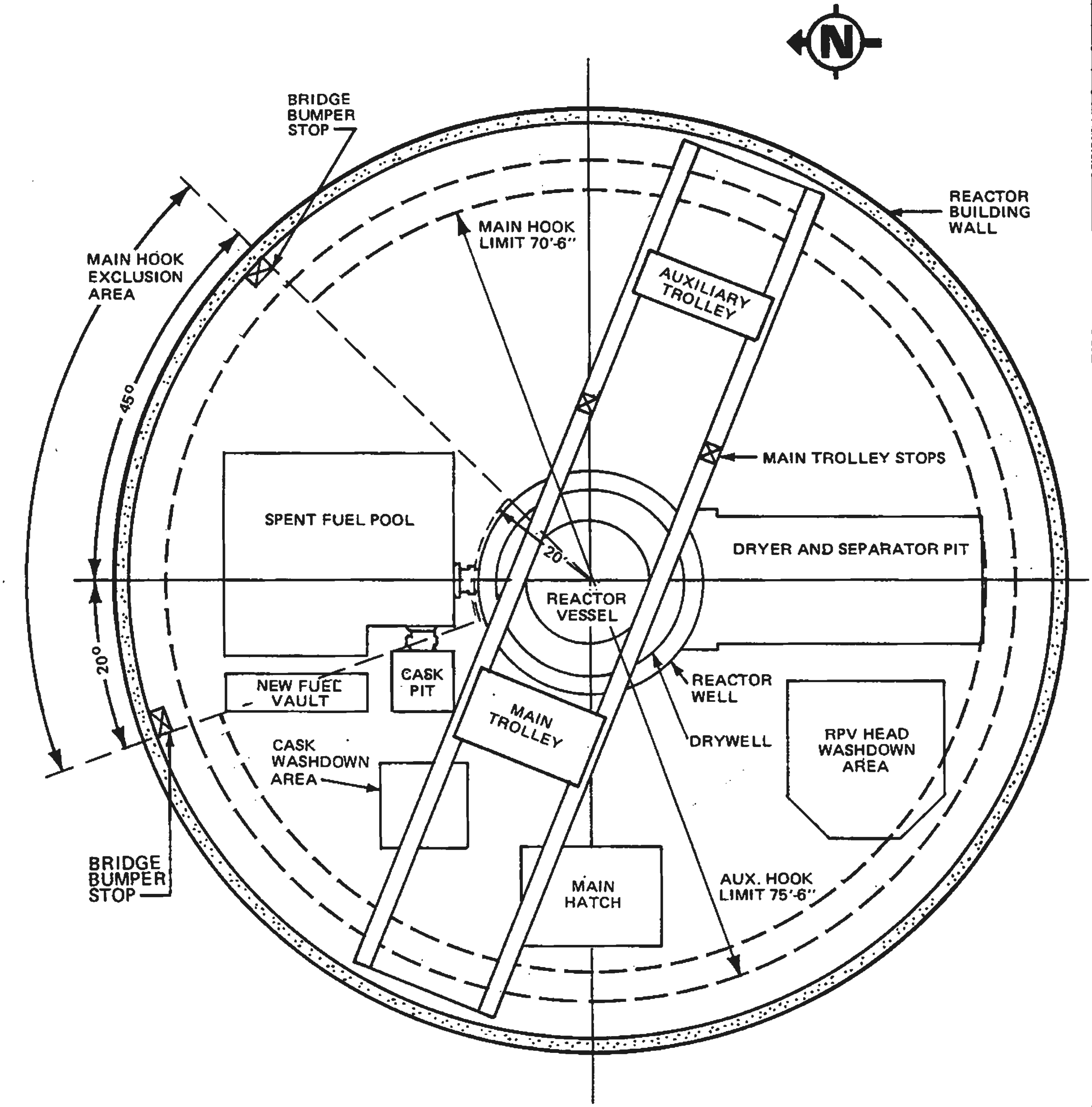
REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

REACTOR BUILDING POLAR CRANE
AUXILIARY LOAD
BLOCK ARRANGEMENT

UPDATED FSAR

FIGURE 9.1-30



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

**REACTOR BUILDING POLAR CRANE
MAIN HOOK
EXCLUSION AREA**

UPDATED FSAR — FIGURE 9.1-31

ALL SHEETS ASSOCIATED WITH
THIS FIGURE ARE DELETED

Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SAFE LOAD PATH DRAWING (EL. 201) REACTOR BUILDING POLAR CRANE 10H200
	Updated FSAR Figure 9.1-32

THIS FIGURE HAS BEEN DELETED

Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station EQUIPMENT LOCATION CONTROL & D/G AREA PLAN EL. 102'-0"
	Updated FSAR Figure 9.1-33

THIS FIGURE HAS BEEN DELETED

Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SAFE LOAD PATH DRAWING (EL. 54'-0") HPCI PUMP & TURBINE HOISTS 1AH211, 1BH211
	Updated FSAR Figure 9.1-34

THIS FIGURE HAS BEEN DELETED

Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SAFE LOAD PATH DRAWING (EL. 102'-0") TABLE 9.1-10, ITEMS 7, 8, 39, 40, 41
	Updated FSAR Figure 9.1-35

THIS FIGURE HAS BEEN DELETED

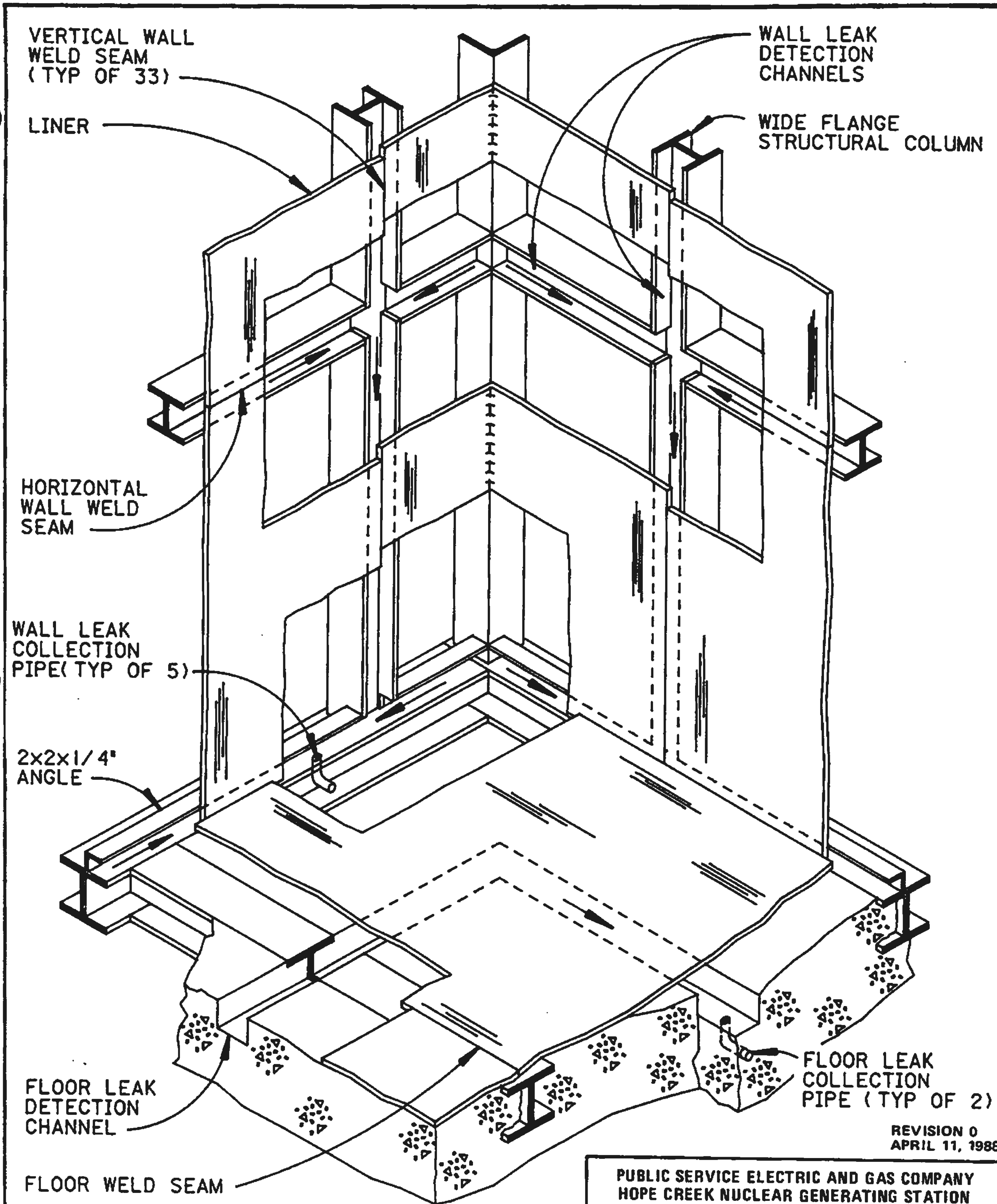
Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SAFE LOAD PATH DRAWING (EL. 102'-0") DIESEL GENERATOR CRANES 1AH400,1BH400,1CH400,1DH400
	Updated FSAR Figure 9.1-36

THIS FIGURE HAS BEEN DELETED

Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SAFE LOAD PATH DRAWING INTAKE STRUCTURE GANTRY CRANE 00H300
	Updated FSAR Figure 9.1-37



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

SPENT FUEL POOL
LINER LEAKAGE COLLECTION SYSTEM
TYPICAL DRAINAGE DETAILS

UPDATED FSAR

FIGURE 9.1-38

THIS FIGURE HAS BEEN DELETED

PSEG NUCLEAR L.L.C.
HOPE CREEK GENERATING STATION

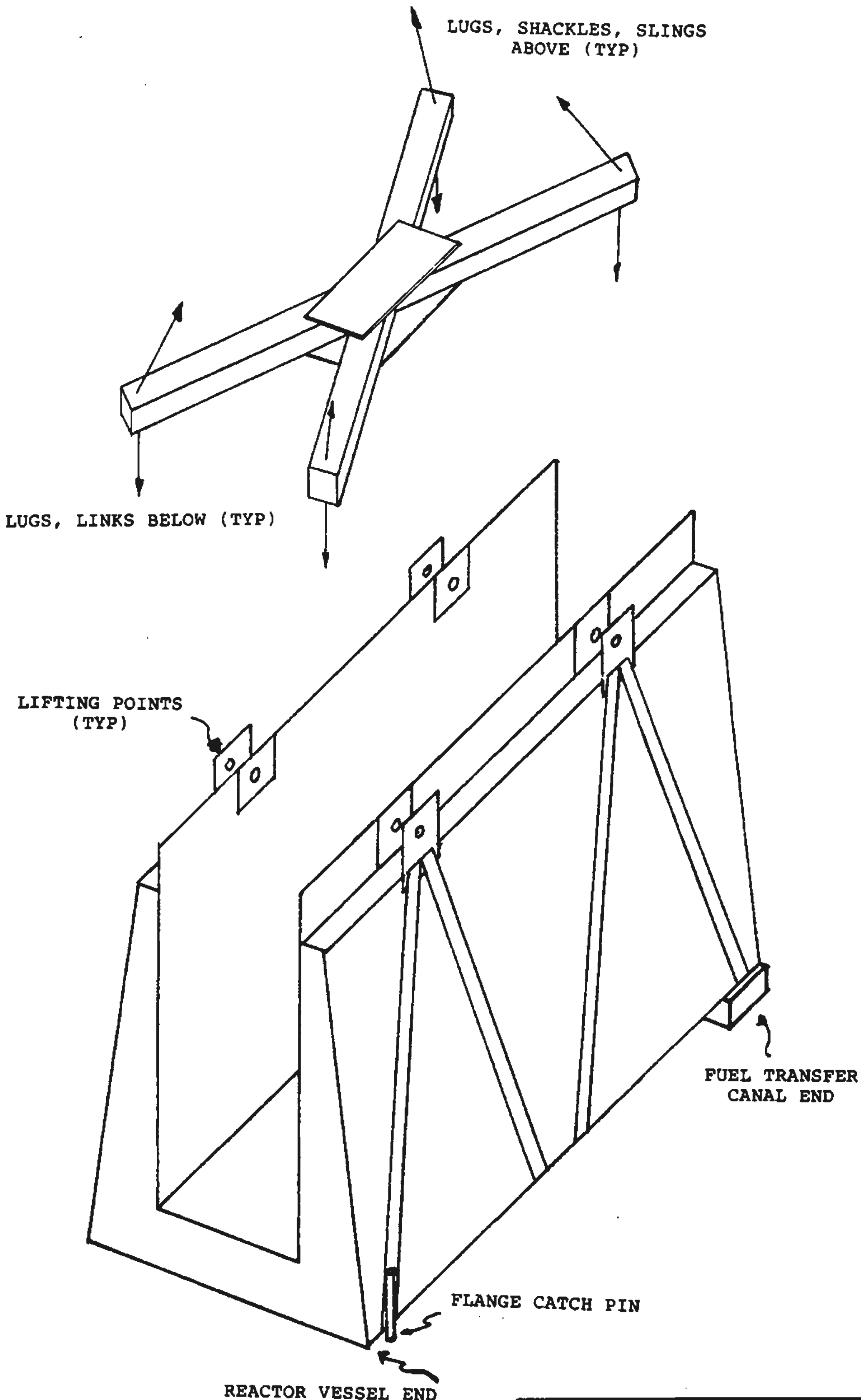
HOPE CREEK UFSAR - REV 11 SHEET 1 OF 1

November 24, 2000 F9.1-39

THIS FIGURE HAS BEEN DELETED

PSEG NUCLEAR L.L.C.
HOPE CREEK GENERATING STATION

HOPE CREEK UFSAR - REV 11	SHEET 1 OF 1
NOVEMBER 24, 2000	F9.1-40



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

SHIELDED FUEL TRANSFER CHUTE AND STRONGBACK

UPDATED FSAR
REVISION 1, APRIL 11, 1989

FIGURE 9.1-41

THIS FIGURE HAS BEEN DELETED

Revision 16, May 15, 2008

PSEG Nuclear, LLC HOPE CREEK NUCLEAR GENERATING STATION	Hope Creek Nuclear Generating Station SAFE LOAD PATH DRAWING (EL. 132'-0") CRD TRANSFER CASK JIB CRANE 10H205
	Updated FSAR Figure 9.1-42

9.2 WATER SYSTEMS

9.2.1 Station Service Water System

The Station Service Water System (SSWS) provides river water to cool the Safety Auxiliary Cooling System (SACS) heat exchangers and the Reactor Auxiliary Cooling System (RACS) heat exchangers during normal operating conditions and loss of offsite power (LOP) conditions. During a loss-of-coolant accident (LOCA) and other design basis accidents (DBAs), the SSWS provides river water only to cool the SACS heat exchangers.

9.2.1.1 Safety Design Bases

The SSWS removes heat from RACS and SACS heat exchangers and transfers the heated water to the cooling tower discharge canal. The SSWS is designed to:

1. Operate during normal plant operation and during a DBA, including a LOCA, LOP, and a LOCA with LOP conditions

2. Deliver sufficient water to satisfy the service and cooling requirements of the Turbine Building, Reactor Building, and Auxiliary Building during cold shutdown and LOP conditions.

3. Supply a connection to add trucked in fresh water or supply an emergency backup source of water, via an intertie between the SSWS and the Residual Heat Removal (RHR) System, to flood the reactor containment during post-LOCA conditions, and supply water to the fuel pool cooling and cleanup systems.

4. Have system components that are required to operate in the event of a LOCA designed to Seismic Category I and quality group C.

5. Be tornado and flood protected

6. Be heated and ventilated to maintain suitable environmental conditions in the intake structure.

9.2.1.2 Power Generation Design Bases

The SSWS is designed to deliver sufficient water to satisfy the service and cooling requirements of the Turbine Building, Reactor Building, and other buildings onsite during normal operation.

The SSWS is designed with adequate heat removal capacity so that, in conjunction with SACS, the nuclear boiler system can be brought to normal shutdown conditions in a reasonably short time. It also supplies strained water to the traveling water screens (TWSs) for screen wash and untreated river water for liquid radwaste dilution. For more detail, see Section 11.2.

The station service water intake structure and station service water intake velocities are designed to minimize equipment fouling.

9.2.1.3 System Description

The SSWS consists of two redundant loops. Each loop cools a separate SACS loop. Either one of these loops can be used for cooling the RACS heat exchangers. Each redundant loop contains:

1. Traveling water screens

2. Service water pumps

3. Service water strainers

4. Spray water pumps

5. Associated valves, piping, and instrumentation.

The SSWS components are designed in accordance with the seismic category and NRC quality groups outlined in Section 3.2. For a description of the SSWS equipment, see Table 9.2-1.

SSWS pumps and associated equipment are located in a Seismic Category I intake structure. Piping is routed through the yard to the reactor building where the RACS and SACS heat exchangers are located. A schematic flow diagram and P&ID of the SSWS are shown on Figure 9.2-1 and Plant Drawing M-10-1.

9.2.1.4 System Operation

9.2.1.4.1 Normal Operation

During normal plant operation, two station service water pumps, one in each loop, are required. The second pump in each loop is on standby and starts when the operating pump in that loop fails.

River water flows through a common trash rack before going into separate pump sumps. Each sump is provided with traveling screens to prevent large debris from passing further into the system. The spray water booster pumps provide the proper pressure for cleaning the TWS.

A self-cleaning strainer downstream of each station service water pump continuously backwashes via a backwash valve. When the associated SSW pump is running, the main backwash valve opens. When the SSW pump is not running, the main backwash valve closes.

Strainer effluent is continuously supplied as a bearing lubricant to all station service water pumps, whether operating or idle. The lube water leaves the pumps from the bottom bearings to the pump sumps.

The strainer high point vent valve is normally open. The vent is hard piped to the backwash line just downstream of the backwash valve to provide continuous venting of the strainer. During a Loss of Power (LOP) the possibility exists that air can be ingested into the strainer thru the open backwash valve due to the negative pressure transient following SSWS pump trip. The normally open strainer vent valve provides the capability to continuously vent any air which is entrained in the strainer.

The hard piped strainer high point vent configuration cannot be used to vent and drain the strainer/piping. A new high point vent is provided in each strainer backwash line just upstream of the isolation valve at the common 10" fiberglass header. This vent provides the capability to drain both the backwash line and the strainer.

The strained station service water discharges through each redundant supply header to the designated SACS heat exchangers and through crosstie valves to RACS heat exchangers.

The effluent from the heat exchangers discharges through seismic lines and then to a common, non-Seismic Category I header located outside of the Reactor Building. Water from the header discharges to the cooling tower discharge canal and serves as makeup for the Circulating Water System.

River water level is indicated in the main control room.

Two temperature sensors are located at opposite ends of the intake structure inlet. The average river temperature from these sensors is indicated in the main control room. Temperature sensors are also located on the discharge of each service water pump strainer. The service water pump strainer discharge temperatures are indicated in the main control room, from which the average river water temperature can be calculated.

9.2.1.4.2 Shutdown Operation

During a normal shutdown, as many as four or as few as two station service water pumps may be required initially to supply cooling water to the four SACS and two RACS heat exchangers as needed. The number of station service water pumps or SACS and RACS heat exchangers required to be in service depends on river water temperature and which SACS and RACS heat loads are being cooled. For long term normal shutdown, only two station service water pumps are required to cool two SACS and two RACS heat exchangers.

Unavailability of one station service water loop extends the required shutdown time, but the remaining loop is sufficient to bring the plant to cold shutdown.

When the cooling tower is drained for maintenance, the effluent from the associated heat exchangers can be diverted to the blowdown line via the bypass line, or the intake structure via the de-icing water line.

9.2.1.4.3 Emergency Operation

9.2.1.4.3.1 Loss-of-Coolant Accident Concurrent with Loss of Offsite Power

During a LOCA, all four station service water pumps with corresponding strainers are automatically powered by standby diesel generators (SDGs) to provide flow through the redundant cooling water loops to the SACS heat exchangers.

Each service water pump and related components are powered from separate diesel generators. Similarly, each safety auxiliary cooling system pump is powered from a separate diesel generator.

The three valves connected to the common header supplying the RACS heat exchangers automatically close in the event of a LOCA.

9.2.1.4.3.2 Operation Following Active Failures

One station service water pump in each loop is required to satisfy minimum cooling requirements of the SACS heat exchangers in the initial phase of cooldown when RHR heat exchangers are not in service.

The Station Service Water System (SSWS) consists of two redundant loops for cooling the SACS heat exchangers. Each loop is equipped with two pumps in parallel. The second pump in each loop is on standby and starts when the operating pump in that loop fails. This permits the removal of one pump per loop, from service for maintenance without affecting the normal operation of the plant. Each pump has the capability to provide somewhat more than 50 percent of the system requirements. This capability provides sufficient margin for components operational degradation.

Operational degradation of SSWS components would be detected by observation of inadequate pressure in the system. The potential for plant disruption due to service water system component trouble is therefore minimized.

Furthermore, the SSWS is a safety-related system which is provided with emergency power and is covered by the inservice testing program described in Section 3.9.6. Under this program the pumps and valve will be periodically tested for operational performance. This testing will detect operational degradation and procedures will require repairs when the allowable degradation is exceeded.

The general design of the pump shall preclude any other operational degradation due to pump or seal leakages. Since these pumps are single stage vertical turbine type, with closed line shaft lubrication, excessive leakage is not expected.

In the event of a crack occurring in the SSWS header to the SACS heat exchangers (B1E201 and B2E201) the operator will manually isolate the SACS loop upon receipt of a low differential pressure alarm on the SSWS across the SACS heat exchangers. As discussed in Section 9.2.2.2 the SACS consists of two redundant loops with two 50 percent capacity pumps and two 50 percent capacity heat exchangers per loop. As a result, only one loop of SSWS and SACS is required to achieve safe shutdown for HCGS.

During the long term containment cooling mode, one loop with two station service water pumps operating provides sufficient cooling to satisfy the minimum requirements of the SACS heat exchangers. In this phase, only one SACS loop is needed.

The SSWS has the capability to add water to the reactor containment via an intertie between one SSWS loop and the RHR system.

9.2.1.4.3.3 Shutdown Following LOP

In the event of an LOP without a LOCA, four station service water pumps start to cool all SACS and RACS heat exchangers. However, only one SSWS loop with two pumps is required to safely shut down the plant.

A continuous vent path is located at the highest point of each SACS heat exchanger discharge pipe. This path is provided to admit air to the SSWS piping following restoration of power from a LOP. This arrangement ensures the pressure surge caused by the subsequent restart of all station service water pumps is within design limits.

9.2.1.4.3.4 Shutdown Following System Pipe Breaks

Level switches located near the floor detect internal flooding in the Reactor Building or intake structure due to leakage from breaks in the safety-related SSWS piping. The leaking SSWS loop is shut off manually, and the reactor is brought to safe shutdown using the remaining SSWS loop.

Flooding due to the leakage from breaks in the nonsafety-related piping serving the RACS heat exchangers is detected by level switches in the RACS heat exchanger room. The RACS piping is automatically isolated from the SSWS. A manual valve is available for the redundant isolation of the outlet line from the RACS heat exchangers if the motor operated valve in that line fails to close. Any leakage that adversely affects the SSWS cooling capability is detected by temperature elements in the SACS heat exchanger discharge piping. Both safety-related SSWS loops are available for plant shutdown.

In the event of a failure that causes blockage in the non-Seismic Category I discharge line to the cooling tower, station service water from the SACS heat exchangers is diverted separately to the yard through Seismic Category I lines from each redundant header. This emergency bypass line is provided with a motor operated valve (MOV) that automatically opens when the non-Seismic Category I discharge line is gradually blocked. However, for a sudden blockage, a rupture disk installed in parallel with the MOV, and rated to rupture under such conditions, allows the station service water to discharge to the yard. The station service water that is discharged to the yard drains to the

river. Localized flooding of the yard does not result in unsafe conditions or endanger any engineered safety features (ESF) or component.

9.2.1.4.3.5 Operation Upon Reactor Building High Radiation

Upon Reactor Building high radiation or refueling floor high radiation, all SSWS pumps are started automatically to cool both SACS loops, which, in turn, cool Filtration, Recirculation, and Ventilation System (FRVS) loads.

9.2.1.5 Safety Evaluation

Each of the two redundant SSWS loops is physically separated and protected from the other to eliminate the possibility of a single event causing the loss of the entire system.

Each SSWS pump, its associated automatic MOV, and TWS form a load group that receives power and control power supplies from a corresponding channel of Class 1E power systems.

The SSWS pumps are located in a Seismic Category I intake structure and installed to ensure adequate submergence, 4-1/2 feet below the design low low water level (el. 76’-0”). The available NPSH at minimum Technical Specification level at elevation 80 ft. (submergence 8.5 ft.) is 39 ft. The pumps have been tested to perform satisfactorily at the required flow rate at these conditions. Plant Technical Specifications require a plant shutdown when river water level reaches 80 ft. PSEG datum. The river water level is used in the ultimate heat sink temperature analyses. (For high and low level ultimate heat sink, see Table 9.2-2.) The four station service water pumps, two pumps in each of two compartments, are each installed in a separate bay in the intake structure. Each compartment is separated by walls.

The integrity of safety-related Seismic Category I buried pipe will not be impaired through soil erosion by a failure of one buried non-Seismic Category I pipe. This conclusion is based on the following conditions:

1. The Seismic Category I service water pipe is buried in

compacted backfill, which is designed not to liquefy under SSE conditions.

2. All non-Seismic Category I pipes are located above the Seismic Category I pipes.

   The non-pressure pipes (gravity lines), such as the storm lines, do not pose a significant soil erosion problem due to the low operating pressure they are subjected to.

   Failure of the non-Seismic Category I pressure pipes may create progressive erosion in the backfill. However, these pipes are, in general, located either close to the ground surface or sufficient distance away from Seismic Category I pipes such that postulated "wash out" of backfill does not adversely affect the integrity of the adjacent Seismic Category I pipes.

   In the areas where large non-Seismic Category I pipes cross over the Seismic Category I pipes, additional protection has been provided. Protection is provided by either encasing the non-Seismic Category I pipes in a guard pipe or in concrete for a distance of 15 feet on either side of the Seismic Category I pipes. This precludes the occurrence of soil erosion in the area of buried safety-related pipes.

3. Instrumentation would give an indication in the control room if a break occurred in certain non-Seismic Category I pressure pipes. For example, loss of flow from the makeup water line to the cooling tower would result in an alarm in the control room when low level is reached in the cooling tower basin. Another example is that low pressure in the fire lines following a break, starts a fire pump that gives an alarm in the control room without a fire signal. Therefore, this alarm would provide an indication to initiate the necessary repairs.

Microbiological growth in the SSWS is prevented by the injection of a dilute solution of sodium hypochlorinate (NaOCl).

All piping and equipment, except TWSs, are manufactured of corrosion resistant material. TWSs are provided with cathodic protection.

To prevent freezing, all valves and a majority of the piping for the SSWS are located inside areas served by Seismic Category I, Class 1E heating systems. The remainder of the piping is buried below the frost line to ensure protection against freezing.

A passive failure in one compartment does not affect redundant equipment in the adjacent compartment.

The TWSs are designed to Seismic Category I criteria. In the event of a failure of a single TWS, water is still supplied by the remaining screen pump combinations.

Motors are protected to the design flood protection level for ESF systems. See Section 3.4 for flood levels. Pump suction is protected against damaging debris by trash racks and traveling screens. A skimmer wall prevents entrance of an oil slick or ice into the structure.

Isolation valves preclude flooding of redundant safety-related components. Leak detection provisions are included to detect single passive failures in piping. The level switches which detect flooding at the intake structure and the Reactor Building (SACS and RACS) are shown on Plant Drawing M-25-1. These switches are Seismic Category I and are powered from the Class 1E buses.

The motor operated isolation valves, operators and related instrumentation are Seismic Category I and are powered from Class 1E buses. The motor operated isolation valves isolate the RACS system and close off the SSWS loop A and loop B intertie system. The motor operated isolation valves receive isolation signals from the level switches mentioned above which detect flooding the RACS room. A manual valve is available for the redundant isolation of the outlet line from the RACS heat exchangers if the motor operated valve in that line fails to close.

GDC 64 and SRP Section 9.2.1 specify that the station service water system (SSWS) should have the capability to detect and control leakage of radioactive material contamination into and out of the system. This requirement is not applicable to the SSWS for HCGS because this system does not directly provide cooling to components susceptible to radioactive leakage into the systems. All such components are cooled by intermediate cooling system, SACS and RACS.

The SACS is monitored continuously downstream of the RHR heat exchanger to detect leakage of radioactivity into the system. If the operating SACS loop should become contaminated due to leakage from the RHR heat exchangers or the fuel pool heat exchanger, then the radiation monitors will alarm in the main control room. The operator will then manually secure the operating SACS loop pumps which initiates isolation of the affected SACS loop and automatic startup of the standby SACS loop. Radiation monitors are shown on Plant Drawing M-11-1, Sh. 1.

The RACS, which provides cooling to the non-safety related components, is monitored continuously at the outlet of the RACS pumps (See Plant Drawing M-13-1) to detect leakage of radioactivity into the systems. If RACS water should become contaminated due to the leakage from one of its components, then the radiation monitor will alarm in the main control room. Operator action will then be required to isolate the RACS loop from the rest of the SSW system by closing the redundant, Class 1E, motor operated valves (See Plant Drawing M-10-1).

9.2.1.6 Tests and Inspections

The system is hydrostatically tested prior to the station operation. All active components, e.g., pumps, valves, and controls, are functionally tested prior to startup and periodically thereafter. Level and frequency of inservice testing is included in Section 16, Technical Specifications.

Inservice Inspection and functional testing of the safety-related portions of the system and components will be in accordance with the examination and testing criteria of Articles IWA, IWD, IWP and

IWV of Section XI, ASME B&PV Code. (See Sections 3.9.6, Inservice Testing of Pumps and Valves, and 6.6, Inservice Inspection of ASME B&PV Code Class 2 and 3 Components.)

The specific examination and tests of the system and components will be listed in the Station Inservice Inspection (ISI) and Inservice Test (IST) program Administrative Procedures.

9.2.1.7 Instrumentation

Local instrumentation is provided at the equipment location for maintenance, testing, and performance evaluation. The station service water pump discharge header is equipped with pressure transmitters.

River water level is indicated in the main control room.

The average river water temperature can be determined by two methods. The first method utilizes two dual element temperature sensors located at opposite ends of the intake structure inlet, which is displayed in the main control room as an average of these sensors. The second method is that the station service water pump strainer discharge lines are equipped with temperature sensors, which are indicated in the main control room, from which the average river water temperature can be calculated. The station service water pump strainer method is the design basis method.

9.2.2 Safety and Turbine Auxiliaries Cooling System

The Safety and Turbine Auxiliaries Cooling System (STACS) is a closed loop cooling water system consisting of two subsystems: a Safety Auxiliaries Cooling System (SACS) and a Turbine Auxiliaries Cooling System (TACS).

The SACS, which has a safety-related function, is designed to provide cooling water to the engineered safety features (ESF) equipment, including the residual heat removal (RHR) heat exchanger, during normal operation, normal plant shutdown, loss of offsite power (LOP), and a loss-of-coolant accident (LOCA).

The TACS, which has no safety-related function, is designed to provide cooling water to the turbine auxiliary equipment during normal plant operation and normal plant shutdown.

The heat from both systems is transferred to the Station Service Water System (SSWS) via the SACS heat exchangers.

9.2.2.1 Design Bases

9.2.2.1.1 SACS

The SACS is designed:

1. To meet the safety objective despite the unavailability of one pump due to maintenance or active failure

2. To protect against a complete loss of function due to single active or passive failure during the post-LOCA cooling period coincident with LOP

3. With Seismic Category I and Quality Group C ESF components that withstand postulated accident conditions without impaired function

4. With sufficient heat removal capacity so that the nuclear reactor can be brought to cold shutdown in the required amount of time

5. So that each SACS loop is separated and protected from the other loop to eliminate the possibility of a single failure causing the loss of the entire system. The pumps and the associated motor operated valves for each loop receive power from separate and independent Class 1E ac buses. Similarly, control power for each essential loop comes from separate and independent Class 1E dc buses.

6. To include the capability of operating one loop from the remote shutdown panel

7. To withstand the most severe natural phenomenon or site related event, including earthquake, tornado, hurricane, or flood, without impaired function

8. To include the capability for full operational testing.

9.2.2.1.2 TACS

TACS is designed to provide sufficient cooling water flow at the proper temperature to meet the turbine generator auxiliaries cooling requirements during normal operation and normal shutdown conditions.

9.2.2.2 System Description

The STACS, which incorporates two subsystems, the SACS and the TACS, is shown schematically on Plant Drawings M-11-1, M-12-1 and M-14-1. Major equipment design parameters are listed in Table 9.2-3. The SACS consists of two redundant loops, A and B, with two 50 percent capacity pumps and two 50 percent capacity heat exchangers per loop. The TACS can be isolated from the SACS by two hydraulically operated butterfly valves in the discharge side and two motor operated butterfly valves in the return side headers of each SACS loop.

The SACS loop cools the following equipment:

1. RHR heat exchangers

2. RHR pump seal and pump motor bearing coolers

3. Diesel generator coolers

4. Diesel generator room coolers

5. Fuel pool heat exchangers

6. RHR pump room coolers

7. High pressure coolant injection (HPCI) pump room coolers

8. Reactor core isolation cooling (RCIC) pump room coolers

9. Core spray pump room coolers

10. Filtration, Recirculation, and Ventilation System (FRVS) coolers

11. Class 1E equipment chillers

12. Control room chillers

13. Containment instrument gas compressor coolers.

14. Post accident sampling station (PASS)

The TACS loop cools the following equipment:

1. Station service air compressors

2. Secondary condensate pump motor bearing coolers

3. Main turbine lube oil coolers

4. Electro-hydraulic control (EHC) hydraulic fluid coolers

5. Generator stator coolers

6. Generator hydrogen coolers

7. Reactor recirculation pump motor generator set coolers

8. Reactor feed pump turbine (RFPT) lube oil coolers

9. Isophase bus coolers

10. Alterrex air cooler

11. Process sampling cooler

12. Mezzanine pipe chase coolers

13. Condenser compartment coolers

14. Turbine Building chillers.

15. Heating system condensate coolers

The minimum required STACS flow rates to the various heat exchangers and coolers under different modes of operation are listed in Table 9.2-4. Flows and heat loads identified in the table incorporate Extended Power Uprate (EPU) conditions. The information is bounding for any power level up to a rated thermal power (RTP) of 3840 MWt for all components except the Generator Stator and Hydrogen coolers which are evaluated at a generator rating of 1373.1 MVA and 0.9375 power factor. STACS equipment capacities are adequate for EPU without hardware modifications.

The SACS loop coolant supply temperature is continuously monitored and controlled to the normal operating temperature range by modulating the SACS heat exchanger bypass valves. In the event of excessive temperature rise, the heat exchanger bypass valves are automatically closed to provide maximum cooling. The bypass is opened by manual initiation. The outlet SACS temperature from the SACS heat exchangers is 95°F maximum and 32°F minimum during normal operating conditions, and up to 100°F post-accident. Operability of the safety-related control room and 1E panel room chillers is assured by a back-up air/nitrogen gas bottle supply which is provided to maintain SACS flow control through the chiller condenser (see Section 9.2.7.2.3.).

Each SACS loop is equipped with its own Demineralizer Loop. SACS Demineralizer Loop A has Demineralizer Tank 1AT-203, while SACS Demineralizer Loop B has Demineralizer Tank 1BT-203. Demineralizer Loop A taps off of SACS Pump AP-210 discharge and Loop B taps off of SACS Pump DP-210 discharge. SACS water passing through either Demineralizer Loop is then returned to SACS at the suction of its respective pump, (i.e. just downstream of the SACS Heat Exchanger outlet). The Demineralizer Tanks remove impurities, reduce the conductivity, and minimize corrosion of the SACS water.

Demineralized water in the system is the process for corrosion inhibition. A chemical addition tank, which is isolated from the rest of the system by a normally closed Seismic Category I valve, is provided if, in the future, an additional means for corrosion inhibition is warranted.

The SACS is monitored continuously downstream of the RHR heat exchanger to detect inleakage of radioactivity into the system. In addition, sample points are provided at selected equipment locations to facilitate leak detection. Such leakage accumulates in the SACS expansion tank and eventually causes a high level that alerts the operator to the abnormal condition. Any overflow from the expansion tank goes to the radwaste drainage system.

The expansion tank connected to each of the two SACS loops is placed at the highest point in the system. It allows for expansion and contraction of the closed loop cooling water volume caused by temperature variation, and compensates for gains and losses of system water. Makeup water to the expansion tank is supplied from the makeup demineralized water system. The low level switch in the expansion tank opens the demineralized makeup supply valve. Thirty-five hundred (3500) gallons of water are available in each expansion tank AT-205 and BT-205 below the Class 1E low-low level alarm. This inventory of water is sufficient to make up for the water losses due to expected leakage from the system during a LOCA coupled with loss of offsite power.

In case the leakage from the system is abnormally high, a safety-related makeup supply from the SSWS and a nonsafety-related makeup supply from fire hose fill connections are available (see Plant Drawing M-10-1), so that makeup water to the SACS can be provided during emergency conditions coupled with loss of makeup supply from the demineralized water system. These makeup supplies can provide emergency makeup water to the SACS by opening Class 1E motor operated valves in the intertie lines.

The SACS also has interties from the SSWS and from a temporary fill connection that can be connected to the fire main in the Auxiliary Building, so that makeup water to the SACS can be provided during emergency conditions coupled with loss of makeup supply from the demineralized water system. To prevent inadvertent admission of station service water, each SACS loop is separated from the SSWS by two normally closed, key locked, motor operated butterfly valves.

The pipe between the butterfly valves is normally empty and continuously drained. In addition, the pipe between the butterfly valves is equipped with a high pressure alarm that detects the pressure of water resulting from leaks or inadvertent operation of an outboard butterfly valve. Furthermore, to preclude the admission of the station service water into the SACS heat exchangers, the STACS pressure is maintained higher than SSWS pressure under normal conditions.

In the event a break occurs in the system which results in a leakage exceeding the makeup supply the low-low level switch in the expansion tank activates an alarm in the main control room. The operator may manually switch the system to the standby loop. The system will be switched automatically to the standby loop upon reaching low-low-low expansion tank level. The fuel pool heat exchanger and the containment instrument gas compressor cooler cross-connecting valves will be automatically closed to isolate the leaking SACS loop. If the break is in the TACS loop, low-low-low expansion tank level in the standby loop will isolate the TACS and annunciate in the main control room.

The SACS is protected against the hydrodynamic effects of pipe breaks in the TACS. A hydropneumatic accumulator is provided at the SACS/TACS supply and return headers to protect the SACS piping from being over-pressurized due to a pressure transient resulting from a pipe break in the TACS loop. The previous design required these accumulators to be partially filled with water and covered by a nitrogen blanket on top of a floating roof. The present design with a water-solid accumulator determined that the pressure wave from the TACS to the SACS is below the allowable pressure limits of the SACS. The hydropneumatic accumulators are operated without a nitrogen blanket and the floating roof has been removed. The terminology “hydropneumatic accumulators” is retained for the TACS accumulators for historical continuity.

The response of the TACS isolation valves 1EGHV-2522A/C or 1EGHV-2522B/D following a TACS piping break are adequate to maintain the operability of the affected SACS loop.

In the event of a LOCA, LOP, or a large TACS leakage resulting in a low-low-low expansion tank level, the TACS is automatically isolated from SACS by the closure of the TACS loop isolation valves at the discharge and return sides of the SACS loops.

In the event of a LOCA coincident with LOP, all four SACS pumps and heat exchangers operate through two isolated redundant loops

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to provide cooling water to the ESF equipment. The valves supplying cooling water to the RHR pump seals and motor bearings open upon RHR pump start. Since the RHR heat exchangers do not require cooling water for at least 10 minutes, cooling to the heat exchangers is initiated manually. If the SACS supply valve to the RHR heat exchanger (1EGHV-2512 A or B) is already open, it will not need to be repositioned.

During the short term Emergency Core Cooling System (ECCS) injection phase of LOCA recovery, both SACS loops are required. No single active failure, including spurious valve actuation, disables either loop in the short term.

During the long term primary containment cooling mode of recovery from LOCA, one loop with two SACS pumps operating provides sufficient cooling to satisfy the minimum requirements of the RHR heat exchangers and other ESF equipment. The system design therefore provides protection against complete loss of function resulting from a single active or passive failure during this period.

During normal plant shutdown or shutdown following LOP, both SACS loops operate with two pumps and two heat exchangers in each loop to provide cooling to the ESF equipment. However, one SACS loop can provide sufficient cooling water to satisfy the minimum cooling requirements.

9.2.2.3 Safety Evaluation

All safety-related components, including supporting structures, of the SACS are designed to Seismic Category I requirements as defined in Section 3.2.1. The piping is designed, fabricated, inspected, and tested in accordance with the requirements of ASME B&PV Code, Section III, Class 3. The SACS pumps, heat exchangers, expansion tank, hydropneumatic accumulators, and related piping are housed within the reactor building and the auxiliary building, both of which are designed to the Seismic Category I requirements

discussed in Section 3.8. The SACS is discussed with respect to the following areas in separate FSAR sections:

1. Flood protection - Section 3.4

2. Internally generated missile protection - Section 3.5

3. Pipe whip protection - Section 3.6

4. Fire protection - Section 9.5

5. Onsite power systems - Section 8.3.

Each SACS loop is located in a different room. Power is supplied from four independent divisions. Failure of either a motor operated valve (MOV), standby diesel generator, electrical division or pump does not prevent the system from removing the full heat load. This arrangement ensures that the full heat removal capacity required is available after a postulated single active failure.

The TACS has no safety-related function. Failure of the system does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant. In the event of a LOCA, LOP, or a pipe break, TACS is isolated from the SACS.

9.2.2.4 Test and Inspection

The SACS is tested in both the preoperational test phase and power ascension test phase. Test abstracts for these tests are described in Sections 14.2.12.1.16 and 14.2.12.3.38.

Inservice Inspection and functional testing of the safety-related portions of the system and components will be in accordance with the examination and testing criteria of Articles IWA, IWD, IWP and IWV of Section XI, ASME B&PV Code. (See Sections 3.9.6, Inservice testing of Pumps and Valves, and 6.6, Inservice Inspection of ASME B&PV Code Class 2 and 3 Components).

The specific examination and tests of the system and components will be listed in the Station Inservice Inspection (ISI) and Inservice Test (IST) Program Administrative Procedures.

9.2.2.5 Instrumentation Applications

The SACS is designed for remote operation from the main control room. In addition, one loop of the SACS and its associated valves can be operated from the remote shutdown panel.

Local and remote indications are provided to monitor process parameters of the system. The following conditions are annunciated in the main control room:

1. High-high/low-low level in the expansion tank
2. Pump motor high temperature
3. Pump/motor shaft excessive vibration
4. Deleted
5. Low differential pressure across the RHR pump seal cooler
6. Low differential pressure across the RHR pump motor bearing cooler
7. Low differential pressure across the SACS pumps
8. High water temperature in the SACS.

9.2.3 Makeup Demineralizer System

The demineralized water makeup, storage, and transfer system is designed to demineralize fresh water from the station wells, store

the demineralized water, and deliver demineralized water to plant services, as required.

9.2.3.1 Design Basis

The Makeup Demineralizer System has no safety-related function and does not transport radioactive fluids. It is designed to provide an adequate supply of demineralized water for the plant makeup and operating requirements.

The system is required to provide demineralized water to various plant systems for flushing, cleaning, and filling prior to and during operation of the station.

The system is manually initiated. After initiation, the demineralizer sequence is controlled automatically or in manual provided adequate controls are in place.

The makeup demineralizers are designed to produce an effluent having the following analysis:

Conductivity, micromho/cm at 25°C(1)	≤1.0
Chlorides (as C1), ppm	≤0.05
pH at 25°C(1)	5.5 to 8
Silica (as SiO_2), ppm	≤0.02

Note:

(1) Specification prior to dissolved CO_2, correction.

The Makeup Demineralizer System is designed to non-nuclear safety codes and standards, as defined in Table 3.2-1.

9.2.3.2 System Description

The Makeup Demineralizer System consists of the following:

1. One makeup demineralizer having two trains, with each

train rated for 150 gpm. Each train consists of a cation exchanger, an anion exchanger, and a mixed bed exchanger

2. One vacuum degasifier vessel, rated for 300 gpm, complete with three 150 gpm degasifier booster pumps and three 290 scfm degasifier vacuum pumps

3. Four 50,000 gallon capacity demineralized water storage tanks

4. One demineralized water jockey pump, rated for 50 gpm

5. Two demineralized water transfer pumps, each rated for 200 gpm

6. Demineralized regeneration system that includes a resin cleaning tank, acid and caustic positive displacement pumps, caustic dilution hot water heater and associated piping, valves, and controls

7. One 50,000 gallon capacity makeup demineralizer regenerant waste tank complete with two 100 gpm regenerant waste pumps

8. Two 15,000 gallon capacity makeup demineralizer feed tanks, complete with three 150 gpm makeup demineralizer feed pumps, as shown on Plant Drawing M-17-0

9. Acid and caustic storage tanks in the condensate demineralizer system for regeneration

10. Associated piping and controls for all demineralizer operations. The piping in the demineralizer trains and diluted caustic piping is saran lined carbon steel.

    The concentrated acid and waste regenerant lines are polypropylene lined carbon steel, and the caustic lines

are stainless steel. The system is rated at a maximum pressure and temperature of 125 psig and 150°F, respectively.

The well water is pumped to the Makeup Demineralizer System from the makeup demineralizer feed tanks by the makeup demineralizer feed pumps. The flow rate through the demineralizers is controlled by a flow control valve located at the inlet to each of the four demineralized water storage tanks. A controller throttles each of the flow control valves in proportion to the respective demineralized water storage tank level.

The demineralizer is capable of either operating two trains in parallel, or operating one train while the other is regenerating. During normal operation, one train is on-line, and the other train is on standby. The standby unit is placed on-line manually, as required. Normal flow through each demineralizer train is 150 gpm.

The demineralized water system is designed to provide demineralized water intermittently to various plant components. The average daily usage of demineralized water during normal plant operation will vary from 15 gpm in summer to 30 gpm in winter months. When the plant auxiliary boiler is not operating, this usage can be reduced to approximately 5 gpm.

When the ion exchange capacity of either the mixed bed or the cation anion vessels is exhausted, the demineralizer train is automatically removed from service. If exhaustion is indicated by high conductivity or high silica content, the cation-anion bed or mixed bed undergoes an automatic, timed rinse. If proper quality is not obtained, the train shuts down automatically. Annunciation of resin exhaustion is indicated on the demineralizer system control panel by a high conductivity or a high silica content alarm. A local panel common trouble alarm is provided in the main control room.

When regeneration of one of the trains is required, the regeneration operation is initiated manually. The regeneration sequence is controlled automatically, or in manual provided adequate controls are in place, after initiation. At the end of the demineralizer regeneration, the train goes into the standby mode.

Dilute acid and caustic solutions used in the regeneration process are provided by in-line dilution of concentrated sulfuric acid and concentrated liquid caustic. The concentrated acid is pumped by one of the acid pumps to an acid mixing tee, where it is diluted with water from the demineralized water storage tank. The concentrated caustic is pumped by one of the caustic pumps to a caustic mixing tee, where it is diluted with heated demineralized water to maintain a caustic solution temperature of 104°F. From mixing tees, the diluted solution is sent to the desired demineralizer vessels for regeneration.

The regenerant waste tank collects the regeneration wastes from the regeneration process and treats it to insure that wastes are maintained at a pH level >2 and <12.5. The wastes are then pumped from the tank by regenerant waste pumps to either the truck filling area outside the north wall of the turbine building and transported to the Salem Generating Station's wastewater treatment facility or directly to the Salem treatment facility by way of an underground waste transfer line.

The demineralized water in the four demineralized water storage tanks is used to fill the condensate storage tank (CST) prior to unit operation. The demineralizer water is also used prior to unit operation for flushing and filling plant systems. During normal operation, the demineralized water is used for the following services:

1. Makeup demineralizer acid and caustic dilution
2. Turbine Building service connections
3. Turbine Building sample station

4. Turbine Building Chilled Water System makeup

5. Resin cleaning tank

6. Lube oil centrifuge hot water heater makeup

7. Service water dewatering pump seal

8. Auxiliary Building sampling station

9. Reactor Building service boxes

10. Reactor Building sample station

11. Reactor Building closed cooling water systems (Safety Auxiliaries Cooling System (SACS), Turbine Auxiliaries Cooling System (TACS), and Reactor Auxiliaries Cooling System (RACS)) makeup

12. Reactor Building Chilled Water System makeup

13. Online Noble Chemistry Injection Skid

14. Auxiliary Building service boxes

15. Standby Liquid Control (SLC) System makeup

16. Railroad bay service boxes

17. Auxiliary Building Chilled Water System

18. Stator Winding Cooling Water System makeup

19. Condenser dewatering pump seal

20. Standby diesel generator (SDG) jacket cooling water makeup

21. CST makeup

22. Auxiliary boiler makeup

23. Service area supply system humidifiers

24. Solid radwaste solidification and volume reduction systems makeup

25. Control room humidifiers

26. Technical support center air handling units.

A single header from the demineralized water storage tanks supplies the demineralized water jockey pump and transfer pumps at a positive suction pressure. The jockey pump continuously pressurizes the transfer system and is controlled manually. A recirculation line back to the demineralized water storage tanks is provided for prevention of pump overheating on low system demands. The two transfer pumps are either automatically or manually controlled. During normal operation, both transfer pumps are in the auto mode. Low pressure on the pump's discharge header starts both transfer pumps. The pumps stop when a set high pressure is reached. If the pumps are operated with only one pump in auto, then the pump in auto would start on low header pressure, and the second transfer pump could be started manually at any time. A low level switch on each demineralized water storage tank trips the jockey and transfer pumps.

The makeup demineralizers, demineralized water feed and storage tanks, and associated equipment are in the Turbine Building.

9.2.3.3 Safety Evaluation

The Makeup Demineralizer System has no safety-related function and does not transport radioactive fluids. Failure of the system does not compromise any safety-related system or component or prevent a safe shutdown of the plant.

9.2.3.4 Testing and Inspection Requirements

The system is preoperationally tested in accordance with the requirements of Section 14.

All system components and controls are tested to verify correct functioning prior to operation.

Prior to station operation, the makeup demineralizer system is in operation to furnish demineralized water for cleaning and flushing, hydrotesting, and filling operations.

The Makeup Demineralizer System is in daily operation, thus periodic equipment testing is not required. All equipment is accessible for inspection while in operation.

Grab samples are periodically tested to verify demineralizer performance and to ascertain stored water quality.

9.2.3.5 Instrumentation Requirements

The Makeup Demineralizer System is furnished with a local control panel. Automatic and manual control of the regeneration and neutralization processes are included in the system panel. Flow, conductivity, and silica monitors are provided for each demineralizer train to indicate when the ion exchangers require regeneration. Periodic grab analyses are used to supplement on-line process when necessary. High conductivity alarms and high silica concentration alarms are provided on the makeup demineralizer system control panel to alert the operator to an abnormal condition.

The pressure, temperature, and conductivity of the acid and caustic regeneration solutions are monitored on the makeup demineralizer control panel.

The regenerant waste is collected in the regenerant waste tank, which is equipped with a high level alarm.

The demineralized water storage tanks are equipped with a level switch that alarms on the local control panel to indicate high and low water level. This switch also trips the demineralized water jockey and transfer pumps at low level. Local pressure indicators are provided at the discharge of all pumps in the system for pump head indication.

The demineralized water makeup, storage, and transfer systems, have a common trouble alarm in the main control room.

9.2.4 Potable and Sanitary Water Systems

The Potable Water System provides cold and hot water of a quality acceptable for human consumption to plumbing fixtures for the entire plant. The sanitary waste disposal system treats and disposes waste from all the plumbing fixtures, except those that could possibly contain radioactivity, which are handled by the radwaste systems. Toilets and urinals in controlled areas discharge to the sanitary waste disposal system and are administratively controlled to prevent discharge of contaminated waste.

9.2.4.1 Design Bases

Design bases for the Potable and Sanitary Water Systems (PSWS) are as follows:

1. The Potable Water System has no safety-related function and is designed to prevent radioactive contamination of the PSWS. There are no interconnections between the PSWS and potentially radioactive systems. The sanitary piping (non-radioactive) is uniquely identified on Plant Drawing M-99-0 using the symbols XSJ and XNG, the last letter denotes the American Water Works Association and the National Standard Plumbing code respectively.

2. Water is supplied in sufficient quantities to satisfy the demand for station potable and makeup water, safety showers and eye washes, and sanitary water.

3. Testing and/or treatment of the potable water is used to prevent any harmful physiological effects to plant personnel.

   Water quality tests, including bacteriological tests of the well water, are made periodically to conform to requirements and standards of the local administrative authority of the New Jersey State Department of Health and U.S. Public Health Service.

4. An emergency potable water storage tank of 750 gallon capacity is provided for the main control room area to supply water following a postulated loss-of-coolant accident (LOCA).

5. Steam and electric water heaters are provided to supply hot water to the lavatories, shower areas, laundry appliances, and other locations where needed. The capacity of the water heaters is based on the maximum hot water demand anticipated during the plant personnel shift change.

9.2.4.2 System Description

The Potable Water System is shown on Plant Drawings M-17-0 and M-98-0. Design parameters for the major components of the system are given in Table 9.2-5.

The Sanitary Waste Disposal System, including the sewage treatment plant, is shown on Figure 9.2-12 and Plant Drawing M-99-0.

The water for the PSWS is supplied from the fresh water supply system. The fresh water supply system pumps water from the wells

to two 10,000 gallon domestic water storage tanks located in the water treatment building. Hookup for portable chlorination is available at the wellhead. Three pumps draw water from these tanks and discharge it to the domestic water hydropneumatic pressure tank. Under automatic control, the first, second, and third pumps are actuated according to preset levels in the hydropneumatic pressure tank to satisfy the water demand.

An air compressor replaces the air in the hydropneumatic tank if the pressure in the tank is less than a pre-established value. The air compressor operates only after the pumps stop at the maximum high water level in the tank.

From the hydropneumatic pressure tank, the distribution system conveys the water to plumbing fixtures, laundry rooms, safety showers and eye washes, and washing stations.

Two steam domestic water heaters are provided to satisfy the hot water demand throughout the plant.

Remote locations, or locations where higher temperature water is needed, are provided with local electrical hot water heaters.

The main control room area is provided with a hydropneumatic domestic storage water tank and air compressor to supply water following a postulated LOCA.

Contamination of the potable water system is prevented by a combination of air gaps and backflow preventors of the reduced pressure zone type.

For personnel decontamination, lavatories, showers, and footbaths are provided with mixing valves for pre-tempered water flow. The showers are actuated by metering pushbutton valves, and the lavatories are actuated by foot pedals.

Sanitary wastes from plumbing fixtures that have no radioactive potential is conveyed to the sewage treatment plant. Potential radioactive waste from the personnel decontamination area or controlled laundry room is handled by the radwaste system. Toilets and urinals from controlled areas discharge to the Sanitary Waste Disposal System.

The sanitary waste disposal system collects wastes from toilets, urinals, showers, lavatories, the uncontrolled laundry room, etc., located in non-radioactive areas.

The sanitary waste disposal system is not interconnected with any potentially radioactive waste systems. However, there are toilets and urinals located in controlled areas which are administratively controlled to prevent discharge of potentially contaminated waste into the sanitary waste disposal system.

9.2.4.3 Safety Evaluation

The potable and sanitary water systems have no safety-related function and are not designed as Seismic Category I. Failure of these systems does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant.

9.2.4.4 Testing and Inspection Requirements

The potable and sanitary water systems are installed, examined, and tested in accordance with the National Standard Plumbing Code, and the appropriate current State of New Jersey standards regarding the plumbing, potable water quality and chlorine content, and sewage effluent.

9.2.4.5 Instrumentation Requirements

The potable and sanitary water systems are furnished with control panels, level switches to start and stop the pumps or actuate high and low level alarms, pressure switches to start and stop the air

compressors, pressure relief valves mounted on all domestic cold and hot water tanks, and pressure reducing valves to limit the pressure for the plumbing fixtures.

Local pressure indicators are provided at the pump discharge for pump head indication.

9.2.5 Ultimate Heat Sink

The ultimate heat sink (UHS) for the Hope Creek Generating Station (HCGS) engineered safety feature (ESF) components is the Delaware River. The UHS provides the required cooling water for the normal, accident, or shutdown conditions of the reactor.

9.2.5.1 Design Bases

9.2.5.1.1 Power Generation Design Bases

Power generation design bases for the UHS are as follows:

1. To dissipate heat load during normal operation through evaporation to the atmosphere by a natural draft cooling tower, as discussed in Section 10.4.5, with cooling tower cold side blowdown discharged to the Delaware River

2. To provide makeup water for the Circulating Water System (CWS) as discussed in Section 10.4.5.

9.2.5.1.2 Safety Design Basis

Safety design bases for the UHS are as follows:

1. To provide a reliable heat sink for the safeguard equipment during normal plant operation, loss-of-coolant accident (LOCA) and/or loss of offsite power (LOP), and plant shutdown conditions.

2. To withstand the most severe natural phenomena or site related event, including a safe shutdown earthquake (SSE), hurricane, tornado, missile, flood, freezing, or transportation accident, and reasonably probable combinations of less severe phenomena and/or events.

3. To perform during periods of adverse meteorological conditions, resulting in maximum water consumption and minimum cooling capability.

   Although related equipment, such as the intake structure, Station Service Water System (SSWS), and Safety Auxiliaries Cooling System (SACS), are safety-related, the UHS does not have any equipment that must meet those safeguard requirements.

9.2.5.2 System Description

The UHS is the Delaware River, which provides the source of cooling water to the SACS heat exchangers through the SSWS, as shown on Figure 9.2-1. The SACS, in turn, provides demineralized cooling water in a closed loop to the ESF components. The water from the SSWS is discharged into the CWS to provide makeup for that system.

Details of the safety-related and nonsafety-related systems and heat load dissipation are discussed in the following sections:

1. SSWS and intake structure - Section 9.2.1

2. Circulating water and cooling tower - Section 10.4.5

3. SACS - Section 9.2.2.

A discussion of Delaware River water temperatures is provided in the Hope Creek Generating Station Operating License Stage - Environmental Report.

The plant may be shut down under normal conditions with an average river water temperature as high as 88.0°F. The plant may be safely shut down under Technical Specifications permitted configurations with a 24 hour average river water temperature as high as 89.0°F with an instantaneous peak of no more than 91.4°F.

These maximum river temperatures are extreme conditions derived from an assessment of system margins using abnormal system alignments and flows for the design assessment parameters. It is expected that the average river water temperature will rarely, if ever, reach this maximum.

The existing safety-related SSWS and SACS systems adequately support safe shutdown and accident mitigation up to and including the Extended Power Uprate (EPU) thermal power of 3840 MWt. Ultimate heat sink temperature limits contained in Technical Specifications are supported by design calculations that demonstrate acceptable margins. GE evaluations, however, conclude that the main condenser and circulating water systems are adequate for operation at EPU conditions although some degree of power reduction may be necessary during extreme environmental conditions (elevated atmospheric and wet bulb temperature). Heat loads associated with normal operation can be adequately removed post-EPU up to and including operation at a rated thermal power of 3673 MWt. Operations above 3673 MWt will require additional analysis of selected turbine-generator components (such as generator hydrogen coolers and generator stator coolers). The capacities of the present cooling water systems remain adequate for EPU. No SSWS, STACS or RACS equipment changes were required for EPU.

9.2.6 Condensate and Refueling Water Storage and Transfer System

9.2.6.1 Design Bases

The condensate and refueling water storage and transfer system has no safety-related function, except for that of supplying condensate to the suction line of the high pressure coolant injection (HPCI) and the reactor core isolation cooling (RCIC) pumps. The system is designed to perform the following functions:

1. Supply water to fill the reactor well, the dryer/separator storage pool via the reactor well, and the spent fuel cask storage pool during refueling operations, and provide storage for this water when refueling is completed.

2. Provide the capability to demineralize the refueling water by pumping it through the condensate demineralizers, or fuel pool filter demineralizers and condensate demineralizer, and return it to the condensate storage tank (CST).

3. Supply condensate for various services in the radwaste system and supply makeup, flush, or seal water for plant systems and equipment.

4. Supply condensate to the suctions of the HPCI, RCIC, core spray, and control rod drive (CRD) pumps.

5. Provide a minimum storage capacity of 135,000 gallons for the RCIC and HPCI pumps.

6. Provide storage and makeup for the condensate system by transferring water to and from the CST under the action of the level controls on the condenser hotwells.

7. Provide storage for recovered condensate from the radwaste system.

8. Provide the capability to drain the reactor well through the condensate demineralizer and back to the CST.

9. Provide the capability for the HPCI and RCIC to recycle water during their test modes.

The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the condensate and refueling water storage facilities are discussed in Section 3.2.

9.2.6.2 System Description

The Condensate Storage System shown on Plant Drawing M-08-0 consists of the following:

1. One atmospheric CST with a capacity of 500,000 gallons

2. Two 100 percent capacity horizontal centrifugal condensate transfer pumps, rated at 600 gpm

3. Two 100 percent capacity horizontal centrifugal condensate transfer jockey pumps, rated at 50 gpm

4. Two 100 percent capacity horizontal centrifugal refueling water pumps, each rated at 1500 gpm

5. Interconnecting piping, valves, instruments, and controls

6. Connections for a future oxygen control system.

The condensate and refueling water storage and transfer system is designed for radioactivity concentration not exceeding $1.0x10^{-1}$µCi/cc or less than 200 Ci total content in the CST. Normal Condensate Storage Tank radioactivity concentration levels should be maintained equal to or less than $1.0x10^{-3}$µCi/cc.

9.2.6.2.1 Condensate Storage Tank

The CST is the normal source of water for the HPCI and RCIC pumps for both operational use and testing. The CST also supplies water to the core spray pumps for testing.

Normally, condensate transfer between the CST and the refueling cavity is accomplished by the condensate system. However, if maintenance is required on the condenser hotwell during shutdown, the two refueling water pumps can be used to transfer water from the CST to the reactor well and the dryer/separator storage pool.

The refueling water pumps are started and stopped manually during refueling operation. Pump A can be controlled from either the main control room or from a remote control panel. Pump B can only be started at the remote control panel. The pumps are run in parallel.

When refueling is complete, the water in the reactor well and the dryer/separator storage pool is cleaned by the fuel pool filter demineralizer system and is then pumped by the refueling water pumps to the CST through the condensate demineralizer. Condensate makeup for the CST is supplied by the demineralized water transfer pumps taking suction from the demineralized water storage tank. The refueling water pumps also serve as backup pumps for main condensate transfer pumps during plant normal operation.

The CST provides water to fill the spent fuel cask storage pool. This water can be returned to the tank by the refueling water

pumps through the condensate demineralizers. In addition, it stores the water that is used to fill the reactor well and the dryer/separator storage pool.

The condensate transfer pumps also take suction from the CST to provide water for various services in the Radwaste Building, the Reactor Building, and for backwashing the condensate and the fuel pool filter demineralizers.

Condensate transfer jockey pump A or B continuously pressurizes the transfer system. If the discharge pressure of the lead pump decreases, the other pump will start. If the header pressure of both jockey pumps continues to drop, the condensate transfer pump A or B will start automatically. Each of these pumps is controlled from the remote control panel.

The water volume in the CST is maintained above 276,000 gallons during normal operation. The water volume above 203,000 gallons serves two functions: 1) it acts as a surge volume for the condensate system by receiving rejected condensate from and making up any deficiency in that system under the action of the level controls in the condenser hotwells, and 2) it provides water to various plant operations via the condensate transfer system. The next 135,000 gallons (between 203,000 and 68,000 gallons) are reserved to meet the RCIC and HPCI pump requirements. Below 68,000 gallons, the HPCI and RCIC suction path is transferred to the torus.

9.2.6.3 Safety Evaluation

The CST is located outdoors and is provided with freeze protection. It is made of stainless steel and resists corrosion effectively.

The CST is surrounded by a Seismic Category I dike capable of containing the total volume of water within the tank.

Before any water that collects within the retaining walls is drained, it is monitored for radiation. If the reading is above the acceptable level, the water is pumped by a portable pump to the liquid radwaste system. If the reading is below acceptable level, the water is drained to the storm sewer.

Failure of the system does not compromise any safety-related system or component, and does not prevent a safe shutdown of the plant. Safety-related HPCI and RCIC suction lines are discussed in Sections 6.3.2 and 5.4.6, respectively.

9.2.6.4 Tests and Inspections

The condensate storage and transfer system is used during plant operation and requires only visual inspections for leakage or deterioration, or to verify operation of the various transfer pumps.

The system is preoperationally tested in accordance with the requirements of Section 14.

9.2.6.5 Instrumentation Applications

9.2.6.5.1 Condensate Storage Tank

CST level is recorded in the main control room. CST high-high and low-low level alarms are provided in the main control room. CST low-low level is also indicated at the remote shutdown panel by the illumination of an indicating lamp (See Section 7.4.1.5.2).

A standpipe is provided inside the CST which cuts off the supply to the condensate transfer pumps whenever the tank level drops to 250,000 gallons.

The CST is the normal source of water for the HPCI and RCIC systems. Redundant transmitter - trip units have been provided to allow for automatic switchover of the HPCI pump suction to the suppression pool in the event of a low condensate storage tank level. Redundant low-low level switches have been provided to allow for automatic switchover of the RCIC pump suction to the suppression pool in the event of a low condensate storage tank level. These level switches and transmitters are seismically supported on a standpipe located inside the Reactor Building and are

electrically separated (powered from different Class 1E power sources) as shown on Plant Drawing M-08-0. The piping between the CST and the Reactor Building penetration is heat traced to prevent freezing in cold weather. The heat tracing and alarm monitoring circuit are powered from a highly reliable emergency diesel backed power source. This circuit monitors the heat tracing power supply and thermostat and alarms on loss of either. Heat tracing is not required for that portion of piping inside the Reactor Building. See Sections 7.3.1.1.1.1 (HPCI) and 7.4.1.1.2 (RCIC) for discussions of the automatic switchover functions.

9.2.7 Plant Chilled Water Systems

9.2.7.1 Turbine Building Chilled Water System

The Turbine Building Chilled Water System (CWS) provides chilled water for cooling the drywell, Reactor Building, Turbine Building, radwaste area, and service area. In addition, the CWS provides chilled water to the reactor recirculation pump motor air coolers, drywell equipment drain sump cooling coil, sample coolers, and mechanical vacuum pump seal coolers.

9.2.7.1.1 Design Bases

The design bases for the CWS are as follows:

1. The CWS is not safety-related, except for the drywell chilled water penetrations and isolation valves. These are designed to meet Seismic Category I requirements and are discussed in Section 6.2.4.

2. The chilled water piping inside the drywell is designed for non-Seismic Category I requirements with Seismic Category I supports to ensure that it cannot impair any adjacent safety-related equipment in the event of a safe shutdown earthquake (SSE).

3. During normal plant operation, the CWS provides chilled water at 47.3°F to the area served. During loss-of-offsite power (LOP) or failure of the CWS, the Reactor Auxiliaries Cooling System (RACS) provides automatic backup to the portion of the CWS that serves the drywell. The RACS is capable of maintaining the drywell temperature within acceptable limits during such abnormal conditions with 95°F supply water.

4. The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the CWS are discussed in Section 3.2.

9.2.7.1.2 System Description

The CWS is shown on Plant Drawing M-87-1. Design parameters for major components of the CWS are listed in Table 9.2-6. Major components of the system include the following:

1. Four centrifugal water chillers

2. Three chilled water circulating pumps

3. One head tank

4. One chemical feed tank (corrosion inhibitors are not used)

5. Various air cooling coils for area served.

6. One mechanical duplex side stream filter

7. One activated carbon side stream filter

8. One side stream, mixed bed demineralizer

Each water chiller includes a motor driven centrifugal compressor, water cooled condenser, evaporator, pumpout unit, oil pump, oil heater, refrigerant piping, instrumentation, and controls. Each water chiller is sized for 33-1/3 percent capacity, and each circulating pump is sized for 50 percent capacity. The chillers and pumps are located at Elevation 171 feet of the Turbine Building. Remote controls, indicators, and alarms for the chillers are located in the main control room and on the vendor supplied remote chiller control panels.

Cooling water for the chiller condensers is provided by the Turbine Auxiliaries Cooling System (TACS). Makeup water for the CWS is provided to the head tank by the Demineralized Water System through an automatic makeup water valve. The head tank is vented to atmosphere, and is located at the highest elevation in the system.

The chemical feed tank may be used to provide protection against internal corrosion. Chemical addition to the CWS is performed manually.

A mechanical duplex side-stream bag filter is provided to perform insoluble contaminant holding capability as well as dual stage internal system filter protection for removal of lubricating oil which could appear in the flow.

The activated carbon filter and mixed bed demineralizer are used to reduce the level of total organic carbon in the chilled water system, and to maintain chilled water conductivity of the recirculated chilled water at a low level to minimize corrosion.

9.2.7.1.3 System Operation

The initial startup of chiller equipment and air cooling units is manual. Two chilled water circulating pumps and three chillers operate during normal plant conditions. The standby chiller is started manually if an operating chiller fails. The standby pump is started automatically by a low flow signal from either operating pump.

The closed loop refrigerant system in each water chiller extracts heat from the circulated water in the evaporator, and rejects the heat to TACS water in the condenser. A temperature sensor in the chilled water outlet regulates the refrigerant flow in the chiller to maintain a constant outlet water temperature.

Two piping loops connected to two sets of cooling coils are provided inside the drywell. Changeover from one loop to the other is accomplished from the main control room by changing the position of loop isolation valves. A primary containment isolation signal automatically closes both sets of isolation valves. The valves can be reopened from the main control room, if desired, to resume cooling water flow.

The CWS is automatically shut down in the event of LOP. RACS water is available for the drywell by automatically opened

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motor operated diversion valves at the CWS/RACS interconnection. These valves can be operated from the main control room. Chilled water can be restarted manually when normal power is restored.

Chilled water flow through various cooling coils and unit coolers is automatically controlled by local temperature actuated valves, as shown on Plant Drawing M-87-1. Some air cooling coils have uninterrupted water flow, and drywell cooling coil valves are controlled from the main control room.

During a refueling operation, chilled water is supplied to the third (standby) Reactor Building Ventilation System (RBVS) cooling unit to increase the ventilation rate. Cooling water for the drywell may be provided manually to both loops of the cooling coils in the drywell air coolers if extra space cooling is required.

9.2.7.1.4 Safety Evaluation

The CWS has no safety-related function, except for the isolation valves at penetrations through the drywell. These valves are described in Section 6.2.4.

9.2.7.1.5 Tests and Inspections

The CWS is periodically tested in accordance with the requirements of Section 16.

9.2.7.1.6 Instrumentation Applications

Chillers and pumps are operated manually from the main control room or the local control panel. Failure of an operating chiller or pump initiates an alarm in the main control room (MCR). Water pressure at each pump suction, pump discharge, chiller inlet, and chiller discharge is displayed locally. Water flow at each pump discharge and chiller discharge is indicated on the local control panel. Chilled water temperature is indicated in the main control room and locally at each chiller. There are high/low water flow

alarms and high/low water temperature alarms. Local panels will give a summary alarm in the main control room for other chiller faults.

High and low water level in the head tank is alarmed in the main control room.

9.2.7.2 Control Area Chilled Water System

The Control Area Chilled Water System consists of two subsystems: The Control Room Chilled Water System and the Safety-Related Panel Room Chilled Water System. The chilled water systems provide chilled water to maintain satisfactory ambient air temperatures, as discussed in Section 3.11 for different portions of the Auxiliary Building.

The Control Room Chilled Water System serves the following areas:

1. Main control room

2. Auxiliary equipment rooms, including the computer room and battery rooms

3. Emergency switchgear rooms

4. Safety Auxiliaries Cooling System (SACS) pump rooms (Reactor Building)

The Safety-Related Panel Room Chilled Water System serves the following areas:

1. Class 1E panel rooms

2. Technical support center

3. Remote shutdown panel room.

9.2.7.2.1 Design Bases

The design bases for the control area CWS are as follows:

1. The control area CWS is safety-related and is designed to Seismic Category I and redundancy requirements to remain functional following a LOCA or design basis accident (DBA).

2. Chilled water from the safety-related panel room chillers and from the control room chillers is supplied by the control area CWS to maintain the design ambient air temperatures in the areas served.

3. Single failure of any active or passive component, coincident with a LOP, will not result in the loss of chilled water supply.

4. The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the control area CWS are discussed in Section 3.2

9.2.7.2.2 System Description

The control area CWS is shown on Plant Drawing M-90-1.

Each of the two subsystems has two independent, 100 percent capacity chilled water loops. Design parameters for major components of the control area CWS are listed in Tables 9.2-7 and 9.2-8. Major components of each loop include the following:

1. One centrifugal water chiller

2. One chilled water circulating pump

3. One head tank

4. One chemical feed tank (corrosion inhibitors are not used)

5. Various air cooling coils in the areas served.

Each water chiller includes a motor driven centrifugal compressor, water cooled condenser, evaporator, pumpout unit, oil pump, oil heater, refrigerant piping, controls, and instrumentation.

Equipment for the control room chillers is located at Elevation 155 feet of the control area, and equipment for the safety-related panel room chillers is located at Elevation 178 feet of the diesel area.

Cooling water for the chiller condensers is provided by the SACS. Makeup water for the control area CWS is provided to the head tank by the demineralized water system through an automatic makeup water valve. The head tank is vented to the atmosphere, and is located at the highest elevation in the system.

The operating chiller is started manually, but the chilled and condensing water flow must be established before the compressor can operate.

9.2.7.2.3 System Operation

The initial startup of chiller equipment and air cooling units is manual. Each of the two control area CWS subsystem loops is capable of operation during all modes of plant operation. One chilled water loop in each subsystem operates while the other is on standby. Each operating chiller is powered from the same Class 1E power bus as the chilled water pump and the air cooling units in the loop. Both loops A and B can be operated from the

control room. In addition, loop B in each of the two control area CWS subsystems can be operated from the remote shutdown panel room.

A main control room alarm is initiated upon low chilled water flow or high or low chilled water supply temperature in the operating loop. The operating loop automatically shuts down, and the standby loop is automatically energized when low chilled water flow or high/low chilled water temperature is detected. The controls to initiate the standby loop are on the same Class 1E power bus as the standby equipment.

The closed loop refrigerant system in each water chiller extracts heat from the circulated water in the evaporator, and rejects the heat to SACS water in the condenser. A temperature sensor in the chilled water outlet regulates the refrigerant flow in the chiller to maintain a constant outlet water temperature. Additionally, a sensor monitoring condenser pressure and its associated SACS air operated control valve regulates SACS cooling water flow through the condenser. A safety-related Seismic Category I back-up air/nitrogen gas bottle supply and tubing and valves are provided to ensure the control of the SACS coolant flow following a loss of instrument air pressure. This SACS flow control is required to preclude a chiller trip resulting from excessive cooling of the condenser by SACS. Because the back-up air/nitrogen gas supply has a limited supply, administrative action is credited and required to monitor and maintain air/nitrogen gas supply pressure such that chiller operation is assured following a loss of instrument air. The capacity of the back-up air/nitrogen gas supply is such that it can support SACS flow control for a minimum of four (4) hours.

Chilled water flow through most air cooling coils in the areas served is controlled automatically by local temperature-actuated valves, as shown on Plant Drawing M-90-1. Some air cooling coils have uninterrupted water flow. The temperature of water leaving the CACWS chillers is thermostatically controlled to 51°F (nominal) for the Control Room Chilled Water system and 51.5°F (nominal) for the safety related Panel Room Chilled Water system.

9.2.7.2.4 Safety Evaluation

The control area CWS is Quality Group C and is designed according to Seismic Category I requirements, except for the chemical feed tanks and the head tank water makeup system and controls. The safety-related components of the control area CWS are redundant and located in a Seismic Category I structure atop the diesel and control areas. Power to these safety-related components is supplied by Class 1E power sources.

Piping, valve, or equipment failure, including that of supporting structures, which can result in the generation of a missile, flooding, or pipe whip and potential damage to safety-related equipment, is discussed in Sections 3.5 and 3.6.

Two independent 100 percent capacity chilled water loops provide complete mechanical redundancy. Coupled with the redundancy of electrical design, a failure of any single active or passive component cannot result in a complete loss of the control area CWS, thus ensuring a safe shutdown capability.

9.2.7.2.5 Tests and Inspections

The control area CWS is preoperationally tested in accordance with the requirements of Section 14.

9.2.7.2.6 Instrumentation Applications

Chillers and pumps are operated from the main control room. Failure of the operating chiller or pump initiates an alarm in the main control room. Water pressure at pump suction, pump discharge, chiller suction, and chiller discharge are displayed locally, while chilled water temperature and flow are indicated in the main control room.

High and low head tank water level is alarmed in the main control room.

9.2.8 Reactor Auxiliaries Cooling System

The Reactor Auxiliaries Cooling System (RACS) provides a heat sink for the nonessential plant components. It does not have a safety-related function. The RACS operates during normal conditions, following loss of offsite power (LOP), and during scheduled unit shutdown conditions. Coolant water in a closed loop system transfers heat through the RACS heat exchangers to the Station Service Water System (SSWS).

9.2.8.1 Design Bases

The RACS is designed to:

1. Meet non-Seismic Category I criteria, with the following exception:

   a. Containment penetrations and the containment isolation valves, which are designed to Seismic Category I requirements and ASME B&PV Code, Section III, Class 2.

2. Remove the maximum anticipated heat loads developed by the components served by the system over the full range of the normal plant operating conditions and ambient temperature conditions.

3. Permit corrosion inhibition to prevent long-term corrosion and organic fouling of the system's piping.

4. Serve as a barrier between potentially radioactive systems and the SSWS.

9.2.8.2 System Description

The RACS consists of three 50-percent-capacity cooling water pumps with two 50-percent-capacity heat exchangers, one expansion tank, one chemical addition tank, and associated valves, piping, and controls, as shown on Plant Drawings M-13-0 and M-13-1. Major equipment design parameters are summarized in Table 9.2-9.

The RACS system provides demineralized cooling water to nonessential equipment, located in the Reactor Building enclosure, the radwaste area, and the Turbine Building, that can carry radioactive fluids or that require a clean water supply to minimize long-term corrosion. The system is monitored continuously to detect

any radioactive in-leakage from the equipment being cooled. If this occurs a process radiation monitor will alarm in the control room and, as described in UFSAR section 9.2.1.5, operator action will be required to isolate the Service Water System from RACS.

During normal operation, two RACS pumps and two heat exchangers are in service. During normal operation, the RACS furnishes cooling water to the following equipment:

1. Reactor Water Cleanup System (RWCU) pump motor coolers
2. RWCU nonregenerative heat exchangers
3. Reactor recirculation pump seal coolers
4. Reactor recirculation pump motor oil coolers
5. Control rod drive (CRD) pump seal coolers
6. Reactor Building equipment drain sump coolers
7. Off-gas system feed gas cooler condensers
8. Deleted
9. Deleted
10. Reactor Building sampling station cooler
11. Deleted
12. Deleted

13. Deleted

14. Emergency instrument air compressor heat exchanger

15. Deleted

16. Off-gas system glycol refrigeration machine

17. Off-gas system charcoal compartment refrigeration machine

18. Deleted

19. Deleted

The demineralized water is circulated throughout the closed loop by the RACS pumps, which are rated at 3400 gpm at 136-foot head. The capacity of cooling water required by each component is set by a manual throttling valve on the cooling water outlet of each unit. RACS pump CP209 serves as a standby to RACS pumps AP209 and BP209 during normal operation and normal shutdown modes. In the event that one of the operating pumps fails, RACS pump CP209 can be manually started to preclude the need to isolate the waste evaporator condenser. The inlet water temperature to all serviced equipment is 95°F maximum and 40°F minimum. The inlet SSWS temperature to the RACS heat exchangers is 89.0°F maximum and 31°F minimum. The maximum outlet SSWS temperature from the RACS heat exchangers is 105.5°F. The RACS pump motors for AP209 and BP209 are connected to Class 1E-supplied buses, and upon LOP without occurrence of a loss-of-coolant accident (LOCA), both RACS pumps restart automatically. In this mode, the RACS system supplies cooling water to the following equipment:

1. Reactor recirculation pump seal coolers

2. Reactor recirculation pump motor oil cooler

3. CRD pump thrust bearing and gearbox oil coolers

4. Emergency instrument air compressor heat exchangers

5. RWCU pump motor coolers

6. Drywell coolers.

The RACS Reactor Building isolation valves will close automatically on LOP signal. During an LOP, RACS supplies cooling water to the emergency air compressor. The RACS cooling water supply lines for the emergency air compressor are located upstream of the Reactor Building isolation valves. For this reason, no operator action is required to supply RACS cooling to the emergency air compressors during an LOP.

The RACS has connections to supply cooling water to the drywell coolers as a backup to the chilled water system. This backup is automatic following LOP without LOCA.

The expansion tank is connected to the suction side of the pumps and placed at the highest point in the system to accommodate thermal expansion and contraction of the cooling water due to temperature variation, and provides ample net positive suction head (NPSH) to the RACS pumps. The expansion tank has a capacity of 640 gallons. It also provides necessary makeup water as required. The RACS supply and makeup water are furnished from the Demineralized Water System. A RACS deep bed demineralizer system is used to purify the water for corrosion control.

The RACS pumps, heat exchangers, chemical addition tank, and expansion tank are located in the Reactor Building.

Valves and piping for the RACS are designed to ANSI Power Piping Code B31.1, except for the primary containment penetrations and isolation valves.

Containment penetrations and isolation valves are designed to Seismic Category I requirements and ASME B&PV Code, Section III, Class 2.

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Pumps, heat exchangers, and pressure vessels are designed to ASME B&PV Code, Section VIII, Division 1. The RACS heat exchangers are designed to TEMA Standard Class R and Heat Exchange Institute (HEI) standards.

The expansion tank is designed to the standards of ASME B&PV Code, Section VIII.

9.2.8.3 Safety Evaluation

The RACS has no safety-related function and is not required to be operable following a LOCA. Upon a LOCA signal, the RACS heat exchangers are automatically isolated from the balance of the SSWS, and the RACS pumps are tripped. Each supply and return header in the drywell has two containment isolation valves that close automatically upon a LOCA signal.

Failure of the RACS does not compromise any safety-related system or component, nor does it prevent a safe shutdown of the plant.

9.2.8.4 Testing and Inspection Requirements

The RACS is preoperationally tested in accordance with the requirements of Section 14.

9.2.8.5 Instrumentation Requirements

Local and remote indicators, alarms, and pressure relief valves are provided to monitor the system process and to protect system components. Inadvertent trip of a pump, or a motor malfunction, activates an alarm in the main control room. Low supply header flow due to pump failure or motor tripping is annunciated in the main control room. If the supply header flow continues to drop, a low-low flow switch alarms in the main control room. The plant can then be brought to a safe shutdown condition.

Demineralized water supply to the expansion tank is controlled by a level switch in the tank. High-high and low-low levels in the tank are annunciated at the remote control panel and in the main control room.

Radiation monitors are installed in the system to continuously monitor radiation levels and detect any radioactive inleakage from the equipment being cooled.

TABLE 9.2-1

STATION SERVICE WATER SYSTEM

Station Service Water Pumps

Quantity	4 pumps
Type	Vertical, wet pit, centrifugal
Rated capacity/total head	16,500 gpm/150 feet
Motor horsepower	800 hp

Station Service Water Strainers

Quantity	4 strainers
Type	Self-cleaning
Normal flow	16,500 gpm
Maximum differential pressure	5 psi
Micron rating	250 - 380 micron

Traveling Water Screen

Quantity	4 screens
Type	Through flow
Normal flow	16,500
Motor horsepower	5 hp

Spray Water Pumps

Quantity	4 pumps
Type	Horizontal, centrifugal
Rated capacity/total head	400 gpm/92.4 feet
Motor horsepower	20 hp

TABLE 9.2-2

DELAWARE RIVER
WATER LEVELS

Levels	Elevations (ft)
High high tide	97.50
Mean high tide	92.20
Mean tide	89.30
Mean low tide	86.40
Technical Specification limit	80.00
Design low low water	76.00

TABLE 9.2-3

STACS EQUIPMENT DESIGN PARAMETERS

SACS Pumps

Quantity	4
Type	Horizontal, centrifugal
Model	Ingersoll Rand pump 14x23S
Seismic Category	I, Class C
Capacity	11,600 gpm
Rated tdh	160 ft
Rated brake power	545 hp

SACS Heat Exchangers *

Quantity	4
Seismic Category	I, Class C
Design water temperature	
Inlet	115°F
Outlet	95°F
Design heat load per shell	110×10^6 Btu/h
Design flow	
Shell side (demineralized water)	10,980 gpm
Tube side (station service water)	10,500 gpm

SACS Expansion Tank

Quantity	2
Capacity	8200 gallons
Seismic Category	I, Class C

* NOTE: The temperatures and heat loads listed for these heat exchangers are for the given design conditions. Actual values will depend on system parameters.

TABLE 9.2-3 (Cont)

SACS Chemical Addition Tank

Quantity	2
Capacity	93 gallons
Seismic Category	Non-I, Class D

SACS Hydropneumatic Accumulators (Operated Water-Solid)

Quantity	2
Dimensions	10-ft dia by 15-ft high
Seismic Category	I, Class C

TABLE 9.2-4

STACS FLOWRATES AND HEAT LOADS FOR VARIOUS MODES OF OPERATION

	Normal Operation		Normal Shutdown	
	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h
Motor-generator set coolers	1,800 [2]	11.27	1,800 [2]	11.27
Main turbine lube oil coolers	1,725 [1]	9.36	1,725 [1]	0.0
EHC hydro fluid cooler	10 [1]	0.04	10 [1]	0.0
General H_2 coolers	2,088 [4]	21.95	2,088 [4]	0.0
Generator stator coolers	1,866 [2]	17.16	1,866 [2]	0.0
Isophase bus coolers	100 [1]	0.68	100 [1]	0.0
Alterrex cooler	160 [1]	0.39	160 [1]	0.0
RFPT lube oil coolers	489 [3]	1.2	489 [3]	1.2
Secondary cond pump coolers	30 [3]	0.13	30 [3]	0.13
Turbine bldg chillers	10,500 [3]	58.59	10,500 [3]	58.59
Process sampling	29 [1]	0.5	29 [1]	0.5
Station air compressor	270 [1]	2.24	270 [1]	2.24
Mezz pipe chase cooler	153 [1]	0.5	153 [1]	0.5
Condenser compartment coolers	671 [4]	2.205	671 [4]	2.205
STACS Demineralizers	55 [1]	0.0	55 [1]	0.0
Htg sys cond. coolers [11] (Turbine Bldg.)	140	1.7	140	1.7
TACS total	20,086	126.216	20,086	78.335

TABLE 9.2-4 (cont)

STACS FLOWRATES AND HEAT LOADS FOR VARIOUS MODES OF OPERATION

	LOP ≥ 30 Minutes			
	One Loop		Two Loops	
	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h
Motor-generator set coolers				
Main turbine lube oil coolers				
EHC hydro fluid cooler				
General H2 coolers				
Generator stator coolers				
Isophase bus coolers				
Alterrex cooler				
RFPT lube oil coolers	NOT		NOT	
Secondary cond pump coolers	OPERATING		OPERATING	
Turbine building chillers				
Process sampling				
Station air compressor				
Mezz pipe chase cooler				
Condenser compartment coolers				
STACS Demineralizers				
Htg sys cond. coolers(11)				
TACS total				

TABLE 9.2-4 (cont)

	LOCA < 10 Minutes		LOCA ≥ 10 Minutes One Loop		LOCA ≥ 10 Minutes Two Loops	
	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h
Motor-generator set coolers						
Main turbine lube oil coolers						
EHC hydro fluid cooler						
General H2 coolers						
Generator stator coolers						
Isophase bus coolers						
Alterrex cooler						
RFPT lube oil coolers	NOT		NOT		NOT	
Secondary cond pump coolers	OPERATING		OPERATING		OPERATING	
Turbine building chillers						
Process sampling						
Station air compressor						
Mezz pipe chase cooler						
Condenser compartment coolers						
STACS Demineralizers						
Htg sys cond. coolers[11]						
TACS total						

TABLE 9-2-4 (cont)

STACS FLOW RATES AND HEAT LOADS FOR VARIOUS MODES OF OPERATION

	Normal Operating		Normal Shutdown	
	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h
SACS Demineralizers	26(1)	-	26(1)	-
1E equipment chillers (Note 20)	408(1)	2.52	408(1)	2.52
RHR heat exchangers	-	-	7,000(1)	260
RHR pump seal coolers	-	-	23(1/1)(15)	0.44
RHR motor bearing coolers	-	-	12(2)	0.02
Fuel pool HXs (Note 20)	2,000(2)	17.6	2,000(2)	17.6(12)
Diesel generator coolers	-	-	-	-
DG room coolers	-	-	-	-
FRVS cooling coils	-	-	-	-
RHR pump room coolers	-	-	78(1)	0.40
RHR pump and HX room coolers	-	-	89(1)	0.42
RCIC pump room coolers	-	-	-	-
Core spray pump room cooler	-	-	-	-
Control room chillers (Note 20)	1,588(1)	7.53	1,588(1)	7.53
Containment gas comp. (Note 20)	4(1)	0.05	4(1)	0.05
HPCI pump room cooler	-	-	-	-
Post LOCA sampling station	-	-	-	-
SACS total	4,026	27.70	11,228	288.98
Grand total (STACS)	23,972	153.92	31,174	365.54

TABLE 9-2-4

	LOP ≥ 30 Minutes			
	One Loop		Two Loops	
	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h
SACS Demineralizers	26 [(1)]	-	52 [(2)]	-
1E equipment chillers	408 [(1)]	2.52	408 [(1)]	2.52
RHR heat exchangers	8,650 [(1)(17)]	127.1 [(17)]	18,000 [(2)]	209.2
RHR pump seal coolers	20 [(4)(15)]	0.36	20 [(4)(15)]	0.36
RHR motor bearing coolers	24 [(4)]	0.04	24 [(4)]	0.04
Fuel pool heat exchangers	2,000 [(2)]	17.6 [(12)]	2,000 [(2)]	17.6 [(12)]
Diesel generator coolers	3,200 [(4)(14)]	5.412	3,200 [(4)(14)]	5.412
DG room coolers	1,040 [(4)(16)]	7.60	1,040 [(4)(16)]	7.60
FRVS cooling coils	-	-	-	-
RHR pump room coolers	156 [(2)]	0.80	156 [(2)]	0.80
RHR pump and hx room coolers	178 [(2)]	0.84	178 [(2)]	0.84
RCIC pump room cooler	13 [(1)]	0.09	13 [(1)]	0.09
Core spray pump room cooler	-	-	-	-
Control room chillers	1,588 [(1)]	7.53	1,588 [(1)]	7.53
Containment gas compressor	4 [(1)]	0.05	4 [(1)]	0.05
HPCI pump room cooler	35 [(1)]	0.23	35 [(1)]	0.23
Post LOCA sampling station	-	-	-	-
SACS total	17,342	170.17	26,718	252.27
Grand total (STACS)	17,342	170.17	26,718	252.27

TABLE 9.2-4 (cont)

	LOCA < 10 Minutes (19)		LOCA ≥ 10 Minutes, One Loop		LOCA ≥ 10 Minutes, Two Loops	
	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h	gpm	$x10^6$ Btu/h
SACS Demineralizers	52 (2)	-	52 (2)	-	52 (2)	-
1E equipment chillers	408 (1)	2.52	408 (1)	2.52	408 (1)	2.52
RHR heat exchangers	-	-	8,650 (1)(17)	127.1 (17)	18,000 (2)	209.20
RHR pump seal coolers	20 (4)(15)	0.36	20 (4)(15)	0.36	20 (4)(15)	0.36
RHR motor bearing coolers	24 (4)	0.04	24 (4)	0.04	24 (4)	0.04
Fuel pool heat exchangers	2,000 (2)	17.6	2,000 (2)	17.6 (12)	2,000 (2)	17.6 (12)
Diesel generator coolers	3,200 (4)(14)	39.50	3,200 (4)(14)	5.412	3,200 (4)(14)	5.412
DG room coolers	1,520 (4)(16)	7.60	1,520 (4)(16)	7.60	1,520 (4)(16)	7.60
FRVS cooling coils	1,400 (4)(18)	4.40	1,140 (3)(18)	4.39	1,140 (3)	4.39 (18)
RHR pump room coolers	156 (2)	0.80	156 (2)	0.80	156 (2)	0.80
RHR pump and hx room coolers	178 (2)	0.84	178 (2)	0.84	178 (2)	0.84
RCIC pump room coolers	13 (1)	0.09	13 (1)	0.09	13 (1)	0.09
Core spray pump room cooler	72 (4)	1.08	136 (2)	0.54	272 (4)	1.08
Control room chillers	1,588 (1)	7.53	1,588 (1)	7.53	1,588 (1)	7.53
Containment gas compressor	-	-	4 (1)	0.05	4 (1)	0.05
HPCI pump room cooler	35 (1)	0.23	35 (1)	0.23	35 (1)	0.23
Post LOCA sampling station	-	-	10 (1)	0.11	10 (1)	0.11
SACS total	10,666	48.52	19,134	175.21	28,620	257.85
Grand total (STACS)	10,666	48.52	19,134	175.21	28,620	257.85

NOTES:

(1) through (6) Number of units in operation, 1 through 6 units, respectively.

(9) Operator action is required to restart SFPCCS.

NOTES: (cont)

(11) Operation of this system occurs only during the heating season and corresponds with reduced load on the Turbine Bldg Chillers. Full flow and heat load will not occur coincident with full flow and load on the chillers. For this reason, this equipment is not included in the TACS System totals.

(12) If SAC HX outlet temp. cannot be maintained less than its max design temp., flow to fuel pool HX will be isolated to reduce total system heat load.

(13) The tables do not include the effects of a loss of instrument air.

(14) The min. flow rate to each EDG cooler is approximately 700 gpm; however, nuisance alarms may sound in the Control Room during periods of high SACS temperatures.

(15) The required SACS flow for the RHR pump seal coolers is 18 gpm if the RHR pump is supporting shutdown cooling. If the RHR's pump's suction is from the suppression pool, the required SACS flow to the RHR pump seal cooler is only 5 gpm.

(16) Value for one room cooler per EDG. For certain single failure conditions, two room coolers per EDG are required at 260 gpm and 1.1 Mbtu/hr per cooler (220 gpm and 1.1 Mbtu/hr per cooler for SACS loop outage and 2 EDGs crosstied, see Section 9.4.6.2.7). Both room coolers are available for these particular single failure scenarios.

(17) RHRHX flow and heat load assumes suppression pool cooling only (limiting condition).

(18) Post LOCA, either three or four FRVS coils operating is acceptable. If four FRVS coils are assumed operating, for the short serm LOCA (< 10 Minutes) the minimum required flow is 1400 gpm based on three at full capacity 380 gpm and one degraded at 260 gpm. With a minimum of three operating in the long term, the required flow is 1140 (380 gpm each). Also, four FRVS coils at an average flow of 340 gpm to each are also acceptable in either the long or short term.

(19) Post LOCA short-term (< 10 minutes); RHR heat load can be transferred to SACS during automatic LPCI injection.

(20) During elevated river water temperature, assuming two SACS loop operation, these loads may be placed on the SACS loop not supplying the TACS loads.

(21) Component flow heat load information in the above table is bounding for any power level up to a rated thermal power (RTP) of 3840 MWt for all components except the generator stator and Hydrogen coolers which are evaluated at 3673 MWt.

TABLE 9.2-5

DOMESTIC WATER SYSTEM DESIGN PARAMETERS

Domestic Water Storage Tanks

Quantity	2
Type	Horizontal, cylindrical
Capacity	10,000 gallons

Domestic Water Pumps

Quantity	3
Type	Horizontal, split case centrifugal
Capacity	85 gpm
Head	277 feet
Motor power rating	30 hp

Domestic Water Hydropneumatic Pressure Tank

Quantity	1
Type	Vertical, cylindrical
Capacity	2670 gallons
Working pressure	85 to 120 psig

Air Compressor

Quantity	1
Type	Oil free, reciprocating
Capacity	14.95 scfm
Pressure	175 psig
Motor power rating	5 hp

Emergency Hydropneumatic Domestic Water Storage Tank

Quantity	1
Type	Vertical, cylindrical
Capacity	750 gallons
Working pressure	60 psig (normal operation)
	38 to 40 psig (after LOCA)

Air Compressor

Quantity	1
Type	Oil free, reciprocating
Capacity	11.7 scfm
Pressure	40 psig
Motor power rating	2 hp

Steam Domestic Water Heaters

Quantity	2
Type	Vertical, cylindrical
Capacity	1680 gal/h, 100°F rise
Tank nominal capacity	680 gallons
Water temperature	40 to 140°F

Electric Water Heaters

Different capacities for remote locations

TABLE 9.2-6

TURBINE BUILDING CHILLED WATER SYSTEM DESIGN PARAMETERS

<u>Water Chillers</u>

Number required	4
Type	Centrifugal flooded evaporator
Capacity	1285 tons of refrigeration
Power rating	1215 kW
Entering chilled water temperature	60°F
Leaving chilled water temperature	47.3°F
Type of refrigerant	R-500/R-134a

<u>Chilled Water Circulating Pumps</u>

Number required	3
Type	Centrifugal, horizontal
Flow rate	3746 gpm
Head	180 ft
Motor power rating	200 hp

<u>Head Tank</u>

Number required	1
Type	Horizontal, cylindrical
Volume	450 gal
Pressure	Atmospheric

<u>Chemical Feed Tank</u> (Corrosion inhibitors are not used)

Number required	1
Type	Vertical, cylindrical
Volume	75 gal

TABLE 9.2-6 (Cont)

TURBINE BUILDING CHILLED WATER SYSTEM DESIGN PARAMETERS

Mech Duplex Side-Stream Filter

Number Required	1
Type	Vertical, cylindrical multi bag filter
Volume	4 ft^3

Activated Carbon Filter

Purchase Order No.	P1-407015
Manufacturer	Graver Water Co.
Equipment No.	10-F-120
Quantity	1
Capacity	100 gpm
Material	316L SS
Design Pressure	150 psig
Design Temperature	130°F

Mixed Bed Demineralizer

Purchase Order No.	P1-40715
Manufacturer	Graver Water Co.
Equipment No.	10-F-121
Quantity	1
Capacity	100 gpm
Material	316L SS
Design Pressure	150 psig
Design Temperature	130°F

TABLE 9.2-7

AUXILIARY BUILDING
CONTROL ROOM CHILLED WATER SYSTEM
DESIGN PARAMETERS

<u>Water Chillers *</u>	
Number required	2
Type	Centrifugal, flooded evaporator
Capacity	536 tons
Power rating	506 kW
Entering chilled water temperature	57°F
Leaving chilled water temperature	47°F
Type of refrigerant	R-12
<u>Chilled Water Circulating Pumps</u>	
Number required	2
Type	Centrifugal, horizontal
Flow rate	1330 gpm
Head	130 ft
Motor power rating	60 hp
<u>Head Tank</u>	
Number required	2
Type	Horizontal, cylindrical
Volume	100 gal
Pressure	Atmospheric
<u>Chemical Feed Tank</u> (Corrosion inhibitors are not used)	
Number required	2
Type	Vertical, cylindrical
Volume	40 gal

* NOTE: The temperatures and heat loads listed for these chillers are for the given design conditions. Actual values for the chillers will depend on system parameters.

TABLE 9.2-8

AUXILIARY BUILDING

SAFETY-RELATED PANEL ROOM CHILLED WATER SYSTEM

DESIGN PARAMETERS

Water Chillers *	
Number required	2
Type	Centrifugal, flooded evaporator
Capacity	180 tons
Power rating	198 kW
Entering chilled water temperature	55°F
Leaving chilled water temperature	45°F
Type of refrigerant	R-114
Chilled Water Circulating Pumps	
Number required	2
Type	Centrifugal, horizontal
Flow rate	430 gpm
Head	180 ft
Motor power rating	40 hp
Head Tank	
Number required	2
Type	Horizontal, cylindrical
Volume	100 gal
Pressure	Atmospheric
Chemical Feed Tank (corrosion inhibitors are not used)	
Number required	2
Type	Vertical, cylindrical
Volume	40 gal

* NOTE: The temperatures and heat loads listed for these chillers are for the given design conditions. Actual values for the chillers will depend on system parameters.

TABLE 9.2-9

REACTOR AUXILIARIES COOLING SYSTEM DESIGN PARAMETERS

RACS Pumps

Type	Centrifugal
Quantity	3
Rated flow	3400 gpm
Rated head	136 feet
Motor power rating	150 hp
RPM	1750

RACS Heat Exchangers *

Type	Horizontal, split flow, shell and tube
Quantity	2
Heat exchanged	41×10^6 Btu/h
Design demineralized water temperatures	
Inlet	119.2°F
Outlet	95°F
Design SSWS water temperatures	
Inlet	85.0°F
Outlet	105.5°F

RACS Expansion Tank

Type	Vertical
Quantity	1
Capacity	640 gallons

* Note: The temperatures and heat loads listed for these heat exchangers are for the given design conditions. Actual values will depend on system parameters.

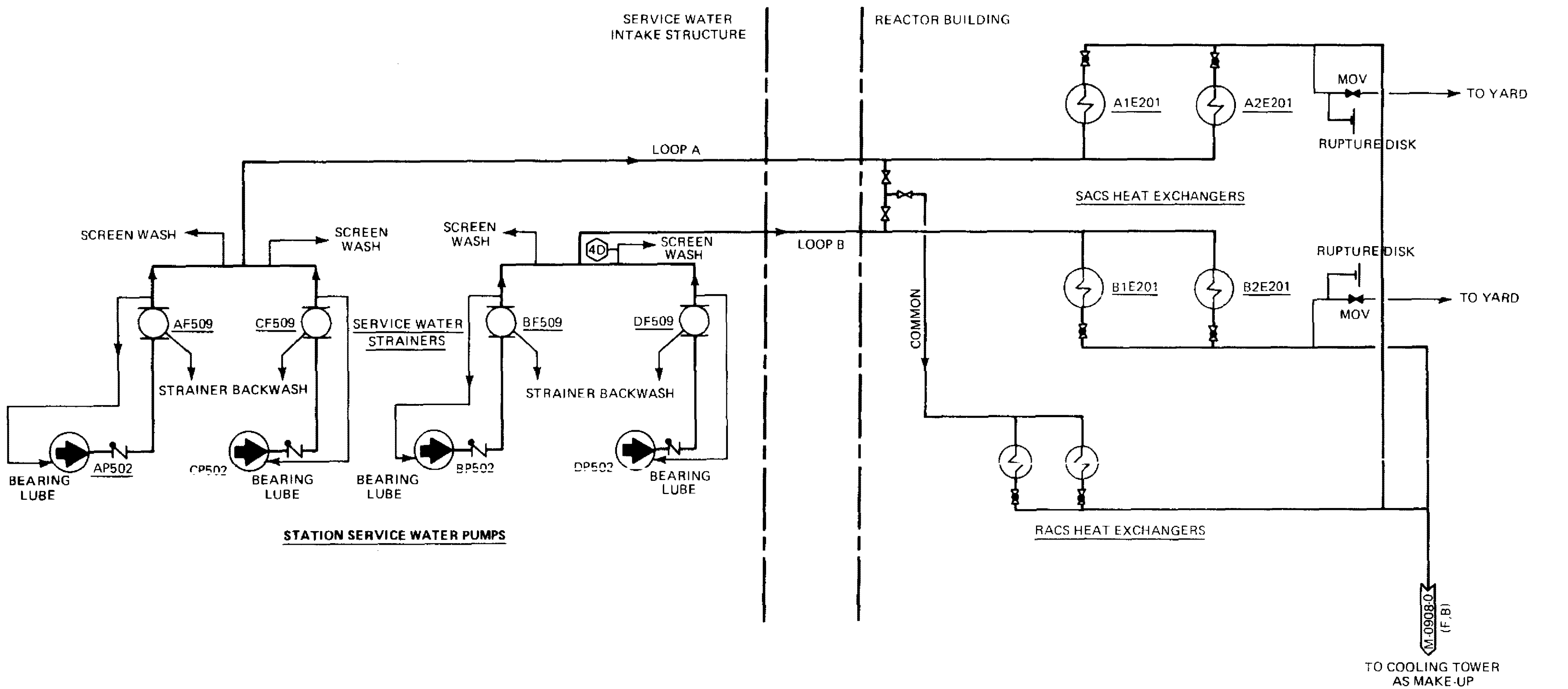
RACS Chemical Addition Tank (not used)

Quantity	1
Type	Vertical
Capacity	93 gallons

** Extruder Evaporator Booster Pumps

Type	Centrifugal, vertical in line
Quantity	2 (one redundant)
Rated flow	119 gpm
Rated pressure differential	-
Motor power rating	7.5 hp
RPM	3500

** Abandoned in place



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

FLOW DIAGRAM OF STATION SERVICE WATER

UPDATED FSAR

FIGURE 9.2-1

Figure F9.2-2 intentionally deleted.

Refer to Plant Drawing M-10-1 SH 1 in DCRMS

Figure F9.2-3 intentionally deleted.

Refer to Plant Drawing M-10-1 SH 2 in DCRMS

Figure F9.2-4 SH 1-3 intentionally deleted.

Refer to Plant Drawing M-11-1 for all sheets in DCRMS

Figure F9.2-5 intentionally deleted.

Refer to Plant Drawing M-12-1 in DCRMS

Figure F9.2-6 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-14-1 for both sheets in DCRMS

FIGURE DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY HOPE CREEK NUCLEAR GENERATING STATION	Updated FSAR Figure 9.2.7 Revision 8 September 25, 1996

Figure F9.2-8 intentionally deleted.

Refer to Plant Drawing M-17-0 in DCRMS

Figure F9.2-9 intentionally deleted.

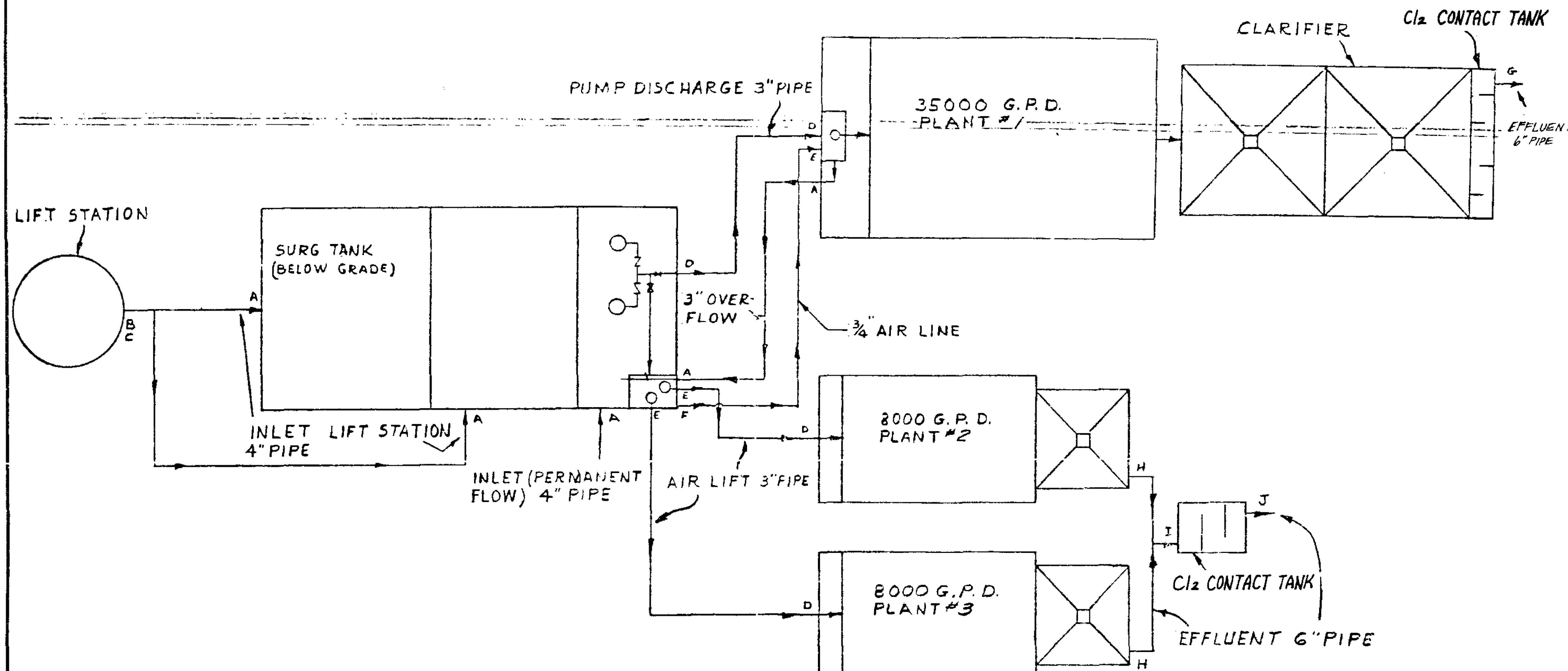
Refer to Plant Drawing M-98-0 SH 2 in DCRMS

Figure F9.2-10 intentionally deleted.

Refer to Plant Drawing M-98-0 SH 1 in DCRMS

Figure F9.2-11 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-99-0 for both sheets in DCRMS



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

SEWAGE TREATMENT
PLANT FLOW SHEET

UPDATED FSAR

FIGURE 9.2-12

Figure F9.2-13 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-08-0 for both sheets in DCRMS

Figure F9.2-14 SH 1-4 intentionally deleted.

Refer to Plant Drawing M-87-1 for all sheets in DCRMS

Figure F9.2-15 SH 1-3 intentionally deleted.

Refer to Plant Drawing M-90-1 for all sheets in DCRMS

Figure F9.2-16 intentionally deleted.

Refer to Plant Drawing M-13-0 in DCRMS

Figure F9.2-17 intentionally deleted.

Refer to Plant Drawing M-13-1 in DCRMS

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air Systems

The Compressed Air System consists of the Service Air System and Instrument Air System. These systems supply all plant equipment requiring compressed air, as well as service air outlets located throughout the plant. The systems are shown on Plant Drawing M-15-0 and are not safety-related except for:

1. The local Seismic Category I air accumulators provided for valves with safety-related functions, discussed in Section 5.4.5.

2. The containment penetrations, referred to in Section 6.2.4.

3. The local Seismic Category I air/nitrogen gas bottle supply is provided for SACS control valves with safety-related functions, discussed in Section 9.2.7.2.3.

9.3.1.1 Design Bases

1. The Service Air System is designed to provide service air to stations located throughout the plant.

2. The Instrument Air System is designed to receive air from the service air system and to provide a continuous supply of filtered, dry, and oil free air for all pneumatic instruments and controls in the plant.

3. The backup system for the instrument air is supplied by an emergency instrument air compressor unit, which is powered from a separate electrical bus.

4. Standby onsite power is available to the emergency instrument air compressor and dryers following a loss of offsite power (LOP). Emergency power is cut off upon a loss-of-coolant accident (LOCA). Cooling water from the Reactor Auxiliaries Cooling System (RACS) is also

provided to this compressor during LOP but not during a LOCA. Power is manually restored from the SDGs 20 minutes after an LOP.

5. The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the compressed air systems are discussed in Section 3.2.

9.3.1.2 System Description

The Instrument and Service Air Systems are shown schematically on Plant Drawing M-15-0. Major equipment design parameters are listed in Table 9.3-1. The system is designed to take air from outside the building, which ranges from a minimum temperature of 5°F to a maximum temperature of 94°F dry bulb, 78°F wet bulb, and compress air to 110 psig for plant use. The minimum temperature in the compressor area is 40°F dry bulb. The maximum temperature is 104°F dry bulb. Some of the distribution piping passes through areas whose maximum design temperature is 120°F. The system is equipped with three 100 percent capacity air dryers that are capable of drying the air to a -100°F dew point temperature at line pressure.

The Compressed Air System includes two service air compressors and one emergency instrument air compressor. The two service air compressors discharge oil free compressed air into a single header with one air receiver common to both compressors. Each compressor has an air intake filter/silencer, an intercooler, and an aftercooler with a built-in moisture separator.

All compressors discussed in this section are designed to minimize the introduction of oil into the system.

The emergency Instrument Air System includes one 100 percent capacity air compressing train consisting of

a compressor unit with built-in filter intercooler, an aftercooler and moisture separator, and an air receiver.

The service air and the instrument air are normally supplied from a single header and air receiver. The instrument air passes through a dryer package consisting of a prefilter, heatless desiccant type air dryer, and an afterfilter before distribution. Three 100 percent capacity instrument air dryer packages are provided in the instrument air system. Two air receivers for the instrument air are also provided downstream of the dryers. The Instrument Air System compressor/dryer combination is designed to provide ISA S7.3 quality air with the exception of particle size to the instrument air piping system.

The Instrument Air System afterfilter is designed to remove 1.0 micrometer particles. The system is designed to permit preventive or corrective maintenance on one dryer and afterfilter train without affecting system operability.

During normal plant operation, one of the two 100 percent capacity service compressors is selected as the lead compressor. Provisions are made to alternate the lead and standby compressor in order to equalize wear. The lead compressor is in continuous operation. The second service air compressor serves as a standby. The standby compressor starts automatically at a predetermined low air pressure whether caused by failure of the lead compressor or an extra demand on the system. Cooling water for the intercooler and aftercooler is provided by the Turbine Auxiliaries Cooling System (TACS).

One of the two drying towers of each instrument air dryer package removes moisture from the air stream while the other drying tower of the instrument air dryer package is regenerated with dry air. Moisture is absorbed, and the regenerated air is expelled to the atmosphere. The towers are alternated on a timed cycle.

The emergency instrument air compressor and its corresponding air dryer package, which are connected to the Non class 1E bus

system (diesel backed) and maintained in automatic operation mode, will start operating only if the instrument air pressure drops below 85 psig. In the event of an LOP, the emergency instrument air compressor will automatically start when power is restored to the bus and if air pressure in the receiver falls below 85 psig. In the event of a LOCA the emergency air compressor will be tripped. Loading and unloading sequence is regulated by the pressure at the emergency instrument air receiver.

Low pressure in the instrument air header shuts a valve in the service air supply header in order to divert all air supplies to the instrument air system.

The dryers are sized such that one dryer is typically operating. In the event of a trouble condition occurring in the operating unit due to high differential pressure from the pre-filter or the after-filter or high dew point, an alarm will be generated on the local control panel. Upon loss of power to the dryer control system the dryer fail open discharge valves will place all dryers in the instrument air path to maintain continuous air flow. On a loss of Instrument Air header pressure (<85 psig), the dryer in service will remain in service, and the dryers in standby will automatically be placed in service.

All of the above Compressed Air System supply equipment is located in the Turbine Building.

9.3.1.3 Safety Evaluation

The instrument and service air systems have no safety-related function other than the integrity of the piping through the containment penetration. Failure of the systems will not compromise any safety-related system or component or prevent a safe shutdown of the plant. The service and instrument air lines penetrating to the reactor have a motor operated valve with a handswitch located in the main control room for isolation. Refer to Section 6.2.4 for details of containment isolation design features.

9.3.1.4 Tests and Inspections

The compressed air systems are preoperationally tested in accordance with the requirements of Section 14. The instrument air system is tested in accordance with Regulatory Guide 1.68.3, Preoperational Testing of Instrument Air Systems. Compressors and dryers shall be tested in accordance with ASME and manufacturers' test procedures.

The instrument air dew point will be tested at the dryer/receiver in accordance with ANSI/ISA-S7.3-1975, Quality Standard For Instrument Air, at a frequency of once per quarter as specified in the air dryer technical manual.

Particle size testing at the dryer/receiver and selected downstream points will be performed on an 18 month frequency. The system will be tested and maintained to provide 10 micron quality air which is the minimum size requirement found in the system functional review.

The instrument air oil/hydrocarbon content will be tested at the dryer/receiver at a frequency of once per 18 months in accordance with ANSI/ISA-S7.3-1975, Quality Standards for Instrument Air.

Contaminant testing will be performed on a once per 18 month frequency at the dryer/receiver to assure contaminants are not being drawn into the airstream.

Periodic maintenance on each instrument air system will be performed using approved preventive maintenance procedures. These procedures will be prepared in accordance with the latest vendor recommendations and will address preventive maintenance for such items as:

1. Moisture Separator,

2. Emergency Instrument Air Compressor,

3. Instrument Air Filter Changeout, etc..

These procedures are available for review.

The periodic testing of instrument air system air quality will be performed using approved surveillance/testing procedures. These procedures and their testing frequencies are addressed as follows:

1. periodic monitoring of the instrument air system dew point and

inspection of downstream filters will be scheduled via the station work order system,

2. periodic checks of air dryer moisture indicator will be performed on a shift basis,

3. periodic blowdown of instrument lines will be performed on a weekly basis.

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Maximum time between testing of the compressed air system, in general, will be in accordance with approved vendor recommendations and will be performed using approved procedures and schedules via the station work order system or department logs. These procedures are available for review.

9.3.1.5 Instrumentation Application

Instrumentation is provided for each instrument air and service air compressor train to monitor and automatically control each compressor's operation.

The service air compressors are tripped on the following signals: low oil pressure, high oil temperature, high cooling water discharge temperature, high air pressure in the receiver, and high vibration. Most of these signals are annunciated in the main control room by common trouble alarms. High air temperature in the aftercooler and moisture separators, low pressure in the air receivers, and high intake filter differential pressure are also alarmed on a local control panel and the main control room by a common trouble alarm. The emergency instrument air compressor is a packaged unit that is self-protecting with all compressor protection integral to the compressor microprocessor based control system. The compressor is tripped on metered parameters that are potentially harmful to the unit such as; low bearing oil pressure, main motor overload, motor starter fault, high inter-stage temperatures, and others. These conditions are alarmed on the compressor LCD display to aid in diagnostics and recovery. The instrument air dryers are equipped with a microprocessor control panel that alarms on internal fault, high moisture content and loss of power. Pre-filters and after-filters are installed externally to each of the air dryer skids. A differential pressure switch is installed across each of the filters to alarm on a high DP condition.

Service air compressor and emergency instrument air compressor trouble are individually annunciated and alarmed on the local common service air compressor control panel. These alarms also indicate on the main control room computer, along with the air dryer trouble alarms.

9.3.2 Process and Post-Accident Sampling Systems

The Process Sampling System (PSS) is designed to monitor and provide grab samples of both radioactive and non-radioactive fluids used in the normal operation of Hope Creek Generating Station (HCGS) and under accident conditions.

Radiation monitoring of gaseous and liquid process streams is discussed separately in Section 11.5.

9.3.2.1 Design Basis

9.3.2.1.1 Process Sampling System

The PSS is designed to provide representative samples of all process streams related to plant power operation and liquid radwaste processing.

The system is designed to allow for the collection of data or a grab sample without hazard to the operator or contamination of general working areas. Samples may be taken from alternative locations as plant conditions require provided that they are determined to be representative and do not present a hazard to personnel or contamination of the work area. Additional requirements for alternate sample points are found in Table 5.2-9.

Sample line size, length, and routing are designed to provide a representative sample by maintaining turbulent flow.

The PSS is designed to ensure representative samples from liquid and gaseous processes in accordance with Regulatory Guide 1.21, Position C.6.

Isolation valves fail in the closed position, in accordance with the requirements of GDC 60 in 10CFR50, Appendix A, to control the release of radioactive materials to the environment. Isolation valves are provided to limit reactor coolant loss from a rupture of the sample line in accordance with ALARA provisions in 10CFR20.1(c) and GDC 60 in 10CFR50, Appendix A, to control the release of materials to the environment.

9.3.2.1.2 Post-Accident Sampling System

The Post Accident Sampling System (PASS) has been removed from the Hope Creek licensing basis as a result of Hope Creek license amendment 149, dated January 29, 2004. The NRC approved the elimination of PASS based on the following contingencies:

- PSEG has developed contingency plans for obtaining and analyzing highly radioactive samples of reactor coolant, suppression pool and containment atmosphere, and has committed to maintain the capability for sampling and analyzing in plant implementing procedures.

- PSEG has verified that it has a capability for classifying fuel damage events at the Alert level threshold and has committed to maintain the capability for the alert classification in plant implementing procedures.

- PSEG has verified that it has the capability to monitor radioactive iodines that have been released to offsite environs and has committed to maintain the capability for monitoring iodines in plant implementing procedures.

UFSAR text regarding the PASS is maintained for historical purposes.

The PASS is designed to meet the requirements of Item II.B.3 of NUREG 0737.

Additional PASS design bases are as follows:

1. The PASS and the onsite laboratory facility are designed to provide the capability to obtain reactor coolant samples and containment atmosphere samples within 1 hour following a loss-of-coolant accident (LOCA), and to provide sampling and analysis within 3 hours of a decision to take a sample.

2. The design of PASS does not require an isolated auxiliary system to be placed into operation in order to use PASS.

3. PASS provides capability to obtain a chloride sample for analysis within 24 hours of the sample being taken.

4. PASS is designed to make it possible to obtain and analyze a sample without radiation exposure to any individual exceeding the criteria of GDC 19.

5. The PASS in conjunction with the lab analysis is designed to provide pertinent data to the operator with adequate accuracy, range, and sensitivity to describe the radiological and chemical status of the reactor coolant systems.

6. The PASS is designed for consideration of the following:

    a. Sample line purging

    b. Reducing plateout in sample lines

c. Minimizing sample loss or distortion

d. Preventing blockage of sample lines by loose material

e. Appropriate disposal of samples or return of sample collection residues to containment or to a closed system

f. Flow restrictions to limit reactor coolant loss from a rupture of the sample line

g. Obtaining samples representative of the reactor coolant in the core area and the containment atmosphere following a transient or accident

h. Minimizing the volume of fluid to be taken from the containment by keeping the sample lines as short as possible

i. Filtration of sample station ventilation exhaust with charcoal adsorbers and HEPA filters.

7. PASS is designed to control releases of radioactive materials by using passive flow restrictions to limit potential leakage from sample lines.

9.3.2.2 System Description

9.3.2.2.1 Process Sampling

Plant Drawing M-23-0 shows the piping and instrumentation diagrams (P&IDs) for the Process Sampling System (PSS).

The PSS consists of centrally located, prefabricated, shop-assembled panels that contain sample conditioning equipment that reduces the pressure and controls the flow and temperature of the samples. All

sample stations are provided with stainless steel sinks that are hooded and ventilated to remove entrained gases liberated during normal sampling. The sinks drain into one of three drainage systems, depending on the service of the water being sampled. The three drainage systems are:

1. Clean radwaste system

2. Dirty radwaste system

3. Chemical radwaste drain system.

Exceptions to this include: 1) Some drainage from the Reactor Building sample station (10C251) which is routed to the main condenser, and 2) drainage from the Turbine Building sampling station (10C150) which is routed to the condensate drain tank (10T10B).

Where possible, automatic analyzers are used to measure critical analysis parameters. Data are recorded on strip chart recorders and in the plant computer.

The grab sample facilities allow operators to collect samples for chemical or radiological analysis.

The following systems are normally sampled in analyzer panels:

1. Reactor coolant at the inlet and outlet of the Reactor Water Cleanup System (RWCU)

2. Spent fuel pool filter demineralizer inlet and outlet

3. Condensate polishing system inlet and outlet

4. Deleted

5. Sampling of the main condenser evacuation system off-gas is provided by an air ejector off-gas Radiation Monitoring System (RMS) and sampling system that includes a vial sampler. The monitor is described in Section 11.5.2.2.5.

6. The condensate pre-filter system influent and each of the four pre-filter vessel effluent are sampled by corrosion product samplers.

Sampling of the Standby Liquid Control (SLC) System tank is by grab sample. The SLC system is addressed in Section 9.3.5.

A gaseous radwaste storage tank is not part of the HCGS design. Off-gas treatment system radioactivity is monitored downstream of the off-gas system charcoal adsorbers, upstream of the offgas system discharge valve. This monitor does not provide for sample removal. It is described in Section 11.5.2.2.6.

Sample flow rates to the analyzer and grab sample panels are designed to provide turbulent flow and to supply a representative sample. The liquid sample stations have flush and blowdown capabilities built into the system to reduce radiation exposure of the operator to as low as reasonably achievable (ALARA). The various sample points and design parameters provided to meet the acceptance criteria are listed in Table 9.3-3.

9.3.2.2.2 Post-Accident Sampling System

The Post-Accident Sampling System (PASS) is designed to obtain representative liquid and gas grab samples from the reactor coolant system and from the primary containment and reactor building atmospheres for radiological and chemical analysis under accident conditions. The grab samples are subsequently transported to the onsite laboratory for chemical and radioisotopic analysis or shipped offsite for analysis.

The system design minimizes operating complexities and "in-line" instrumentation, is modular for maintenance and contamination control purposes, and is compact in size to reduce the amount of shielding required. The system can be used to provide samples

under all plant conditions, ranging from normal shutdown and power operation to post-accident conditions.

Plant Drawings M-38-0 and J-38-0 show the piping and instrumentation diagrams and the logic diagrams respectively for the PASS. The equipment includes isolation and control valves, piping racks, shielded sample stations (gas and liquid), liquid chillers, and control panels for the sampling stations and the isolation valves. The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the PASS are as shown on Table 3.2-1. Demineralized water and nitrogen gas are provided as support systems for the PASS.

9.3.2.2.2.1 Sample Points

All sample points are dedicated lines which provide a representative sample in the event of an accident. The lines which carry samples originating from the primary containment or Reactor Building atmospheres are provided with 1/4 inch restriction orifices to limit the release of radioactive material in the Reactor Building (for the primary containment atmosphere samples) and in the Auxiliary Building (for the reactor building atmosphere sample) in the event of a sample line break.

In addition to the restriction orifices, normally closed double isolation valves are provided for all primary containment PASS lines and normally closed single isolation valves are provided for all Reactor Building PASS lines. These valves are remotely operated from control panels located near the post-accident sampling station and allow the PASS operator to select individual lines for sample gathering. A keylock permissive switch for these valves has been provided in the main control room (MCR) to ensure that a sample cannot be obtained without the knowledge of the control room operator. Sampling can be terminated at any time by the control room operator through the use of this permissive switch.

Post-accident sampling points and the design parameters are listed in Table 9.3-3.

1. Suppression Chamber and Drywell Atmosphere

   Sample lines are installed to obtain atmosphere samples from two separate areas in both the drywell and the suppression chamber. Drywell samples are taken at Elevation 153 ft on approximately opposite sides of the containment. Suppression chamber samples are taken at elevation 80 ft on opposite sides of the containment. The drywell and suppression chamber sample lines are connected directly to containment penetrations. Containment gas samples will be representative of conditions throughout the primary containment because the containment is not compartmentalized and the atmosphere is fully mixed.

2. Reactor Building Atmosphere

   A sample line is provided to allow sampling of the Reactor Building atmosphere to aid in determining post-accident accessibility of the reactor building enclosure. The sample is taken at approximately the 62 ft elevation of the reactor building near the torus water cleanup pump.

3. Reactor Coolant and Suppression Pool

   When the reactor is pressurized, reactor coolant samples are obtained from a tap off the jet pump pressure instrument system. The sample point is on a calibrated jet pump instrument line outside the primary containment and upstream of the excess flow check valve. This sample point location is preferred over the normal reactor sample points on the reactor water cleanup system inlet line and recirculation line because the reactor water

cleanup system is expected to remain isolated under accident conditions, and it is possible that the recirculation line containing the sample line may be isolated. The jet pump pressure tap is in a location protected from damage and debris. This sample point provides representative samples of reactor coolant under various reactor conditions:

a. Normal operation/small pipe break: Reactor water level can be maintained at or near normal water level. With a nearly normal water level, or at least water in the upper plenum, natural circulation will occur with a large loop from the downcomer to the shroud region via the jet pumps. With thermal conditions pumping water up through the core and back down past the tap from which the PASS sample is taken, a representative relationship will exist which will allow the results of the sample to be related to the condition of the core.

b. Large Pipe Break: A large pipe break, such as a recirculation pump suction line break, may occur wherein the water level may be controlled only by the height of the jet pumps and the ability to add water to the vessel. The sample taps are located sufficiently low to permit sampling at a reactor water level even below the lower core support plate. As reactor pressure decays, low pressure coolant injection (LPCI) is initiated into the core region. This water volume supplies more coolant than is boiled off by the decay heat. This excess water will flow down past the core, up through the jet pumps, and out through the postulated break, assuring a representative sample at the sample point.

To ensure a representative liquid sample from the jet pumps at low (<1 percent) power conditions for small break

or non-break events, the reactor water level will be raised to the level of the moisture separator when this action is not inconsistent with station emergency procedures. This will fully flood the separators and will provide a thermally induced recirculation flow path for mixing.

Samples will be taken from the reactor via the jet pump pressure instrument lines for as long as is possible. This allows a more direct and therefore faster response to core conditions. Upon decay or loss of reactor pressure, the jet pump sample point is lost, and the RHR loops sample points must be employed. Reactor coolant and/or suppression pool samples may be taken from the RHR sample lines, depending on the mode of RHR operation. These modes are:

a. LPCI: Suppression pool water is injected into the core, flows up through the jet pumps, and back to the suppression pool via the postulated break. The system will be operated for an estimated 30 minutes minimum prior to sampling of the suppression pool water to ensure that a representative sample is obtained at the sample taps.

b. Shutdown Cooling: The RHR system, aligned in the shutdown cooling mode, provides cooling and circulation of reactor coolant through the core, resulting in a representative sample at the RHR sample taps.

c. Suppression Pool Cooling: The RHR system, aligned in the suppression pool cooling mode, provides cooling and circulation of the suppression pool water The system will be operated for an estimated 30 minutes minimum prior to sampling of the suppression pool

water to ensure that a representative sample is obtained at the RHR sample taps.

These sample lines tap off upstream of the first isolation valve in the RHR system sample lines at the discharge of each RHR heat exchanger.

9.3.2.2.2.2 Isolation Valves and Sample Lines

Containment isolation for the drywell/suppression chamber gas sample lines, the jet pump instrument liquid sample line, and the gas/liquid sample return lines is provided by the isolation valves noted in Section 9.3.2.2.2.1. System isolation for the RHR liquid sample lines is provided by the isolation valves discussed in Section 9.3.2.2.2.1. All PASS isolation valves in the reactor building are environmentally qualified for the conditions in which they must operate.

The gas sample lines are heat traced to prevent precipitation of moisture and the resultant loss of iodine in the sample lines. Sample line routings are as direct and short as practical. Recirculation flow rates in the liquid sample lines are maintained in the turbulent flow region.

The liquid sample lines have top or side takeoff taps to minimize the possibility of line plugging.

Primary containment gas/liquid sample lines and Reactor Building gas sample lines are designed Seismic Category I up to and including each lines' piping to tubing reducer which is located immediately downstream of the restriction orifice. All sample lines beyond the piping to tubing reducers conform to quality group D, meet the requirements of ANSI B31.1, Power Piping Code, and are non-Seismic Category I. All isolation valves are located in the Seismic Category I portion of the sample lines.

9.3.2.2.2.3 Piping Station

The piping station includes sample coolers and control valves that determine the liquid sample flow path to the sample station. The piping station provides a flow path to recirculate liquid samples, bypassing the sample station until a representative sample condition is obtained.

The piping station is located near the steam tunnel in the Reactor Building El. 67 (13 feet above the floor) near the Auxiliary Building wall and is isolated from the PASS equipment. All sample lines to the sample station penetrate the Reactor/Auxiliary Building wall; the liquid sample lines are routed to the piping station for cooling before being sent to the sample station while the gas sample lines are routed directly to the sample station. The PASS sample station is described in Section 9.3.2.2.2.4.

The piping station receives cooling water from the Safety Auxiliaries Cooling System supply header located in the Reactor Building. The piping station is isolated from the PASS sampling station and control panels by the Reactor/Auxiliary Building wall.

The piping station is mounted flush against the steam tunnel and is accessible via an installed platform.

9.3.2.2.2.4 Sample Station and Control Panels

The sample station consists of a wall mounted frame and sample enclosures, and is mounted on the Reactor/Auxiliary Building wall at El. 54 of the Auxiliary Building. Included within the sample station are equipment trays that contain modularized liquid and gas samplers.

A penetration exists in the Reactor/Auxiliary Building wall which allows the various sample lines to interface with the sample station enclosure. This penetration is located behind the wall mounted sample station to eliminate any exposed sample lines. The liquid

sample portion of the sample station is shielded with 6 inches of lead brick; the gas sampler has 2 inches of lead shielding.

PASS control instrumentation is installed in a two-bay control panel. One of the panel bays contains the conductivity and radiation level readouts. The other panel bay contains the flow, pressure, and temperature indicators and various valve controls and switches. A graphic display which shows the status of the pumps and valves is provided on this panel, which is located near the PASS sample station.

The PASS isolation valve control panels are located near the PASS control panel. Once the MCR permissive keylock switch is activated, the isolation valves can be operated from these panels. Valve status indication is provided on the control panels; 100-percent- closed valve status signals are provided to the MCR via the plant computer. The valves close if the MCR permissive is removed.

9.3.2.2.2.5 Gas Sampler

The gas sample system is designed to operate at pressures ranging from subatmospheric up to the design pressures of the primary containment 1 hour after a LOCA. The gas sample is chilled to remove moisture, and a 15-milliliter grab sample can be taken for determination of gaseous activity and gas composition by gas chromatography. The gas is collected in an evacuated vial using hypodermic needles. When purging the drywell and suppression chamber gas sample lines to obtain a representative sample, the flow is returned to the suppression chamber. During purging of the Reactor Building line and when flushing the sample panel lines with nitrogen, flow is returned to

the Reactor Building. The sample station design allows for sample gas or nitrogen flushing of the entire sample panel line downstream of the four position selector valve. This capability minimizes the possibility of cross contamination between the various samples.

9.3.2.2.2.6 Liquid Sampler

The Liquid Sampling System is designed to operate at pressures ranging from 0 to 1150 psi. The design recirculation flow rate of 1 gpm is sufficient to maintain turbulent flow in the sample line and serves to minimize the possibility of cross contamination between samples. The recirculation flow is returned to the suppression pool. The Liquid Sampling System is designed to allow demineralized water flushing of the system lines from a point in the piping station through the sampling needles.

9.3.2.2.2.6.1 Diluted Liquid Sample

The small volume liquid samples are taken into 15 milliliter septum bottles mounted on sampling needles. In the sampling lineup, the sample flows through a conductivity cell (0.1 to 1000 micromhos/cm) and through a ball valve bored to 0.10 milliliter volume. After flow through the sample is established, the ball valve is rotated 90 degrees, and a syringe is used to flush the sample and a measured volume of diluent (generally 10 milliliters) through the valve and into the sample bottle. This provides an initial dilution of approximately 100:1. The sample bottle is contained in a shielded cask and remotely positioned on the sample needles through an opening in the bottom of the sample enclosure.

9.3.2.2.2.6.2 Non-Diluted Liquid and Dissolved Gas Samples

Alternatively, the sample can be diverted through a 70 milliliter holdup cylinder to obtain depressurized samples of primary coolant gas and liquid phases. A coolant sample is circulated through a holdup cylinder, the cylinder is then isolated and the contents

circulated through a loop. The gases are vented to an evacuated gas collection chamber, and a fraction of the gas is expanded into a syringe for analysis of individual species by gas chromatography. The concentration of total dissolved gas is determined by measuring the pressure rise in the gas collection chamber following gas expansion and applying the ideal gas law. Ten milliliter aliquots of degassed liquid can then be taken for offsite (or onsite depending on activity level) analyses which require a relatively large undiluted sample. This sample is obtained remotely using the large volume cask and cask positioner through needles on the underside of the sample station enclosure.

9.3.2.2.2.7 Sample Station Ventilation

The sample station enclosure will be vented into the reactor building through the sample line penetration described in Section 9.3.2.2.2.4. The sample station ventilation ducting is routed to the Reactor Building Ventilation System/Filtration, Recirculation and Ventilation System common return duct in the Reactor Building. The ventilation rate required for heat removal and proper sweep velocity during operation is about 40 scfm. A pressure gauge is attached to the sample station enclosure to monitor the pressure differential between the enclosure and the PASS area. The pressure differential will assure the operator that airborne activity in the sample enclosure will be swept into the Reactor Building.

9.3.2.2.2.8 Sample Station Sump

The sample station is provided with a bottom sump to collect liquid leakage. This sump can be isolated, pressurized, and discharged into the sample station liquid return line to the suppression pool.

9.3.2.2.2.9 Sample Handling Tools and Transport Containers

Appropriate sample handling tools and transporting casks are used. Gas vials are installed and removed by use of a vial

positioner through the front of the gas sampler. The vial is manually lowered into a shielded cask directly from the positioning tool. This allows the operator to maintain a distance of about 3 feet from the unshielded vial. The cask provides about 1-1/8 inches of lead shielding. A 1/8-inch-diameter hole is drilled in the cask so that an aliquot can be withdrawn from the vial with a gas syringe without exposing the analyst to the unshielded vial.

The small volume (diluted) liquid sample cask is a cylinder with a lead wall thickness of about 2 inches. The cask weighs approximately 50 pounds and has a handle which allows it to be carried by one person.

The 10-milliliter undiluted sample is taken in a 700-pound lead shielded cask which is transported and positioned by a four-wheel dolly. The sample is shielded by about 5-1/2 inches of lead.

9.3.2.2.2.10 PASS Power Supply

The PASS isolation and control valves, sample station control panels, isolation valve control panels, and auxiliary equipment are connected to a non-1E battery-backed power source. The safety auxiliaries cooling system, which is needed for the sample coolers, is powered from the emergency diesel generators following a loss of offsite power. Power for the gas sample line heat tracing is supplied from a diesel-backed source.

9.3.2.2.2.11 Storage and Disposal of Sample

Post Accident Sampling System accident samples are handled in accordance with the HCGS Emergency Plan Procedures. Ultimate storage and disposal of PASS accident samples will be performed in accordance with station procedures.

9.3.2.3 Safety Evaluations

9.3.2.3.1 Process Sampling System Safety Evaluation

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

The process sampling lines, connected to the reactor coolant pressure boundary (RCPB) through the first isolation valve outside containment, are designed to seismic category I requirements, as defined in Section 3.7. Sample lines that penetrate the containment are provided with isolation valves in accordance with 10 CFR 50, Appendix A, GDC 55, as described in Section 6.2.4.

9.3.2.3.2 Post-Accident Sampling System Safety Evaluation

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

However, NUREG-0737 Section II.B.3.1 requires that the PASS meet the following:

1. The licensee shall have the capability to promptly obtain reactor coolant samples and containment atmosphere samples. The combined time allotted for sampling and analysis should be 3 hours or less from the time a decision is made to take a sample.

The following is a conservative time sequence for sampling, transport, and analysis to demonstrate that samples can be obtained and analyzed within the specified 3-hour period:

a. Recirculate sample, install sample vial -- 15 min.

b. Operate sample station -- 15 min.

c. Transport sample to lab -- 20 min.

d. Analyze sample --- 30 min.

Sample points and sample gathering methods are discussed in Section 9.3.2.2.2.

2. The licensee shall establish an onsite radiological and chemical analysis capability to provide, within the 3-hour time frame established above, quantification of the following:

a. Certain radionuclides in the reactor coolant and containment atmosphere that may be indicators of the degree of core damage (e.g., noble gases, iodines and cesiums, and nonvolatile isotopes).

   A generic procedure to assess the extent of core damage based on radionuclide concentrations and other parameters has been prepared by the BWR Owners' Group (FSAR Section 1.8.1.97). An HCGS plant-specific procedure based on this methodology has been prepared and was submitted to the NRC in letter, R.L. Mittl, PSE&G, to W. Butler, NRC, dated June 24, 1985, and is included as a station procedure and referenced in the HCGS Emergency Plan Implementing Procedures.

b. Hydrogen levels in the containment atmosphere;

At greater than 15 percent power, the primary containment atmosphere is maintained under a nitrogen blanket. Hydrogen and oxygen concentrations are monitored by chemical analysis of gas samples drawn from various points in the drywell and suppression chamber. During post accident conditions, hydrogen and oxygen concentrations are monitored by one of two hydrogen/oxygen analyzers. The combustible gas analyzers are discussed in Section 6.2.5.2.5.

c. Dissolved gases (e.g., H_3), chloride (time allotted for analysis subject to discussion below), and boron concentration of liquids.

Total Dissolved Gas analysis will be performed by the method recommended by the BWR Owners Group and GE (as discussed in FSAR Section 1.8.1.97).

Chloride analysis will be performed by Ion Chromatography, Boron by Specific Ion Electrode.

d. Alternatively, have in-line monitoring capabilities to perform all or part of the above analyses.

Monitoring capabilities (radiation monitors and conductivity cell) are discussed in Section 9.3.2.5.2.

HCGS will have the capability of sending samples offsite. Arrangements will be made with offsite facilities to perform analyses and a licensed shipping cask will be obtained (such as recommended by the BWR Owners group) prior to core load.

3. Reactor coolant and containment atmosphere sampling during postaccident conditions shall not require an

isolated auxiliary system (e.g., the letdown system, reactor water cleanup system) to be placed in operation in order to use the sampling system.

Isolated auxiliary systems are not required for PASS operation. The PASS is described in Section 9.3.2.2.2.

4. Pressurized reactor coolant samples are not required if the licensee can quantify the amount of dissolved gases with unpressurized reactor coolant samples. The measurement of either total dissolved gases or H_2 gas in reactor coolant samples is considered adequate. Measuring the O_2 concentration is recommended, but is not mandatory.

   The method of gathering pressurized and non-pressurized reactor coolant samples is discussed in Section 9.3.2.2.2.

5. The time for a chloride analysis to be performed is dependent upon two factors: 1) if the plant's cooling water is seawater or brackish water and 2) if there is only a single barrier between primary containment systems and the cooling water. Under both of the above conditions the licensee shall provide for a chloride analysis within 24 hours of the sample being taken. For all other cases, the licensee shall provide for the analysis to be completed within 4 days. The chloride analysis does not have to be done onsite.

   A chloride analysis will need to be performed within 4 days of the sample being taken because 1) the plant has brackish cooling water and 2) two barriers are provided between primary containment systems and the cooling water (see Plant Drawing M-10-1).

6. The design basis for plant equipment for reactor coolant and containment atmosphere sampling and analysis must

assume that it is possible to obtain and analyze a sample without radiation exposures to any individual exceeding the criteria of GDC 19 (Appendix A, 10CFRPart 50) (i.e., 5 rem whole body, 75 rem extremities). (Note that the design and operational review criterion was changed from the operational limits of 10CFRPart 20 (NUREG-0578) to the GDC 19 criterion (October 30, 1979 letter from H.R. Denton to all licensees)).

The PASS radiation shielding design is in accordance with Section 12.3.2.2.6 to keep personnel exposures as low as practicable and within the limits established by GDC 19. The estimated doses are as follows:

Function	Time	Integrated Whole Body Dose (rem)	Integrated Extremity Dose (rem)
Recirculate and operate sampler	30 min	2.1	3.9
Transport Sample	20 min	1.2	0.07
Analyze	30 min	0.03	0.10
Total		3.33	4.07

7. The analysis of primary coolant samples for boron is required for PWRs. (Note that Revision 2 of Regulatory Guide 1.97 specifies the need for primary coolant boron analysis capability at BWR plants.)

   Boron is analyzed during post-accident conditions per procedure CH-EO.SH-004.

8. If in-line monitoring is used for any sampling and analytical capability specified herein, the licensee shall provide backup sampling through grab samples, and shall demonstrate the capability of analyzing the samples. Established planning for analysis at offsite facilities is acceptable. Equipment provided for backup sampling shall be capable of providing at least one sample per week until the accident condition no longer exists.

   HCGS PASS has the capability to obtain grab samples as described in Section 9.3.2.2.2.

9. The licensee's radiological and chemical sample analysis capability shall include provisions to:

   a. Identify and quantify the isotopes of the nuclide categories discussed above to levels corresponding to the source terms given in Regulatory Guide 1.3 or 1.4 and 1.7. Where necessary and practicable, the ability to dilute samples to provide capability for measurement and reduction of personnel exposure should be provided. Sensitivity of onsite liquid sample analysis capability should be such as to permit measurement of nuclide concentration in the range from approximately 1μCi/g to 10 Ci/g.

   b. Restrict background levels of radiation in the radiological and chemical analysis facility from sources such that the sample analysis will provide results with an acceptable small error (approximately a factor of 2). This can be accomplished through the use of sufficient shielding around samples and outside sources, and by the use of ventilation system design which will control the presence of airborne radioactivity.

A diluted liquid sample can be obtained as described in Section 9.3.2.2.2.6.

All sample bottles will be identified prior to sampling to eliminate unnecessary exposure resulting from handling high level samples. A centralized logging system will be developed to track sample aliquot identification, dilution factors, sample disposition, etc.

Liquid samples will be taken at the sample station in septum-type bottles and transported to the analysis facility in lead containers.

Sample aliquots are taken from the septum bottles for analysis or further dilution. Aliquoting and transfer will be performed using shielded containers, or behind a lead brick pile. Calibrated hypodermic syringes will be used for aliquoting the higher activity samples. Tongs or other holding/clasping devices will be available for holding the sample bottle during the transfer and dilutions to reduce hand and body exposure. Unless prohibited by the intended analysis, dilutions will be done using very dilute (about 0.01N) nitric acid as the diluent to minimize sample plateout problems.

Primary coolant samples obtained from the sampling station are diluted by a factor of 100 (0.1 ml coolant diluted to 10 ml). Under severe accident conditions, a calibrated syringe would be used to obtain an aliquot for this sample for further dilutions. At the maximum expected primary coolant activity level (3 Ci/cc), a dilution factor of $1 X 10^5$ would be required for gamma spectroscopy.

Gross activity measurements are accurate within a factor of 2. The onsite radiological and chemical laboratory

facilities are equipped with gamma spectral analysis equipment to quantify the radionuclides present in gas and liquid samples. Shielding is provided for the radiation detectors to minimize the effect of background radiation. Initial dilutions are performed in the process of taking liquid samples at the sample stations. Any additional dilutions required will be performed in the laboratory fume hood behind a lead brick pile.

If the levels of noble gases in the ambient atmosphere surrounding the detector are high enough to cause significant interference or to overload the detector, a compressed air or nitrogen purge of the detector shield volume will be maintained. Thus, useful samples may be obtained from the post-accident sampling station for coolant activity levels ranging from design basis accident source terms to well below the maximum level that can be tolerated at the normal reactor sample station.

10. Accuracy, range, and sensitivity shall be adequate to provide pertinent data to the operator in order to describe radiological and chemical status of the reactor coolant systems.

    The analytical methods selected by HCGS were based on research done by NUS, Exxon Nuclear, General Electric, and EPRI using the NRC Standard Test Matrix.

    a. Offsite provisions for chloride analysis will be accurate ~10 percent over the range 0.5 to 20 ppm and 0.05 ppm below concentrations of 0.5 ppm.

    b. Onsite chloride will be determined by Ion Chromatography. Table 9.3-7 lists range and

accuracy for onsite analysis. No radiation damage is anticipated with resins based on experience developed at Battelle. Resins are conventionally used to separate various isotopes at Batelle without problems. Damage occurs after extended exposure; however, the degradation process is slow. Anion resin will start to degrade at about 10E8 rads and cation resin at 5 x 10E8 rads. This is several orders of magnitude higher than will be encountered for the resins in the ion chromatograph. It is anticipated that electronic components of the type included in the ion chromatograph will be resistant to cumulative exposure well above 10E5 rads.

In the absence of dissolved hydrogen, it is possible the primary coolant will contain low ppm concentrations of hydrogen peroxide from radiolysis of water. The effect of this peroxide on readout of the conductivity cell in the ion chromatograph was investigated by adding peroxide to a solution containing 2 ppm HCl and measuring conductivity before and after the addition of peroxide. The justification for using a 2 ppm HCl solution is noted below. Essentially no effect was observed on conductivity within the limits of the accuracy of the instrumentation.

Chloride determination on an ion chromatograph are obtained by processing the water though resin columns and monitoring the conductivity of the effluent. The chloride (or other anions) will pass through the resin column in wave form at known time intervals after injection of the solution to be analyzed. Cations are removed by the suppressor corresponding acids such as HCl, H_2SO_4, etc., passing through the conductivity cell in wave form, each at a different, though known, time interval,

after the injection of the solution to be analyzed. Conductivity of the solution at a specific time interval is then related to acid concentration for the anionic species which passes through at that time.

Information developed in testing performed by NUS indicates that 5-10 ppm chloride in the sample size used will result in a maximum HCl concentration of about 2 ppm after it is separated in peaks as it passes through ion exchange columns in the ion chromatograph. The 2 ppm HCl concentration used in the peroxide test is based on the reasonable assumption that chloride level in the primary coolant will generally be below 10 ppm. Sensitivity will be in accordance with EPRI NP-3513.

c. A combination electrode will be used to measure the pH of coolant samples. Testing performed by GE has verified that expected levels of irradiation result in a shift of less than 0.3 pH units.

d. The boron determination is made on a 1:100 dilution of reactor water, the 5 ml sample radiation level is on the order of 30 R/hr at 1 cm two hours after the accident. The total dose to the fluoroborate electrode during the analyses sequence will be on the order of tens to hundreds of rads. The level of exposure is not anticipated to have any significant effect on the accuracy of measurement or operating lifetime of the probe.

e. The post-accident sample station is equipped with a 0.1 uS conductivity cell. The conductivity meter has a linear scale with a six-position range of 0-3, 0-10, 0-30, 0-100, 0-300 and 0-1000 uS when using the 0.1 uS cell. This conductivity measurement

system will be used to determine the primary coolant or suppression pool conductivity. During normal operation the Hope Creek UFSAR section 5.2.3.2.2.2 requires maintaining the primary coolant below 1.0 uS/cm, and conductivity measurements are the primary method of coolant chemical control.

Conductivity measurements are, of course, non-specific, but they serve the important function of indicating changes in chemical concentrations and conditions. Perhaps even more important, in the case of the BWR primary coolant, the conductivity measurements can establish upper limits of possible chemical concentrations and can eliminate the need for additional analyses.

The conductivity measurement can also be used to bound the possible range of pH values.

f. Equipment used for post-accident sampling and analyses will be calibrated or tested approximately every six months. Personnel classroom training in the collection and analysis of samples will be performed every six months.

11. In the design of the post-accident and analysis capability, consideration should be given to the following items:

a. Provisions for purging sample lines, for reducing plateout in sample lines, for minimizing sample loss or distortion, for preventing blockage of sample lines by loose material in the RCS or containment, for appropriate disposal of the samples, and for flow restrictions to limit reactor coolant loss from a rupture of the sample line. The post-accident reactor coolant and containment atmosphere samples

should be representative of the reactor coolant in the core area and the containment atmosphere following a transient or accident. The sample lines should be as short as possible to minimize the volume of fluid to be taken from containment. The residues of sample collection should be returned to containment or to a closed system.

b. The ventilation exhaust from the sampling station should be filtered with charcoal absorbers and high efficiency particulate air (HEPA) filters.

Purging of the gas sample lines and flushing of the liquid sample lines is discussed in Section 9.3.2.2.2.5 and 9.3.2.2.2.6 respectively. The gas sample lines are purged from a nitrogen gas supply. The liquid sample lines are flushed from a demineralized water tank which is pressurized from the nitrogen gas supply.

The liquid sample lines are designed for turbulent flow to reduce plateout (see Section 9.3.2.2.2.2).

Minimizing sample loss or distortion is discussed in Sections 9.3.2.2.2.1 and 9.3.2.2.2.2. Sample line blockage prevention is discussed in Section 9.3.2.2.2.2.

Sample line flow restrictors and isolation valves are discussed in Sections 9.3.2.2.2.1. and 9.3.2.2.2.2.

The PASS ventilation system is discussed in Section 9.3.2.2.2.7.

9.3.2.4 Testing and Inspection Requirements

9.3.2.4.1 Process Sampling System

The system will be preoperationally tested in accordance with the requirements of Section 14. System operability is demonstrated by use during normal plant operation.

9.3.2.4.2 Post-Accident Sampling System Testing and Inspection

For preoperational testing, nitrogen leak tests, hydrostatic tests, and electrical tests are required. Containment isolation valve leakage is tested periodically. During normal plant operation, the PASS is isolated from the rest of the plant. Calibration of instruments is performed. Inspection includes checking for line leaks, demineralized water tank level, nitrogen gas supply bottle pressure, and the refrigeration unit for lack of makeup water.

Periodic test and calibration of the PASS are described in the appropriate plant procedures.

9.3.2.5 Instrumentation Requirements

9.3.2.5.1 Process Sampling System Instrumentation

Temperature and flow indicators are used to facilitate manual operation and to verify sample conditions before samples are drawn.

The analytical variables are recorded. The main variables pertaining to the quality of the reactor coolant are entered into the computer.

All monitored variables have alarm trips that signal when present limits have been exceeded. Common trouble alarms are transmitted to the main control room.

9.3.2.5.2 Post-Accident Sampling System Instrumentation

1. Radiation monitors for the liquid and gas sample trays are displayed on the sample station control panel to verify that sample conditions are acceptable for taking samples.

   An area radiation monitor near the sample station informs operators of abnormally high activity. The display for this monitor is on the sample station control panel.

2. The post-accident sample station is equipped with a 0.1 cm^{-1} conductivity cell. The conductivity meter has a linear scale with a six position range selector switch to give conductivity ranges of 0-3, 0-10, 0-30, 0-100, 0-300, and 0-1000 micromho/cm when using the 0.1 cm^{-1} cell. This conductivity measurement system will be used to determine the primary coolant or suppression pool conductivity.

3. Remote operated valves located within the sample station enclosure have status lights indicating valve positions. These lights are located on the sample station control panel with their respective remote-manual switches.

4. Sample line isolation valves located in the Reactor Building and the Auxiliary Building have their control switches and position indicators on two remote control panels that receive a permissive signal originating from a keylock switch in the main control room. Computer inputs are provided whenever these isolation valves are not 100 percent closed. See the logic diagram on Plant Drawing J-38-0.

5. A mimic of the sample system is provided on the sample station control panel for ease of operator understanding and system control.

6. Gas sample temperature, flow, and pressure indicators are located in the sample station to verify a proper gas sample. The process variables for the liquid samples, e.g., temperature, pressure, conductivity, and flow rate, are displayed on the sample station control panel.

7. High liquid level in the gas cooler drain trap will alarm on the sample station control panel.

9.3.2.6 SRP Rule Review

In SRP Section 9.3.2, Revision 2, Acceptance Criterion II.5.a implies that the PASS should have the capability for verifying dissolved oxygen concentration in the reactor coolant. The PASS was designed prior to the issuance of SRP Section 9.3.2, Revision 2, and Regulatory Guide 1.97, Revision 2, which both now call for verification of dissolved oxygen.

During a meeting between GE and the NRC staff on May 2, 1984, GE agreed to include the capability for a dissolved gas grab sample in the PASS. The accuracies of the dissolved oxygen and dissolved total gas measurements were accepted by the NRC staff in a letter from W.V. Jonhston (NRC) to G.G. Sherwood (GE) dated July 7, 1984.

9.3.3 Equipment and Floor Drainage Systems

The plant equipment and floor drainage systems consist of the radioactive and nonradioactive waste drainage and collection systems. The radioactive and nonradioactive drainage systems are segregated to prevent transfer of radioactive contamination to the nonradioactive liquid wastes and uncontrolled access areas. The exception to this is the Turbine Building Circulating Water Dewatering Sump. This sump collects drainage from equipment and floor drains which are potentially contaminated with tritium from the supply HVAC units in the Auxiliary and Turbine Buildings.

The nonradioactive waste drainage systems consist of the normal waste, oily waste, chemical (acid/caustic) waste, sanitary, and plant storm drainage systems. The radioactive waste drainage systems consist of the clean radwaste (CRW), dirty radwaste (DRW),

high conductivity radwaste (ARW), decontamination radwaste (DECRW), detergent radwaste (DERW), and oily radwaste (ORW) drainage systems. All of the radwaste drainage systems shown in detail on Plant Drawing M-61-1 collect and transfer potentially radioactive liquid wastes.

The equipment and floor drainage systems are provided throughout the plant to collect liquid wastes from their sources and transfer them to sumps or tanks following selective collection.

The liquid radwaste is segregated based on its radioactivity and chemical purity, and then transferred to the appropriate radwaste management system for processing, recycle, or discharge.

9.3.3.1 Design Bases

The plant radioactive and nonradioactive drainage systems meet the following design bases:

1. The radioactive equipment and floor drainage systems serve the following major structures:

    1. Reactor Building

    2. Drywell

    3. Turbine Building

    4. Auxiliary Building.

2. Nonradioactive drainage systems are provided for the collection and disposal of storm drainage, sanitary drainage, oily waste, acid/caustic wastes, and normal waste.

3. An additional drainage system is provided for the lower basement level of the Turbine Building for

the collection and disposal of circulating water system waste to the circulating water return piping to the cooling tower. The drainage system also collects condensate and associated area equipment and floor drains from HVAC units which include Reactor Building ventilation, Service Area, Technical Support Center, and the Turbine Building Supply Units. This system is potentially contaminated with tritium from the supply HVAC systems which condense moisture from steam leaks.

4. The equipment drain system is designed to receive a drain maximum allowable equipment leakage of 25 gpm as stipulated in the Technical Specification for the drywell and Reactor Building, without overflowing.

5. To prevent backflow into the engineered safety features (ESF) equipment rooms, check valves are provided in each floor drain line from those rooms. Seismic Category I level switches, designed in accordance with IEEE 279 and 308, alarm in the main control room upon high water level in the ESF equipment room.

6. Vent lines from the sumps in the Auxiliary and Turbine Buildings containing potentially radioactive wastes are connected to and processed by high efficiency particulate air (HEPA) and charcoal filtration systems prior to release to the plant vent. The only exception to this is the Turbine Building Circulating Water Dewatering Sump, which is described in Section 9.3.3.1.3.

7. The capacity of the drywell and Reactor Building CRW sumps and sump pumps is designed to receive equipment leakage at the plant specification rate without overflow. Each sump, excluding the emergency sump in the Turbine Building, has a duplex pump arrangement. The backup pump starts after the water level rises above the first pump start level. The lead pump is alternated with each pump down cycle.

8. If the sump level for the equipment and floor drain sumps in the drywell and the equipment drain sumps in the reactor building exceeds preset high levels, an alarm is annunciated in the main control room. The level alarms for the other sumps are annunciated in the radwaste control room.

9. The inlet lines to the sumps are kept submerged a minimum of 1 foot below pump shutoff level to prevent backgassing.

10. The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the plant drainage systems are discussed in Section 3.2.

11. The oily radwaste drainage system in the turbine building drains to static oil interceptors, prior to discharge to the turbine building DRW drainage system and sumps.

12. Drainage lines from areas that are required to maintain an air pressure differential and drain to the same header are provided with water seals.

13. The sump pump's suction nozzles for the drywell sumps are submerged twelve inches below the minimum set water level to maintain a water seal and to prevent a vent path from the containment.

14. An emergency sump is provided in the Unit 1 turbine building for collection of wastes in the event of overflow of the DRW sump or to collect water used to extinguish a fire. The sump content is sampled and analyzed for radioactivity before being routed to the nonradioactive oily/low volume waste system.

15. An emergency sump is provided in the Unit 2 Turbine Building for collection of condensate from the Administration Building HVAC unit along with floor drains from the cancelled Unit 2 Turbine Building areas. The sump content is sampled and analyzed for radioactivity before being sent to a nonradioactive waste system.

9.3.3.2 System Description

The plant drainage systems consist of collection piping, equipment drains, floor drains, vents, traps, cleanouts, collection sumps, sump pumps, and associated instrumentation.

The plant drainage systems that provide for collection of various liquid wastes operate as listed below:

1. Radioactive drainage systems:

a. The CRW system collects liquid wastes of high chemical purity, i.e., less than 10 µmho/cm and less than 20 ppm suspended solids; of high radioactivity concentration of up to 10^{-1} µCi/cc; and with high potential for airborne releases from the drywell and the Reactor, Auxiliary, and Turbine Buildings. The drainage has hard piped connections to equipment drain funnels that convey the wastes by gravity to a sump in the respective enclosure.

b. The DRW system collects liquid wastes of lower chemical purity, i.e., up to 100 µmhos/cm and 200 to 300 ppm suspended solids; and of low radioactivity concentrations, up to 10^{-3} µCi/cc, from the drywell and the Reactor, Auxiliary, and Turbine Buildings. The drainage is collected by floor drains and equipment drain funnels and is conveyed by gravity to a sump in the respective enclosure. In the circulating water area of the turbine building, the floor drain sump is crosstied with the emergency sump to collect a flow rate input higher than the floor drain sump pumps' discharge capacities.

c. The ARW collects liquid wastes of high conductivity, i.e., 500 to 1000 µmhos/cm and 100 to 200 ppm suspended solids from the Auxiliary and Turbine Buildings. The drainage is collected by floor drains and equipment drain funnels and is conveyed by gravity to a sump in the respective enclosure.

d. The DECRW collects corrosive, potentially radioactive liquid wastes from the washdown and decontamination areas in the Reactor, Auxiliary, and Turbine Buildings; floor and equipment drain filters; condensate and fuel pool

filter demineralizers; and chemistry laboratory drains. The wastes are collected by floor drains and by hard piped connections to equipment drain funnels and are conveyed to the chemical waste tank in the auxiliary building.

e. The DERW system collects potentially radioactive liquid waste from the controlled laundry facilities, controlled lavatory, personnel showers, and decontamination areas. In addition, other miscellaneous sources of high conductivity, low activity water (e.g. mop water, water from decontamination projects, etc.) may be deposited in the detergent waste subsystem. The drainage is collected by floor drains and by hard piped connections to the laundry equipment drain funnels and is conveyed to the Liquid Radwaste System detergent drain tank located in the Auxiliary Building.

f. The ORW system collects potentially radioactive, oil water mixtures from the reactor feed pump rooms, motor generator set rooms, lube oil reservoir area, lube oil storage tank areas, mezzanine/air equipment area, and lube oil reservoir rooms for the reactor feed pump turbine (RFPT). The drainage is collected by floor drains and equipment drain funnels and is conveyed to the oil water separator located in the Turbine Building. The oil phase is discharged to 55-gallon drums, and the clarified effluent water is conveyed to the DRW drainage system in the Turbine Building.

g. The Turbine Building Circulating Water Dewatering Sump collects drainage that is potentially contaminated with tritium and discharges it to the cooling tower basin.

2. Nonradioactive liquid waste systems:

a. Oily waste drainage systems collect liquid wastes from the nonradioactive equipment areas in which oil is expected to be present. These areas include the circulating water pumphouse, Diesel Generator Building, transformer areas, oil circuit breaker areas, and Auxiliary Buildings.

b. The acid waste drainage system collects liquid wastes containing nonradioactive chemicals and corrosive substances from equipment and floor drains in the sodium hypochlorite and sulphuric acid/caustic storage tank areas, diesel building HVAC units and chillers, and corridors outside diesel building battery rooms on elevation 163'.

c. Sanitary drainage systems collect liquid wastes from all plant plumbing fixtures, with the exception of the lavatory basins and showers in the personnel decontamination area.

d. Storm drainage systems collect water from precipitation on enclosure roofs, areaways, the ground, and paved and unpaved surfaces outside the buildings.

e. The normal waste system collects liquid wastes from the nonradioactive equipment and floor drains. Condensate drainage from four Radwaste Area Supply units may also be collected by the normal waste system.

Oily, acid, and normal wastes drain to the low volume waste water collection and treatment system in the yard. Storm wastes drain to the Delaware River. Sanitary wastes drain to the sewage treatment plant for treatment and discharge.

There are some areas in the Hope Creek plant which contain both radioactive and non-radioactive drains. In those areas of the plant where nonradioactive drainage located in radiologically controlled areas, or are connected to a radioactive drainage system, the appropriate physical barriers and system operating procedures are provided to preclude the inadvertent transfer of contaminants to nonradioactive drainage systems. Table 9.3-8 lists areas in the plant where these physical barriers and plant procedures are employed. Hence, Hope Creek has no potential problems with radioactive fluid entering non-radioactive drains as a result of excessive flow or pluggage of the radioactive drains or pipe failures.

9.3.3.3 <u>Component Description</u>

All plumbing and drainage systems are installed in accordance with ANSI B31.1, National Standard Plumbing Code, and applicable local and state codes. Major components and design parameters are listed in Table 9.3-4.

In potential high radioactivity areas, the collection system piping for liquid waste is of carbon steel, except for the ARW, DECRW, and DERW systems, which have stainless steel piping.

The fabrication and installation of the piping provides for a uniform slope, inducing waste to flow in the piping at a velocity of not less than 2 ft/s. Equipment drainage piping is terminated not less than 6 inches above the finished floor or drain funnel at each location that collects the discharge from equipment.

All floor drains are installed with rims flush to the low point elevation of the finished floor. Floor drains in potentially radioactive areas are welded directly to the collection piping and provided with a threaded assembly inlet to allow insertion of a threaded plug of the same material, used to seal the floor drains when the drainage systems are pressure tested.

Inlets to all drainage systems, except in areas of potential radioactivity, are provided with a vented P-trap water seal to minimize entry of vermin, foul odors, and toxic, corrosive, or flammable vapors. Vent lines to the outside atmosphere are provided downstream of the P-traps to prevent excessive backpressures that could cause blowout or siphoning of the water seal. They are not normally installed on inlets in areas of potential radioactivity in order to reduce the potential for accumulation of radioactive solids.

Cleanouts are provided, when practical, in all collection system piping where the change in direction of horizontal runs is 90° and at maximum intervals of 50 feet. Cleanouts for the potentially radioactive collection systems are welded directly to the piping.

Potentially radioactive collection sumps are provided with a fitted checker plate cover for convenient maintenance access. The Turbine Building Circulating Water Dewatering Sump, described in Section 9.3.3.1.3, is the only exception to this. All sumps except for the drywell are recessed in concrete at the lowest elevation of the area served. The drywell sumps are located below the reactor pressure vessel (RPV) pedestal. The

radwaste sumps in the Turbine and Auxiliary Buildings are fitted with a 2-inch vent pipe to exhaust potential sump gases to a ducted, filtered exhaust system. The drywell and Reactor Building sumps vent back into their respective enclosures.

The drywell and Reactor Building equipment drain sumps are provided with cooling coils using Reactor Auxiliaries Cooling System (RACS) water to keep the wastes at their normal operating temperature of 140°F.

9.3.3.4 System Operation

The equipment and floor drainage systems' wastes are selectively collected and drain directly to the area collection point by gravity. After collection in area sumps, the liquid radwaste is pumped to the radwaste collection tanks for processing by the appropriate treatment subsystems. The sump pumps start automatically when a preset high water level is reached. They stop at a preset low water level. Leaks inside the drywell drain to the drywell floor sump, except for the reactor recirculation pump seal leakoffs, which are routed to the drywell equipment sump. After a preset level is reached in the emergency sump in the turbine building and an alarm is annunciated, the sump contents are analyzed for radioactivity before discharge. The only exception to the above treatment of radwaste is the Turbine Building Circulating Water Dewatering Sump. This is described in Section 9.3.3.2.1.g.

The Sanitary Drainage System collects liquid wastes and entrained solids discharged by plumbing fixtures, with the exception of lavatory basins and showers in the personnel decontamination area and conveys them to the sewage treatment plant.

The Storm Drainage System collects water from precipitation on enclosure roofs, areaways, paved and unpaved surfaces, and irrigation runoffs outside the buildings, and conveys them to the Delaware River.

Low volume and oily water wastes from the emergency diesel generator and chemical regenerant waste from the makeup demineralizer, chemical storage tank dikes, equipment drains, transformer dikes, etc, are collected and pumped to the waste treatment plant in the yard area. These wastes are treated to a level that meets Environmental Protection Agency (EPA) and New Jersey Department of Environmental Protection (NJDEP) discharge limits before being discharged into the Delaware River.

9.3.3.5 Safety Evaluation

The plant drainage systems have no safety-related function. It has been verified that flooding from a postulated failure of non-Seismic Category I systems and components (including large tanks and piping connected to these tanks) will not compromise the operation of any safety-related system or prevent safe shutdown of the plant. Most large volume non-Seismic Category I tanks and systems are located in the Turbine Building and the radwaste area of the Auxiliary Building with no potential for flooding areas containing equipment required for safe shutdown. Safety-related cables in these areas are located above any potential flood levels, or if flooded, the effects are evaluated.

In the Reactor Building and the control and diesel areas of the Auxiliary Building potential flooding from postulated failure of non-Seismic Category I systems and components is contained within the compartment containing the equipment or is evaluated for effects on other areas. The flooding will drain to the respective floor drain sumps. Essential equipment is located in areas/compartments not subject to flooding by the failure of non-Seismic Category I components or the potential flooding effects are evaluated.

In the unlikely event that a seismic event also causes the exposed drain line from the postulated floor area to leak, the fluid may drip into an area containing essential equipment.

The essential equipment is either located such that is not subjected to the dripping or is designed to withstand the effects of the dripping. The dripping fluid will drain from the compartment through the floor drains.

Each Emergency Core Cooling System (ECCS) compartment is provided with a separate drain line to the Reactor Building DRW sump. Flooding of the ECCS pump compartments in the reactor enclosure by backflow through the floor drains is prevented by the use of check valves (backwater) installed in these lines. Backflow through equipment drain funnels is prevented by the use of plates welded to the drain pipe and the drain funnel. Blank welded plates are fitted to equipment drains designated as not to be used. These plates close the drains to the atmosphere and prevent backflooding. A normally closed manual valve is provided for the floor drain line in the Safety Auxiliary Cooling System (SACS) pump compartment to prevent backflow. The check valves are evaluated to assure they will perform their function following an SSE. The piping inside the sumps associated with these check valves has been analyzed to assure it will not fail in an SSE.

Each ECCS compartment is equipped with watertight doors to prevent any spread of the flooding. In the ECCS compartment, Seismic Category I level instrumentation installed in the main control room for high water level alarms in the event of drain blockage or flooding.

The drywell drain sumps and the floor drain sumps in the reactor enclosure are also used as a means to detect plant leakage as discussed in Section 5.2.5.

9.3.3.6 Tests and Inspections

All drainage piping is tested prior to its embedment in concrete. Potentially radioactive drainage piping is pneumatically tested to 20 ± 5 psig air for a minimum of 10 minutes, in accordance with ANSI B31.1 (1973). Where this test is not practical, a service leak test will be used for inspection, in accordance with ANSI B31.1, Section 137.7. Nonradioactive oily, acid,

and storm drainage piping is hydrostatically tested to the equivalent of 20 ± 5 psig for 10 minutes. Piping to drain condensation from the HVAC units will be pneumatically tested to 20 ± 5 psig, where practical. Sections of piping which were impractical to hydrotest will be observed for inservice leakage. The sanitary drainage piping is tested according to the National Standard Plumbing Code at a hydrostatic pressure of 10 feet of water for 15 minutes. Plant drainage system operability is checked by normal use and by the instrumentation provided in the sumps and the main control room.

9.3.3.7 Instrumentation Application

1. Drywell equipment and floor drain sumps - A level measurement in each sump is fed to a programmable controller that starts and stops the lead sump pump at preset high and low levels, respectively. The programmable controller also starts the second pump and alternates the lead pump after each pump cycle. The alarm on high level in each sump is annunciated in the main control room.

   Temperature measurement and alarm on high temperature are provided for the drywell equipment drain sump.

2. Equipment, floor drain, and high conductivity sumps in Reactor, Turbine, and Auxiliary Buildings - High and low level switches provided in each sump automatically start and stop the sump pumps. A level switch set at a higher level starts the second pump. A mechanical alternator device, provided for the duplex pump arrangement, alternates the lead pump after each pump down cycle.

   High-high and low-low level switches are provided in each sump to alarm on high influent rate or sump pump and instrumentation malfunction. The alarms for the reactor building equipment drains are annunciated in the main control room. Alarms for the other sumps are annunciated in the radwaste control room.

Temperature, flow, and pressure of the liquid influent are detected by sensing or monitoring devices, such as sight flowglasses, flowmeters, and temperature sensors, in the hard piped connections to the drainage system to aid in identifying and quantifying the source of any excessive leakage or drainage.

9.3.4 Chemical and Volume Control System

This section is not applicable to Hope Creek Generating Station.

9.3.5 Standby Liquid Control System

9.3.5.1 Design Bases

Portions of the Standby Liquid Control (SLC) System are designed to meet Seismic Category I criteria. The SLC system meets the following design bases:

1. Backup capability for reactivity control is provided, independent of normal reactivity control provisions in the nuclear reactor, to shut down the reactor if the normal reactivity control provisions become inoperative.

2. The system has the capacity for controlling the reactivity difference between the steady-state rated operating condition of the reactor with voids and the cold shutdown condition, including shutdown margin, to ensure complete shutdown from the most reactive condition at any time in core life.

3. The time required for actuation and effectiveness of the system is consistent with the nuclear reactivity rate of change predicted between rated operating and cold shutdown conditions. Neither a fast reactor scram nor operational control of fast reactivity transients is

specified to be accomplished by this system. However, its performance ensures compliance with the criteria imposed for the postulated failure of the normal scram function during anticipated transients.

4. Means are provided by which the functional performance capability of the 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 system.

5. The neutron absorber is dispersed within the reactor core in sufficient quantity to provide a reasonable margin for dilution leakage, and imperfect mixing.

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

7. The single failure of an active component of the system does not cause the loss of more than one half of the system pumping capability.

9.3.5.2 System Description

The SLC system, shown on Plant Drawing M-48-1, is initiated through two keylocked switches in the main control room to pump a boron neutron absorber solution into the reactor if the operator determines that the reactor cannot be shutdown or kept shutdown with the control rods. The system is also designed to automatically initiate upon receipt of a signal from the Redundant Reactivity Control System (RRCS) logic. Low vessel water level (L2), high reactor vessel domes pressure, or manual RRCS actuation starts a timer. If the core power is not downscale at the end of this time delay, SLC operation is initiated. The RRCS will initiate both SLC system pumps during an ATWS event.

The main control room switches are provided to ensure positive action from the main control room should the need arise. Procedural controls are applied to the operation of these keylocked main control room switches. Keylocked switches are provided to prevent inadvertent manual initiation of the SLC system.

The SLC system is needed only in the improbable event that not enough control rods can be inserted into the reactor core to accomplish shutdown and cooldown in the normal manner. Normally the reactor scram function of the Control Rod Drive (CRD) System discussed in Section 4.6.1.2.5, backed up by the alternate rod insertion (ARI) function, is expected to ensure prompt shutdown of the reactor when required. The operator control console and the emergency response information system displays provide abnormal status information, including reactor power, low water level, and high dome pressure to indicate if SLC system initiation is needed.

Initiation of the SLC system causes isolation of the Reactor Water Cleanup (RWCU) System, except during SLC system recirculating tests, to prevent loss or dilution of the sodium pentaborate solution. Initiation of one injection pump loop closes the inboard containment isolation valve of the RWCU system, and initiation of the other loop closes the RWCU system outboard containment isolation valve. Shutoff of the SLC injection pump following initiation does not reopen the RWCU system containment isolation valves.

The boron solution storage tank, the test tank, the two positive displacement injection pumps, the two explosive actuated injection valves, the two motor operated stop-check shutoff valves, and the associated local valves and controls that comprise the SLC system are located in the Reactor Building. The boron solution is pumped into the core spray piping leading to the core spray loop A sparger. The solution enters the reactor vessel through the sparger inlet nozzle and is sprayed radially over the top of the core from the sparger A spray nozzles. See Section 6.3.2. for a description of the core spray system design.

The boron absorbs thermal neutrons and thereby terminates the nuclear fission chain reaction in the uranium fuel. With both pumps operating (from time of SLC initiation), the SLC system can deliver the control liquid to the RPV in $\leq$46 seconds with HPCI operating and $\leq$ 190 seconds without HPCI operating.

The specified reactivity control liquid is an aqueous solution of sodium pentaborate ($Na_2B_{10}O_{16} \bullet 10H_2O$). It is prepared by dissolving stoichiometric quantities of borax and boric acid in demineralized water. An air sparger is provided in the boron solution storage tank for mixing. To prevent system plugging, the tank outlet is raised above the bottom of the tank.

As shown on Figure 9.3-9, the design ensures enough solution for reactor shutdown. This is accomplished by placing sodium pentaborate in the SLC boron solution storage tank and adding demineralized water to at least the low-level alarm point. The solution can be diluted with water to within 6 inches of the overflow level volume to allow for evaporation losses or to lower the saturation temperature.

The minimum temperature of the fluid in the boron solution storage tank and the suction piping is consistent with that obtained from Figure 9.3-9 for the solution temperature. The saturation temperature of the recommended solution is 62°F at the low-level alarm volume, and is a lower temperature at 6 inches below the tank overflow volume, as shown on Figures 9.3-9 and 9.3-10. The equipment containing the solution is installed in a room in which the air temperature is maintained above boron solution saturation temperature, as shown in Reference 3.11-5. An electrical resistance heater system provides a backup heat source that maintains the solution temperature at 75°F (automatic operation) to 85°F (automatic shutoff) to prevent precipitation of the sodium pentaborate from the solution during storage. High or low boron solution temperature (in either the tank or the pump suction piping), or high or low liquid level in the tank, is annunciated in the main control room. Discussion of the boron solution storage tank level instrumentation is provided in Section 7.4.1.

Each positive displacement injection pump is sized to inject the boron solution into the reactor at the rate of 43 gpm. The pump and system design pressure between the explosive actuated valves and the pump discharge is 1400 psig. Two relief valves in the pump discharge lines are set at 1400 psig. 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 in the pump discharge lines provide assurance of opening when needed and ensure that boron solution does not leak into the reactor, even when the pumps are being tested.

Each explosive actuated valve is closed by a plug in the valve inlet chamber. The plug is circumscribed with a deep groove so the end readily shears off when pushed with the valve shearing plunger. This opens the inlet hole through the plug. The sheared end is pushed out of the way in the chamber; it is shaped so it 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 continuously monitored by a trickle current, and an alarm occurs in the main control room if either circuit opens. Indicator lights in the main control room show which primer circuit has opened.

A discussion of the SLC system containment isolation provisions is provided in Section 6.2.4.

An indicator light in the main control room shows that power is available to the pump motor contactor and that the contactor is deenergized (pump not running). Another light indicates that the contactor is energized (pump running).

A decrease in storage tank liquid level, high injection pump discharge pressures, and a loss of continuity on the explosive valves indicate that the system is functioning.

Local handswitches are provided for recirculation testing of the injection pumps. The local switches have a "stop" position that does not stop the pump if an initiation signal from either the RRCS or control room is present. This prevents isolation of the pumps from outside the main control room. Pump discharge pressure and discharge valve status are indicated in the main control room.

The SLC system pumps can be shut off from the main control room by depressing the "stop" pushbutton for each SLC pump at the SLC control station on the operator's console. Manual shutoff is possible even when an automatic RRCS signal is present. The pumps are also shut off automatically at zero tank level using a two out of two logic for each pump.

SLC system equipment drains and tank overflow are not piped to the radwaste system, but are piped to separate 55-gallon drums that can be removed and disposed of independently of the radwaste system to prevent any trace of boron from inadvertently reaching the reactor.

Instrumentation consisting of boron solution temperature indication and control, and heater system status is provided locally at the storage tank. Indication for the SLC storage tank solution level is provided in the main control room. Table 9.3-5 contains the process data for the various modes of operation of the SLC system. Seismic category and quality class design criteria are included in Table 3.2-1. System testing requirements are discussed in Section 9.3.5.4.

9.3.5.3 Safety Evaluation

The system is never expected to be needed for safety reasons because of the large number of independent control rods available to shut down the reactor.

To ensure the availability of the SLC system, two sets of the components required to actuate the system, i.e., pumps and explosive valves, are provided in parallel.

The system is designed to bring the reactor from rated power to a cold shutdown at any time in core life. The reactivity compensation provided reduces reactor power from rated to zero power level and allows for cooldown of the nuclear system to room temperature, with the control rods remaining withdrawn in the rated power pattern. It includes the reactivity gains that result from complete decay of the rated power xenon inventory. It also includes the positive reactivity effects from eliminating steam voids, changing water density from hot to cold, reduced Doppler effect in uranium, reducing neutron leakage from boiling to cold, and decreasing control rod worth as the moderator cools.

Under the worst condition, the minimum average concentration of natural boron required in the reactor core to provide adequate shutdown margin, after operation of the SLC system, is 660 ppm. Calculation of the minimum quantity of sodium pentaborate to be injected into the reactor is based on the required 660 ppm average concentration in the reactor coolant, including recirculation loops, at 68°F and with the reactor vessel water level at level 8. The result is increased by 25 percent to allow for imperfect mixing and leakage. Additional sodium pentaborate is provided to accommodate dilution by the RHR system in the shutdown cooling mode. This concentration is achieved if the solution is prepared as defined in Section 9.3.5.2 and is maintained above its saturation temperature.

Cooldown of the nuclear system requires a minimum of several hours to remove the thermal energy stored in the reactor, cooling water, and associated equipment. The controlled limit for the reactor vessel cooldown is 100°F per hour, and normal operating temperature is approximately 550°F. Use of the main condenser and various shutdown cooling systems requires about 6 to 24 hours

to lower the reactor vessel to a subcooled 70°F condition. This condition requires the minimum 660 ppm concentration of boron.

The SLC system equipment essential for injection of neutron absorber solution into the reactor is designed as Seismic Category I, as discussed in Section 3. The system piping and equipment are designed, installed, and tested in accordance with requirements stated in Section 3.2.

The SLC system is required to be operable in the event of a plant offsite power failure; therefore, the pumps, heaters, valves, and controls are powered from the onsite standby power supply. Redundant active components are powered and controlled from separate buses and circuits, so that a single active failure of the power supply does not prevent system operation.

The SLC system pumps have sufficient pressure margin, up to the system relief valve setting of approximately 1400 psig, to ensure solution injection into the reactor at all reactor operating pressures. The main steam safety/relief valves (SRVs) begin to relieve pressure above approximately 1100 psig. Therefore, the SLC system positive displacement pumps cannot overpressurize the nuclear system.

Only one of the two SLC injection pumps is needed to meet the design bases of Section 9.3.5.1. If a redundant component, e.g., one pump, is found to be inoperative, there is no immediate threat to shutdown capability, and reactor operation can continue during repairs.

The SLC system is evaluated against the applicable 10CFR50 Appendix A General Design Criteria as follows:

1. Criterion 2 - The SLC system is located in the area outside of the primary containment (drywell) and below the refueling floor. In this location, it is protected by the containment and compartment walls from external

natural phenomena such as earthquakes, tornadoes, hurricanes, and floods and internally from the effects of postulated events, e.g., a DBA-LOCA.

2. Criterion 4 - The SLC system is designed for the expected environment in the primary containment and specifically for the compartment in which it is located. In this compartment, it is not subject to the more violent conditions postulated in this criterion, such as missiles, whipping pipes, and discharging fluids.

3. Criterion 21 - Criterion 21 is applicable to protection systems only. The SLC system is a reactivity control system and should be evaluated against Criterion 29 discussed in item 6.

4. Criterion 26 - The recirculation system flow control is the second reactivity control system required by this criterion. The requirements of this criterion do not apply within the SLC system itself.

5. Criterion 27 - This criterion applies no specific requirements to the SLC system and therefore is not applicable. See Section 3.1 for discussion of combined capability.

6. Criterion 29 - The SLC system pumps and injection valves are redundant. The two pumps and two injection valves are arranged and cross tied so that operation of either valve and either pump results in successful operation of the system. The SLC system also has testing capability. A special test tank is supplied for providing test fluid for a periodic injection test. Pumping capability may be tested at any time. A trickle current continuously monitors continuity of the firing mechanisms of the injection valves.

The SLC system is evaluated against the applicable Regulatory Guides as follows:

1. Regulatory Guide 1.26 - Because the SLC system is a reactivity control system, all mechanical components are at least Quality Group B. Those portions that are part of the reactor coolant pressure boundary are Quality Group A. This is shown in Table 3.2-1.

2. Regulatory Guide 1.29 - All components of the SLC system that are necessary for injection of neutron absorber into the reactor are Seismic Category I, as shown in Table 3.2-1.

3. Branch Technical Positions APCSB 3-1 and MEB 3-1 - Since the SLC system is located in its own compartment within the reactor building, it is adequately protected from flooding, tornadoes, and internally and externally generated missiles, as discussed in Section 3. SLC system equipment is protected from pipe break by providing adequate distance between the Seismic Category I and non-Seismic Category I SLC system equipment where such protection is necessary. In addition, appropriate distance is provided between the SLC system and other piping systems. Where adequate protection cannot be ensured, barriers have been considered to ensure SLC system protection from pipe break, as discussed in Section 3.6.

   It should be noted that the SLC system is not required to provide a safety function during any postulated pipe break events. This system is only required under an extremely low probability event, where in all of the control rods are assumed to be inoperable while the reactor is at normal full power operation. Therefore, the protection provided is considered over and above that required to meet the intent of APCSB 3-1 and MEB 3-1.

This system is used in special plant capability demonstration events cited in Section 15.9 (specifically, events 51, 52, and 53), which are extremely low probability non-design basis postulated incidents. These analyses are to demonstrate additional plant safety considerations far beyond reasonable and conservative assumptions.

A system level, qualitative type failure mode and effects analysis relative to the system's ability to meet the single failure criterion is discussed in Section 15.

9.3.5.4 Testing and Inspection Requirements

Operational testing of the SLC system is performed in at least two parts to avoid inadvertent injection of boron into the reactor.

With the storage tank outlet valve and the maintenance valve downstream of the explosive valve closed, and with the valves on the test tank discharge and return lines opened, demineralized water can be circulated by locally starting one of the pumps. This test can be accomplished on one loop during normal plant operation while the remaining loop is available to inject control liquid in response to an initiation signal.

During a refueling or maintenance outage, both pumps and automatic valves can be tested. In the test mode, demineralized water is pumped from the test tank through the explosive valves and into the vessel upon receipt of a simulated ATWS signal from the RRCS logic. During testing, the storage tank outlet valve is closed while the test tank discharge valve is open.

After functional testing, the injection valve shear plugs and explosive charges are replaced and all the valves returned to their normal positions, as indicated on Plant Drawing M-48-1.

After closing a local locked open valve to the reactor, leakage through the injection check valves can be detected by opening the

valves in the test connection between the containment isolation injection check valves. Position indicator lights in the main control room indicate that the local valve is either closed for tests, or open and ready for operation. Leakage from the reactor through the first check valve can be detected by opening the same test connection in the line between the containment isolation injection check valves when the reactor is pressurized.

Should the boron solution ever be injected into the reactor, either intentionally or inadvertently, then after making certain that the normal reactivity controls will keep the reactor subcritical, the boron is removed from the reactor coolant system by flushing for gross dilution followed by operating the RWCU system. There is practically no effect on reactor operations when the boron concentration is below approximately 50 ppm.

The concentration of the sodium pentaborate in the solution tank is determined periodically by chemical analysis.

Electrical continuity of the explosive valve ignition circuit is also subjected to periodic testing, as discussed in the Technical Specifications.

The SLC system preoperational test is described in Section 14.

9.3.5.5 Instrumentation Requirements

The instrumentation and controls for the SLC system are designed to allow the injection of sodium pentaborate into the reactor and to maintain the boron solution well above its saturation temperature. A further discussion of the SLC system instrumentation and controls is found in Section 7.4.

9.3.6 Primary Containment Instrument Gas System

During normal operation, the Primary Containment Instrument Gas System (PCIGS) supplies gas to various components inside primary containment. During an accident, the system also supplies air to the ADS valve actuators inside primary containment. The system, shown on Plant Drawing M-59-1, is safety-related and Seismic Category I with the following exceptions:

1. The supply line to the Traversing Incore Probe (TIP) System

2. The supply line to the drywell/suppression chamber vacuum relief valves from the isolation valves inside the suppression chamber

3. The intertie between the two trains of the primary containment instrument gas system past the isolation valves

4. The supply header inside the drywell downstream of the header isolation valves.

The quality assurance program discussed in Section 17 is applicable to the Seismic Category I portions of this system.

9.3.6.1 Design Bases

1. The PCIGS is designed to provide a continuous supply of dry, oil free, filtered compressed gas to components inside primary containment.

2. Two 100 percent capacity instrument gas compressing trains are provided that are interconnected during normal operation but separated in the event of an accident.

3. Standby diesel generator (SDG) Class 1E electrical power is available for the instrument gas compressors following a loss of offsite power (LOP) or a loss-of-coolant accident (LOCA).

4. Provisions are made so that the PCIGS may be connected to the Plant Instrument Air System, discussed in Section 9.3.1, for maintenance activities. Instrument air into the Instrument Gas System is admitted through a remote manually actuated, normally closed valve.

5. All safety-related portions of the PCIGS are classified Seismic Category I and have a quality group classification commensurate with required functions as discussed in Section 3.2.

6. Cooling water is available for the intercoolers, aftercoolers, and compressors from the Safety Auxiliaries Cooling System (SACS), discussed in Section 9.2.2, during all modes of operation.

7. Safety-related portions of the PCIGS have been qualified for service under the seismic and environmental conditions postulated to exist during and following postulated accidents. This is discussed in Sections 3.9 and 3.11.

8. Containment isolation is provided as discussed in Section 6.2.4.

9.3.6.2 System Description

The PCIGS is shown schematically on Plant Drawing M-59-1. The major equipment design parameters are listed in Table 9.3-6.

The PCIGS consists of two redundant compressor trains. Each train consists of an inlet filter, compressor, intercooler and moisture separator, aftercooler and moisture separator, dryer prefilter, dryer, outlet filter, and receiver. All of the above equipment is located in the Reactor Building.

Each compressor train, as previously noted, has its own dual-tower, heatless, desiccant dryer. During operation, one tower is removing moisture from the gas while the other tower is regenerating with dry gas. The gas used by the regenerating tower is returned to the compressor intake. The two towers are alternated on a timed cycle.

The system is designed to meet the requirements of ANSI MC11-1, 1976, pertaining to the quality of the instrument gas. Further details can be found in Table 9.3-6.

The PCIGS outlet filter removes 0.3 micrometer particles with a 98 percent efficiency. The system is designed to permit preventive or corrective maintenance on one compressor, dryer and filter train without affecting system operability.

Inlet screens have been provided at the drywell intake and each of the post-LOCA intakes to preclude any loose debris from entering the compression trains.

9.3.6.2.1 Normal Operation

During normal operation, the two trains are interconnected downstream of the receivers isolation valves that terminate the two safety-related headers inside the drywell. Suction is taken from the drywell through a common suction line and intake screen. One compressor is selected to operate in the lead mode. This compressor automatically starts and stops to meet the system demand. The other compressor operates in the lag mode, starting when the demand exceeds the capacity of the lead compressor or the lead compressor fails to start. Cooling water flow from the SACS system is controlled by a motor-operated valve that opens when the compressor starts and closes when the compressor stops.

The components supplied during normal operation are:

1. The main steam line safety/relief valves (SRVs)

2. The inboard MSIVs

3. The TIP System

4. The drywell/suppression chamber vacuum relief valves

5. All other gas operated valves inside primary containment.

9.3.6.2.2 Loss of Offsite Power Operation

The Containment Instrument Gas System will be manually loaded onto the SDG approximately 30 minutes after an LOP. No changes to the system valve positions or modes for compressor operation are made to the system after restarting. If drywell temperature increases enough to affect PCIG temperatures, the compressor suction will be manually transferred from the drywell to the Reactor Building air space. All valves that could require a source of gas before the compressors are restarted are provided with individual accumulators to ensure operability.

9.3.6.2.3 Loss-of-Coolant Accident Operation

A high drywell pressure signal signifying a possible LOCA trips the compressors. The LOCA signal also closes all of the primary containment isolation valves, the intertie line isolation valves, and the valves at the termination of the two safety-related headers inside the drywell. The plant operators will then have the capability of restarting the compressors and overriding the LOCA signal to the supply header containment isolation valves. Both trains of the containment instrument gas system are switched to the lead mode of operation following the LOCA signal. The suction from the drywell is isolated and each compressor takes suction from inside the Reactor Building through its own suction line and intake screen. The isolation valves on the interties and on the TIP and vacuum relief valve supply lines will remain closed.

The service that will be supplied during a LOCA by the PCIGS is the SRVs used by the Automatic Depressurization System (ADS), discussed in Section 6.3. Valves such as the SRVs, which may be required immediately following the LOCA but before restarting the PCIGS, are provided with local accumulators to ensure availability.

9.3.6.3 Safety Evaluation

The PCIGS system serves a safety-related function by providing a reliable gas supply to the SRVs including those controlled by the ADS. The safety relief valves are used whenever the alternate shutdown cooling flowpath is used or when long term reactor vessel venting is desired. The safety relief valves can be used during the post-LOCA time period.

The safety-related portions of the system are designed to Seismic Category I criteria and ASME B&PV Code, Section III. The compressor is not "N"-stamped but was designed, tested, and fabricated to the intent of ASME B&PV Code, Section III, Class 2, and Regulatory Guide 1.48. The components and their respective Code classifications are shown in Table 3.2-1. Failure of the nonsafety-related portions of the system will not impair the ability of the system to fulfill its safety-related functions.

The system is housed within the Reactor Building. Protection from the following phenomena is provided as described in the following referenced sections:

1. Wind and tornado protection - Section 3.3

2. Flood protection - Section 3.4

3. Missile protection - Section 3.5. In addition, each compressing train is housed in its own compartment to preclude damage from missiles generated by the other compressing train.

4. Protection against dynamic effects associated with pipe ruptures - Section 3.6.

5. Environmental design considerations are discussed in Section 3.11.

Failure of a single component will not interrupt the operation of the PCIGS because of the redundant trains provided with separate sources of electric power fed from independent Class 1E sources.

9.3.6.4 Tests and Inspections

The PCIGS components are tested and inspected before leaving the supplier's shop to ensure that the system will meet the design criteria. The system is preoperationally tested in accordance with the requirements of Section 14.

Operability of the system is demonstrated by actual use during normal operation.

PCIGS dew point will be tested in accordance with ANSI MC11.1-1975, Quality Standard for Instrument Air, at a frequency of once per quarter.

PCIGS particle size testing will be performed at the dryer/receiver on an 18 month frequency to assure 10 micron quality gas is supplied to the system piping. This is the minimum particle size requirement found during the system functional review. This is well below the 50 micron maximum particle size requirement required for the critical components supplied by PCIGS such as ADS and the MSIV's. PCIGS gas oil/hydrocarbon testing will be performed at the dryer/receiver on an 18 month frequency to the requirements of ISA S7.3.

Contaminant testing of PCIGS will be performed at the dryer/receiver on an 18 month frequency to assure contaminants not expected in the Primary Containment atmosphere are not being introduced into the system.

9.3.6.5 Instrumentation Applications

Instrumentation is provided for each train of the PCIGS to monitor and automatically control the system's operation. Further information on the system control and logic is discussed in Section 7.3.

The compressor is instrumented to shut down under the following conditions:

1. Low lubricating oil pressure
2. High lubricating oil temperature
3. High discharge gas temperature
4. High cooling water temperature
5. High inlet gas temperature
6. Low cooling water flow
7. High discharge gas pressure
8. Low suction pressure
9. High receiver pressure.

The occurrence of any of the above will alarm at the local control panel and in the main control room. A startup time delay bypass switch is provided for low lubricating oil pressure to allow for low pressures during compressor startup. Receiver low and high pressures are alarmed in the main control room.

Each compressor system has a shutdown switch that actuates on receipt of the LOCA signal.

The compressor designated as "lead" is automatically started on low instrument gas receiver pressure. The "lag" compressor automatically starts on low-low receiver pressure.

TABLE 9.3-1

COMPRESSED AIR SYSTEMS DESIGN PARAMETERS

Service Air Compressors

Quantity	2
Type	Three stage, direct drive, centrifugal
Capacity, each, scfm	3000
Pressure rating, psig	110
Motor power rating, hp	800
Phase/frequency/rpm	3/60/3600

1st Stage Service Air Compressor Intercooler

Quantity	2 (integral with compressors)
Type	Shell and tube
Number of air passes	1
Number of water passes	12
Duty, Btu/h	680,181

2nd Stage Service Air Compressor Intercooler

Quantity	2 (integral part of compressor)
Type	Shell and tube
Number of air passes	1
Number of water passes	12
Duty, Btu/h	587,000

Service Air Aftercooler with Moisture Separators

Quantity	2
Type	Shell and tube

Service Air Aftercooler with Moisture Separators

Duty, Btu/h	574,700
Shell design	
Fluid	Air
Flow rate, lb/h	14,022
Design pressure, psig	150
Design temperature, °F	300
Tube design	
Fluid	Turbine Auxiliaries Cooling System water
Flow rate, gpm	60
Design pressure, psig	150
Design temperature, °F	300

Service Air Receiver

Quantity	1
Type	Horizontal, cylindrical
Capacity, ft^3	427
Design pressure, psig	150
Design temperature, °F	-20 to 500

Emergency Instrument Air Compressor

Type	Two stage, oil free Rotary screw
Quantity	1
Capacity, scfm	1070
Pressure rating, psig	150 (125 psig operating pressure)
Motor power rating, hp	250

Emergency Air Oil Cooler, Intercooler, and Aftercooler

Quantity	1
Type	Shell and tube
Duty, Btu/h	684,000
Shell design	
Fluid	Reactor Auxiliaries Cooling System water
Flow rate, gpm	45
Design pressure, psig	145 (max)
Design temperature, °F	95 (max)

Emergency Instrument Air Receiver

Quantity	1
Type	Vertical, cylindrical
Capacity, each, ft^3	57
Design pressure, psig	125
Design temperature, °F	400

Instrument Air Dryer Package

Prefilters	
Quantity	2 (1 per dryer)
Type	Dry type with renewable media
Flow rate, scfm	1200
Rating	99 percent of 0.01 micron particles

Instrument Air Dryer Package

Dryers	
Quantity	2
Type	Heatless type, dual drying chamber, desiccant type
Capacity, each, scfm	1200
Pressure, psig	150 (max)
Temperature,°F	120 (max)
Outlet moisture content:	-100°F dew point at line pressure
Inlet moisture content:	Saturated
Afterfilters	
Quantity	1 per dryer
Type	Dry type with renewable media
Flow rate, scfm	600
Rating	General purpose 1.0 micron particles

Instrument Air Dryer Package Tag No. 1AF104

Prefilter	
Quantity	1
Type	Dry with renewable media
Flow rate, scfm	900
Rating	100 percent of.6 micron particles
Dryer	
Quantity	1
Type	heatless, dual drying chamber, desiccant
Capacity, scfm	900
Pressure, psig	110
Temperature, °F	110
Outlet moisture content:	-100° F dew point at line pressure
Inlet moisture content:	Saturated
Afterfilters	
Quantity	1
Type	Dry with renewable media
Flow rate, scfm	900
Rating	100 percent of .9 micron particles

Instrument Air Receivers

Quantity	2
Type	Horizontal, cylindrical
Capacity, each, ft^3	155
Design pressure, psig	150
Design temperature, °F	-20 to 500

TABLE 9.3-2

TABLE DELETED

TABLE 9.3-3

BWR SAMPLE POINTS-CAPABILITIES AND DESIGN DATA

BWR Sample Points	Panel Number Location	Pressure psig Max/Norm	Temperature °F Max/Norm	Root Valve Piping Class	Root Valve Isolation Provisions	ALARA Provision	Automatic Monitoring Performed	Grab Samples For	P & ID Location	Minimum Sample Flow Rate	Comments
Air Ejector offgas	10C335 Aux bldg				Double isolation on steam jet air ejector	Vial Sampler	Radiation	Radiation	M26, Sh 1 (B3)		Vital sampler; see Section 11.5
RWCU reactor coolant inlet	10C251 Reactor Bldg	1420/1161	150/120	EBC	None	Hooded sample station	Conductivity DO, pH	Insolubles, chlorides	M44	500ml/min /ft/sec	
RWCU reactor coolant outlet	10C251 Reactor Bldg	1300/1102	150/120	EBC	None	Hooded sample station	Conductivity	chlorides	M44	500ml/min /ft/sec	
SLCS tank	Grab sample from standby control tank				Liquid		None	Boron	NA	NA	See Section 9.3.5
Sumps inside ctmt (drywell (floor dr) (drywell equip drn)	00C350 Aux bldg	175/160 175/160	150/100 150/100	HBD HBD	HV-F004 HV-F003 HV-F019 HV-F020	Hooded sample station	None	Radioactiv-ity, Conduc-tivity,pH Chlorides	M61, Sh1 (E2),(G2) M61, Sh2 (D2),(G2)	500ml/min /ft/s	
Spent fuel pool	Aux bldg 00C350	160/100 160/100	150/90 150/90	HCD HCD	None None	Hooded sample station	Demin Outlet Conductivity	Silica and heavy elements	M54-0 (G4) M54-0 (H6)	500ml/min /ft/s	
Drywell atmospheric	1AP 270 1B0 Reactor bldg			HCB HCB	Double isol valves	Located in reactor bldg remote readout	Noble gases Radionuclide spectra		M25-1, Sh1 (F4)	500ml/min /ft/s	See Section 11.5

BWR Sample Points

Post-Accident Sampling System	Panel Number Location	Pressure psig Max/Norm	Temperature °F Max/Norm	Root Valve Piping Class	Root Valve Isolation Provisions	ALARA Provision	Automatic Monitoring Performed	Grab Samples For	P & ID Location	Minimum Sample Flow Rate	Comments
Offgas treatment system	00C323						Radiation	None			No sampling capability; see Section 11.5
Condensate polisher system inlet and outlet	10C150 Turbine building	220/150	135/124	HBD	None	Hooded Sample station	Conduc-tivity DO	Metallic impurities		500ml/min /ft/s	See Note 1
Suppression Pool RHR loop A	Aux bldg 10C909	150/NA 150/NA	120/NA 120/NA	CCB CCB	Double normally closed isolation valves with flow orifices	Passive restric-tion of orifices downstream of isola-tion	Conductivity radiation	Gross activity gamma spectrum, boron chloride dissolved H2, O_2, pH	M51-1 Sh1 (D,3) M51-1 Sh1 (D, 7) Penetration P-227 (return)	1 gpm 1 gpm	Samples return suppression chamber RHR loops in suppression pool cooling mode
Reactor coolant Jet Pump RHR loop A RHR loop B	Aux bldg 10C909	1150/NA 450/NA 450/NA	546/NA 320/NA 320/NA	CCA CCB CCB	Double normally closed isolation valves with flow orifices	(1)(2)	Conductivity radiation	Gross activity gamma spectrum, boron, chloride dissolved oxygen pH	M42-1Sh1 (D, 3) M51-1 Sh1 (D, 3) M51-1Sh2 (B, 4)	1gpm 1gpm 1gpm	Sample cooled to 150°F at piping station before entering sample station
Drywell atmosphere	Aux bldg 10C909	62(10min)/ NA	340(200min)/ NA	HCB	Double normally closed isolation valves with flow orifices	(1)(2)	Radiation for I_2, sample	Hydrogen,oxygen Iodine/ particulate cartridge, gamma spectrum, gas liquid chromatography	Penetra-tion J-7E and J10-E	0.1-0.5 cfm	Samples return to suppression chamber

TABLE 9.3-3 (Cont)

BWR Sample Points

Post-Accident Sampling System	Panel Number Location	Pressure psig Max/Norm	Temperature °F Max/Norm	Root Valve		ALARA Provision	Automatic Monitoring Performed	Grab Samples For	P & ID Location	Minimum Sample Flow Rate	Comments
				Piping Class	Isolation Provisions						
Suppression Chamber Atmosphere	Aux bldg 10C909	62(10min)/ NA	340(150min) NA	HCB	Double normally closed isolation valves with flow orifices		Radiation for I_2, sample	Hydrogen, oxygen, Iodine/ particulate cartridge, gamma spectrum, gas liquid chromatography	Penetration J-206 J-221, J-220 (return)	0.1-0.5 cfm	Samples return to suppression chamber
Reactor building enclosure	Aux bldg 10C909	2	150	HCB	One normally closed isolation valves with flow orifices		Radiation for I_2, sample	Hydrogen, oxygen, Iodine/ particulate cartridge, gamma spectrum, gas liquid chromatography	M38-0 Sh2, (E,6)	0.1-0.5 cfm	Samples return to reactor building atmosphere

Notes: (1) Non-pass samples may be taken at alternative sample points as described in Section 9.3.2.1.1 (PSS samples only).

TABLE 9.3-4

PLANT DRAINAGE SYSTEMS
COMPONENT DESCRIPTION

SUMPS				PUMPS					
Drainage System	Quan-tity	Type	Working Capacity, gallons	Quan-tity	Type	Total Discharge Head, feet	Flow Rate, gpm	Horse-power	Design Pressure/ Temperature, psig/°F
Drywell equipment drains (CRW)	1	Vertical, stainless steel(sst)-lined sump	130	2	Vertical/centrifugal	70	50	5.0	14.7/160
Drywell floor drains (DRW)	1	Vertical, sst-lined sump	130	2	Vertical/centrifugal	70	50	5.0	14.7/160
Reactor Bldg equipment drains (CRW)	2	Vertical, sst-lined sump	150	4	Vertical/centrifugal	70	50	5.0	14.7/160
Reactor Bldg floor drains (DRW)	2	Vertical, sst-lined sump	500	4	Vertical/centrifugal	70	50	5.0	14.7/120
Radwaste Bldg equipment drains (CRW)	3	Vertical, sst-lined sump	450	6	Vertical/centrifugal	70	50	5.0	14.7/120
Radwaste Bldg floor drains (DRW)	3	Vertical, sst-lined sump	450	6	Vertical/centrifugal	70	50	5.0	14.7/120
Radwaste Bldg high conductivity (ARW)	2	Vertical, sst-lined sump	450	2	Vertical/centrifugal	70	50	5.0	14.7/120
Turbine Bldg equipment drains (CRW)	2	Vertical, sst-lined sump	450	4	Vertical/centrifugal	70	50	5.0	14.7/120
Turbine Bldg high conductivity (ARW) drains	1	Vertical, sst-lined sump	300	2	Vertical/centrifugal	70	50	5.0	14.7/100
Turbine Bldg floor drains (DRW)	2	Vertical, sst-lined sump	450	2	Vertical/centrifugal	70	50	5.0	14.7/120
Turbine Bldg emergency sump (DRW)	1	Horizontal carbon steel (cs)-lined sumps	4000	1	Vertical/centrifugal	70	1,300	28.0	14.7/200

TABLE 9.3-4 (Cont)

SUMPS				PUMPS						
Drainage System	Quantity	Type	Working Capacity, gallons	Quantity	Type		Total Discharge Head, feet	Flow Rate, gpm	Horsepower	Design Pressure/ Temperature, psig/°F
Oily waste drains	1	Vertical cs-lined sump	250	2	Vertical/centrifugal		75	35	3	14.7/70
Oily wastewater	1	Concrete pit (lift station 1A)	12,000	3	Horizontal/ centrifugal	(2)	56	2,400	75	14.7/100
						(1)	25	100	2	14.7/100
Low volume wastewater	2	Concrete pit (lift station 1B; 1C)	1500	4	Horizontal/ centrifugal	(2)	45	100	3	14.7/100
						(2)	66	150	5	14.7/100

TABLE 9.3-5

STANDBY LIQUID CONTROL SYSTEM OPERATING PRESSURE/TEMPERATURE CONDITIONS

	Standby Mode[1]		Test Modes[1] Circulation Test		Test Modes[1] Injection Test[2]		Operating Mode[1]	
Piping	Pressure, psig[3]	Temperature, °F	Pressure, psig[3]	Temperature, °F	Pressure, psig[3]	Temperature, °F	Pressure, psig[3]	Temperature, °F
Pump suction	Storage tank static head	70/110[4]	Test tank static head[5]	70/110[4]	Test tank static head[5]	70/110[4]	Storage tank static head	70/110[4]
Pump discharge to explosive valve inlet	0	70/110	0/1255	70/100	40 (plus reactor static head)	70/100	40 (plus reactor static head) to 1255	70/110
Explosive valve outlet to, but not including, motor operated stop check globe valves	Reactor static head to 1140[6]	70/110	Reactor static head to 1140[6]	70/100	<40 (plus reactor static head)	70/100	<40 (plus reactor static head) to <1255	70/110
Motor operated stop check globe valves to core spray line	Reactor static head to 1140[6]	70/560[7]	Reactor static head to 1140[6]	70/560[7]	Reactor static head[2]	≤125[2]	Reactor static head to 1140[6]	70/560[7]

(1) The pump flow rate is zero (pump not operating) during the standby mode, at 43 gpm during the test modes (one pump operation) and is at rated system flow during the operating mode (two pump operation).

(2) Reactor to be at 0 psig steam dome pressure and ≤125°F before changing from the standby mode to the injection test mode.

(3) Pressures tabulated represent pressure at the points identified below. To obtain pressure at intermediate points in the system, the pressures tabulated must be adjusted for elevation difference and pressure drop between such intermediate points and the pressure points identified below:

Piping	Pressure Point
Pump suction	Pump suction flange inlet
Pump discharge to explosive valve inlet	Pump discharge flange outlet

TABLE 9.3-5 (Cont)

Piping	Pressure Point
Explosive valve outlet to, but not including, motor operated stop check globe valves	Explosive valve outlet
Motor operated stop check globe valves to the reactor	Reactor core spray nozzle

(4) During chemical mixing, the liquid in the storage tank is at a temperature of 150°F maximum.

(5) Pump suction piping is subject to demineralized water supply pressure during flushing and filling of the piping and during any testing where suction is taken directly from the demineralized water supply line rather than the test tank.

(6) Maximum reactor operating pressure is 1140 psig at the reactor core spray sparger outlet.

(7) 560°F represents maximum sustained operating temperature.

TABLE 9.3-6

CONTAINMENT INSTRUMENT GAS SYSTEM DESIGN PARAMETERS

Instrument Gas Compressor

Quantity	2
Type	Two stage, nonlubricated reciprocating
Capacity, each, scfm	35
Pressure rating, psig	125
Motor rating, hp	15

Instrument Gas Receiver

Quantity	2
Type	Vertical, cylindrical
Capacity, nominal each, ft^3	225
Design pressure, psig	125
Design temperature, °F	150

Instrument Gas Intercooler

Quantity	2
Type	Shell and tube
Tube design	
Fluid	Nitrogen or air
Flow rate, scfm	35
Design pressure, psig	125
Design temperature, °F	350
Shell design	
Fluid	Demineralized water
Flow rate, gpm	4
Design pressure, psig	150
Design temperature, °F	150

<u>Instrument Gas Aftercooler</u>

Quantity	2
Type	Shell and tube
Tube design	
Fluid	Nitrogen or air
Flowrate, scfm	35
Design pressure, psig	125
Design temperature, °F	325
Shell design	
Fluid	Demineralized water
Flow rate, gpm	4
Design pressure, psig	150
Design temperature, °F	150

<u>Instrument Gas Compressor Thermosiphon</u>

Quantity	2
Type	Shell and tube
Tube Design	
Fluid	Demineralized water
Flow rate, gpm	4
Design pressure, psig	150
Design temperature, °F	150
Shell Design	
Fluid	50/50, water/glycol
Flow rate, gpm	0.25
Design pressure, psig	Atmospheric
Design temperature, °F	175

Instrument Gas Dryer

Quantity	2
Type	Dual tower, heatless desiccant
Capacity, each, scfm	35
Pressure, psig	125
Inlet temperature, °F	105
Outlet dew point	-50°F at line pressure
Inlet moisture content	Saturated
Design pressure, psig	125
Design temperature, °F	150

Instrument Gas Inlet Filter

Quantity	2
Type	Dry type with renewable media
Flow rate, scfm	20 (nominal system capacity)
Rating	98 percent of 5μ particles

Instrument Gas Dryer Prefilter

Quantity	2
Type	Dry type with renewable media
Flow rate, scfm	20 (nominal system capacity)
Rating	98 percent of 0.3μ particles
Removal efficiency for incident water and oil at rated flow	99.99 percent

Instrument Gas Outlet Filter

Quantity	2
Type	Dry type with renewable media
Flow rate, scfm	20 (nominal system capacity)
Rating	98 percent of 0.3μ particles

Compressor Suction Inlet Screens

Quantity	3
Size	2" raised face flange
Mesh	$\leq$ 0.045" - (225 per in^2)

TABLE 9.3-7

RANGE AND ACCURACY FOR ONSITE ANALYSES

ANALYSIS	EQUIPMENT[1]	SUITABILITY	METHOD	RANGE & ACCURACY
1. Chloride	Dionex 2020-I	Recommended by EPRI (NP-3513)	Ion Chromatography	0.5 to 20 ppm ± 10 percent < 0.5 ppm ± .05 ppm
2. Conductivity	GE PASS Conductivity Meter	Verified by NRC Exxon Study and GE	Direct Measurement by in-line Conductivity cell	0.54 to 2.0 μS ± 10 percent > 2.0 μS ± 20 percent
3. Radiochemical Gross Gamma Isotopic	GE Detector Multichannel	Recommended by EPRI (NP-3513)	Gamma Spectroscopy	Within a factor of two across the entire range
4. pH	pH Meter	Recommended by EPRI (NP-3513)	Potentiometry with glass Electrode	5 to 9 ± 0.3 pH units < 5 or > 9 ± 0.5
5. Boron	Selective Ion Electrode	Recommended by EPRI (NP-3513)	Potentiometry	50-1000 ± 50 ppm
6. Dissolved Gas Measurement	GE PASS	Verified by GE & Accepted by the NRC	GE PASS system	< 400 cc/kg as recommended by BWR owners group and accepted by the NRC

Notes: (1) or equivalent as determined by applicable specifications.

TABLE 9.3-8

RADIOLOGICALLY CONTROLLED AREAS OF THE PLANT WHICH CONTAIN NON-RADIOACTIVE DRAINAGE SYSTEMS

Case	Location	Non-Radioactive Drain Arrangement	Administrative Controls/ Physical Barrier Description
1	- Turbine Building - 54', Condenser Dewatering Pumps Area, Rm. 1101 - Auxiliary Building - 153', H&V Equipment Area Rm 3601 & 153'-3", Mech Rm 3613 (Rm 3613 is not in RCA, but contains drains that are potentially contaminated with tritium and are cross-tied to the DRW System.) - Turbine Building - 171', H&V Equipment Area Rm. 1703	- 3 floor and 2 equipment drains are connected to the Circulating Water Sump 10T168, which may be contaminated with tritium. - 15 equipment & 4 floor drains are connected to the Circulating Water Sump, which may be contaminated with tritium. A normally isolated inter-tie to the DRW system is also provided. - 4 equipment and 10 floor drains are connected to the Circulating Water Sump 10T168, which may be contaminated with tritium. Normally isolated inter-ties to the DRW system are also provided.	The Circulating Water Sump is equipped with a Rad Monitor (RE-4557) which trips the sump pumps if a high concentration of radionuclides are present. Trip setpoint is based on compliance with 10CFR20, Appendix B limits and the design objectives of 10CFR50, Appendix I. Floor & equipment drain openings are labeled as nonradioactive. The Circulating Water Sump is routinely sampled and analyzed for radionuclide concentrations.
2	- Reactor Building - 102', SACS Pump & HX Rooms 4307 & 4309 - Reactor Building - 77', RACS Pump & HX Rooms 4209 & 4211	- 6 Open drain funnels that collect Service Water from vents & drains and ultimately discharge to the Cooling Tower Basin.	Physical elevations of funnel openings are above design maximum flood levels in rooms. The four drain funnels that are near the floor are labeled as nonradioactive.
3	- Turbine Building - 77', Makeup Demineralizer Skid Area 1225	- 3 open resin strainers (OAS-139, OBS-139, & OCS-139) that collect vent & drain effluents from demineralizer vessels and ultimately discharge to Salem Nonradwaste Basin or a tanker truck.	Strainer openings are labeled as nonradioactive Strainers drain to Makeup Demineralizer Regenerant Waste Tank 00T122, which by procedure, is sampled for radionuclides prior to being batch released to a nonradiologically controlled area.
4	- Turbine Building - 54', Unit 1 Room 1118. - Turbine Building - 54', Unit 2 Room 2118 (Rm 2118 is not in the RCA, but is vulnerable to radioactive waste intrusion.)	- Effluent from Unit 1 & 2 Emergency Sumps are directed to a nonradioactive waste system. Sumps are vulnerable to radioactive waste intrusion if a flood occurred in the Turbine Bldg. common area on 54' elevation. Unit 1 Emergency Sump also receives overflow from Unit 1 DRW Sumps.	By procedure, sumps are sampled and analyzed for radioactivity before being sent to a nonradioactive waste release point.
5	- Turbine Building - 137', Unit 2 Areas 42, 43, 46, & 47	- 6 floor drains are connected to the NW System.	NW System directs fluids to the Unit 2 Emergency Sump (See Case 4). Drain openings are labeled as nonradioactive. Plugs are installed in each drain opening (No credit taken for this feature.)

TABLE 9.3-8 (cont)

RADIOLOGICALLY CONTROLLED AREAS OF THE PLANT WHICH CONTAIN NON-RADIOACTIVE DRAINAGE SYSTEMS

Case	Location	Non-Radioactive Drain Arrangement	Administrative Controls/ Physical Barrier Description
6	- Auxiliary Building - Elev. 155'-3", H&V Equipment Area, Rm. 3609 - Auxiliary Building - Elev. 172'-3", (Non-RCA), H&V Equipment Area, Roof	- Condensate from HVAC units OAVH317 & OBVH317 is piped to the NW & DRW Systems. - Floor drain piping & condensate piping from OAVH315 & OBVH315 is connected to NW & DRW Systems.	NW to DRW crosstie is at a physical elevation higher than any DRW floor drain connection, which precludes inadvertent contamination of the NW System due to back flow. Drains from OAVH317 & OBVH317 are hard piped, which precludes radioactive fluid from entering NW system from backflow of adjacent floor drains. Lock Closed isolation valve separates the DRW and NY System (No credit taken for this feature.) Plant procedures require NW drain path to be isolated prior to establishing drain path to DRW (No credit taken for this feature.)

Figure F9.3-1 intentionally deleted.

Refer to Plant Drawing M-15-0 SH 1 in DCRMS

Figure F9.3-2 intentionally deleted.

Refer to Plant Drawing M-15-0 SH 2 in DCRMS

Figure F9.3-3 SH 1 intentionally deleted.

Refer to Plant Drawing M-15-0 SH 4 in DCRMS

Figure F9.3-4 SH 1-3 intentionally

deleted. Refer to Plant Drawing

M-23-0 in DCRMS

Figure F9.3-5 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-38-0 for both sheets in DCRMS

Figure F9.3-6 SH 1-2 intentionally deleted.

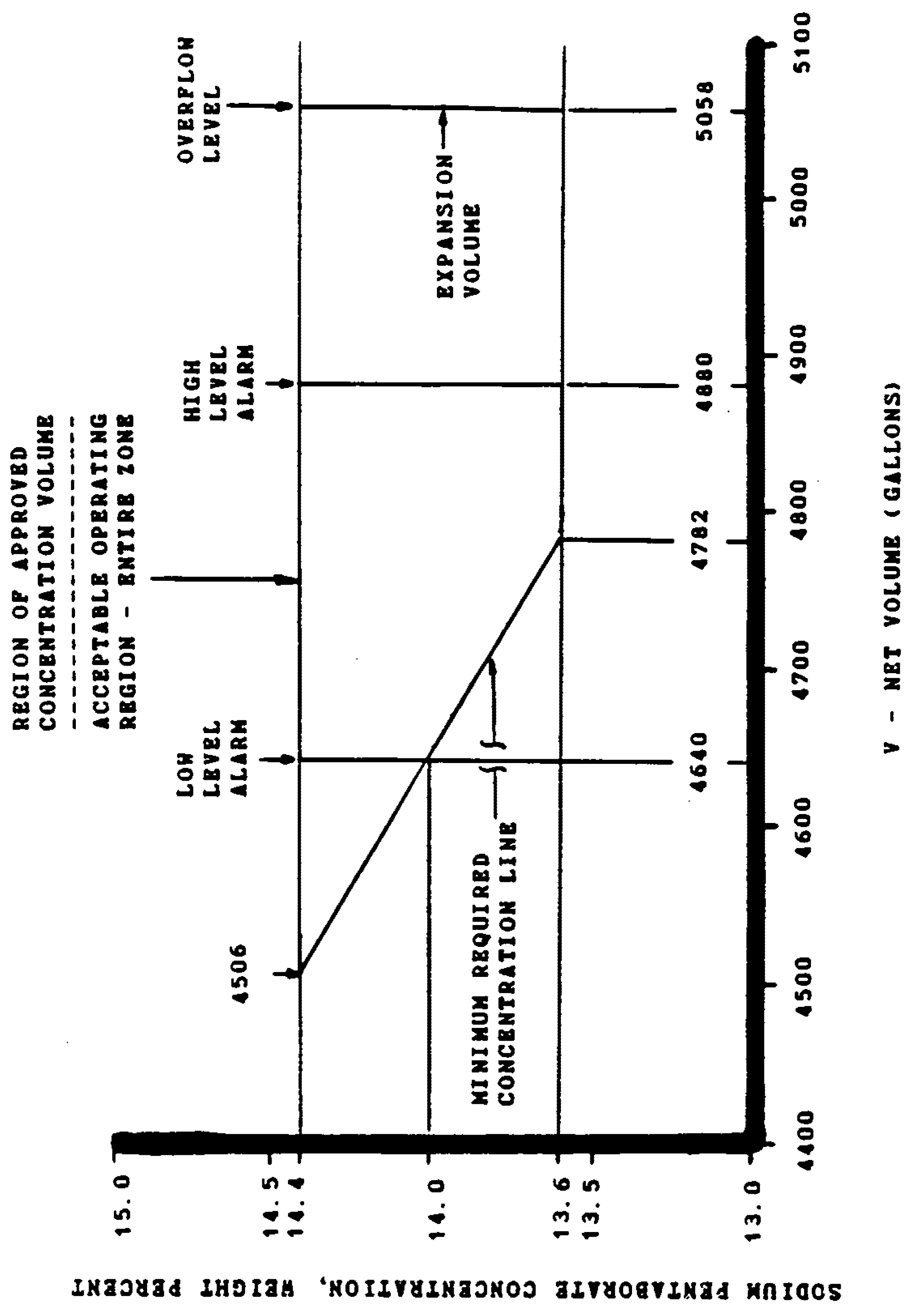
Refer to Plant Drawing J-38-0 for both sheets in DCRMS

Figure F9.3-7 SH 1-3 intentionally deleted.

Refer to Plant Drawing M-61-1 for sheets 1 & 3 in DCRMS
Refer to Plant Drawing M-61-0 for sheet 2 in DCRMS

Figure F9.3-8 intentionally deleted.

Refer to Plant Drawing M-48-1 in DCRMS

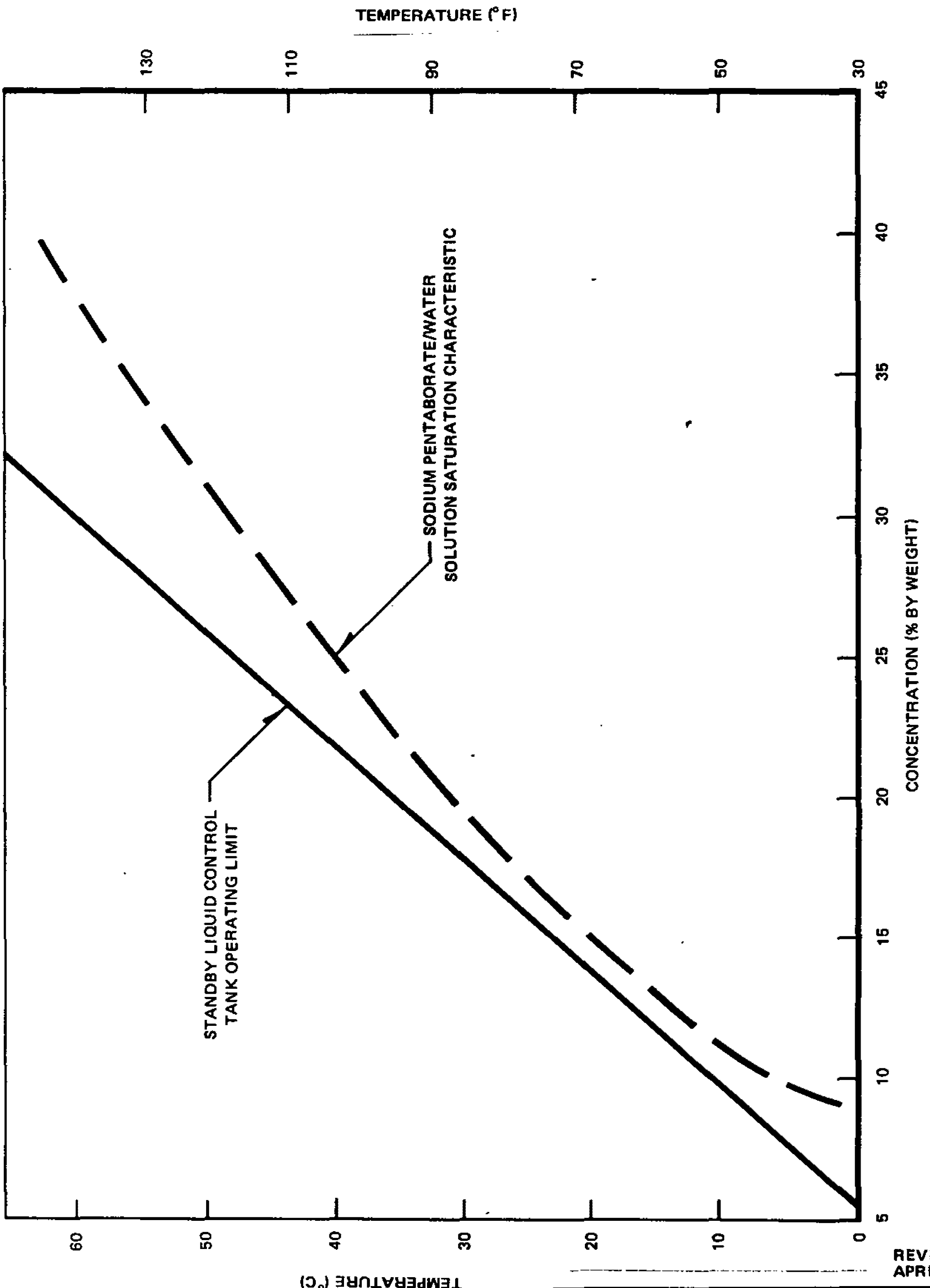


PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK GENERATING STATION

SODIUM PENTABORATE ($Na_2B_{10}O_{16} \cdot 10H_2O$) VOLUME CONCENTRATION REQUIREMENTS

UPDATED FSAR
REVISION 1, APRIL 11, 1989

FIGURE 9.3-9



REVISION 0
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

SATURATION TEMPERATURE
OF SODIUM
PENTABORATE SOLUTION

UPDATED FSAR

FIGURE 9.3-10

Figure F9.3-11 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-59-1 for both sheets in DCRMS

Figure F9.3-12 SH 1-4 intentionally deleted.

Refer to Plant Drawing M-97-0 for all sheets in DCRMS

Figure F9.3-13 intentionally deleted.

Refer to Plant Drawing M-97-0 SH 5 in DCRMS

Figure F9.3-14 SH 1-4 intentionally deleted.

Refer to Plant Drawing M-97-1 sheets 1 and 3 for F9.3-14 sheets 1-2 in DCRMS
Refer to Plant Drawing M-97-2 sheets 1 and 3 for F9.3-14 sheets 3-4 in DCRMS

Figure F9.3-15 intentionally deleted.

Refer to Plant Drawing M-97-1 SH 2 in DCRMS

9.4 AIR CONDITIONING, HEATING, COOLING, AND VENTILATION SYSTEMS

9.4.1 Control Room and Control Area HVAC Systems

The following systems are described in this section:

1. Control Room Supply (CRS) System
2. Control Area Exhaust System (CAE)
3. Control Room Emergency Filter System (CREF)
4. Control Equipment Room Supply System (CERS)
5. Control Area Battery Exhaust System (CABE)
6. Control Area Smoke Exhaust System (CASE)
7. Wing area supply (WAS)
8. Wing area exhaust (WAE).

9.4.1.1 Design Basis

9.4.1.1.1 Control Room Supply System

The CRS system provides heating, ventilation, cooling, and environmental control for the control room and the adjacent areas: operations superintendent's office, computer room, instructional viewing room, ready room, storage room, and toilets.

The main CRS system is safety-related, and is designed to accomplish the following objectives during normal plant operation, as well as during abnormal conditions:

1. Maintain the space at a nominal relative humidity between 20 percent and 60 percent for personnel comfort and equipment performance.

2. Maintain the space temperature at a nominal 72°F ±6°F for personnel comfort and equipment performance.

3. Provide redundancy for active and passive components to meet the single failure criteria.

4. Operate the redundant active components from separate Class 1E power sources.

5. Maintain pressure above that of the adjacent areas to inhibit air leakage into the control room, except when the CRS and the CREF systems are in the total recirculation mode, in accordance with the mode switch position.

6. Monitor radiation levels at the outside air intakes and automatically filter any contaminated fresh air through the emergency charcoal filters upon detection of high radiation, in accordance with the mode switch position.

7. Provide missile protection for the equipment, ducts, and accessories.

8. Meet Seismic Category I requirements.

9. Provide tornado protection for separate fresh air intakes that penetrate to the outdoors.

10. Operate during normal, shutdown, and accident conditions without loss of function.

The meteorological conditions considered in the design of the control room supply system are provided in Table 9.4-22.

9.4.1.1.2 Control Area Exhaust System

The CAE system exhausts excess air from the main control room, toilets, and store room. The CAE system, except for the isolation and tornado dampers, is not safety-related. It is designed to accomplish the following objectives:

1. Provide tornado protection for the exhaust ducts that penetrate to the outdoors for the protection of other safety-related systems.

2. Provide missile protection for safety-related systems

3. Meet Seismic Category I requirements for hangers and supports only.

4. Automatically deenergize upon loss of coolant accident (LOCA), loss of offsite power (LOP), or high radiation signal.

5. The CAE system is energized after the CRS is operating.

6. Provide redundancy by including two 100 percent capacity exhaust fans.

9.4.1.1.3 Control Room Emergency Filter System

The CREF system is designed to maintain control room habitability by providing filtration of fresh air and recirculated air during any accident that may release high radioactivity.

The CREF system is safety-related. Additional discussion of this system appears in Sections 6.4 and 6.5.1.

The CREF system is designed to accomplish the following objectives:

1. Automatically maintain filtered outside air supply to the main control room areas upon detection of high radiation in the intake air supply if the mode switch is in the outdoor air position.

2. Maintain room pressure above that of the adjacent areas to inhibit air inleakage into the main control room, except when the system is selected for the 100 percent recirculation mode.

3. Operate during and after an accident condition without loss of function.

4. Provide redundancy for active and passive components to meet the single failure criteria.

5. Operate the redundant active components from separate Class 1E power sources.

6. Provide tornado protection for fresh air intake ducts.

7. Provide missile protection for the equipment, ducts, and accessories.

8. Meet Seismic Category I requirements.

9. Provide capability in the 100 percent recirculation mode to permit ten people to inhabit the main control room for 100 hours without exceeding the maximum allowable concentration of 1 percent of CO_2 by volume.

The meteorological conditions considered in the design of the control room emergency filter system are provided in Table 9.4-22.

9.4.1.1.4 Control Equipment Room Supply System

The CERS system provides ventilation, cooling, and heating to the diesel area heating, ventilation, and air conditioning (HVAC) equipment room and all elevations within the control area of the Auxiliary Building, except the main control room.

The CERS system is safety-related and is designed to accomplish the following objectives during normal plant operation, as well as during abnormal conditions:

1. Maintain temperatures in areas served by the CERS within acceptable limits.

2. Meet the specified cooling and ventilation requirements during normal, shutdown, and accident conditions without loss of function.

3. Provide redundancy for active and passive components to meet the single failure criteria.

4. Operate the redundant active components from separate Class 1E power sources.

5. Provide missile protection for the equipment, ducts, and accessories.

6. Provide tornado protection for redundant and separate fresh air intake ducts that penetrate to the outdoors.

7. Meet Seismic Category I requirements.

The meteorological conditions considered in the design of the control equipment room supply system are provided in Table 9.4-22.

9.4.1.1.5 Control Area Battery Exhaust System

The CABE system exhausts air from the battery rooms to ensure that hydrogen concentrations remain within acceptable limits.

The CABE system is safety-related and is designed to accomplish the following objectives during normal plant operation, as well as during abnormal conditions:

1. Maintain hydrogen concentrations for all battery rooms below a 2 percent level. This is done in conjunction with the CERS system.

2. Provide redundancy for active components to meet the single failure criteria.

3. Operate the redundant active components from separate Class 1E power sources.

4. Meet Seismic Category I requirements.

5. Provide missile protection for the CABE equipment, ducts, and accessories.

6. Operate during normal, shutdown, and accident conditions without loss of function.

7. Withstand the effects of a tornado at the exhaust air duct penetrating to the outdoors.

The meteorological conditions considered in the design of the CABE system are provided in Table 9.4-22.

9.4.1.1.6 Control Area Smoke Exhaust System

The CASE system exhausts smoke and noxious gas in the event of a fire at any of the elevations within the control area of the Auxiliary Building, except the main control room. The CASE system is not safety-related.

The CASE system is designed to accomplish the following objectives during normal plant condition:

1. Provide missile protection for safety-related equipment, ducts, and accessories.

2. Meet Seismic Category I requirements for hangers and supports only.

9.4.1.1.7 Wing Area Supply System

The WAS system provides heating and ventilation in the electrical access areas, Elevations 54 through 124 feet.

The WAS system is not safety-related and is designed to accomplish the following objectives during normal plant operation:

1. Maintain temperatures in the spaces at or below a maximum of 104°F and a minimum of 60°F.

2. Provide redundant active components supplied from separate non-Class 1E power sources to enhance system reliability.

3. Meet Seismic Category I requirements for hangers and supports only.

9.4.1.1.8 Wing Area Exhaust

The WAE system exhausts air from the electrical access areas, Elevations 77 through 124 feet. The WAE system is not

safety-related. Elevation 54 feet is exhausted by the radwaste exhaust system.

The WAE system is designed to accomplish the following objectives:

1. Provide missile protection for safety-related systems.

2. Provide redundant active components supplied from separate non-Class 1E power sources to enhance system reliability.

3. Meet Seismic Category I requirements for hangers and supports only.

9.4.1.2 System Description

The main control room and control area HVAC systems are shown on Plant Drawing M-78-1. System design parameters are listed in Table 9.4-1. The instrumentation and controls shown on Plant Drawing M-89-1 are considered an integral part of these systems. Table 9.4-21 provides a description of the mechanical and performance characteristics for each type of damper and louver.

The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the control room and control area HVAC systems are discussed in Section 3.2.

9.4.1.2.1 Control Room Supply System

The CRS system maintains design conditions in the main control room and in associated adjacent rooms. It is comprised of two 100 percent capacity air handling units, each supplied by a separate Class 1E power source. Each unit is equipped with an outside air intake, outside air radiation monitors, an outside air smoke detector, motorized isolation dampers, 55 percent ASHRAE dust spot efficient prefilters, 80 to 85 percent ASHRAE dust spot efficient afterfilters, humidifier, chilled water coil, electric heating coil,

and supply fan. A fixed amount of outside air is provided to satisfy ventilation, exhaust, and pressurization requirements. Each unit is connected to a common Seismic Category I supply and return duct system that distributes supply air throughout the rooms. Air is returned from the rooms by a control room return air (CRRA) fan to the CRS unit. The CRS unit is actuated manually from the main control room. The excess ventilation air is exhausted to the outdoors by the CAE system.

Supply air temperature of the CRS unit is controlled by a temperature controller modulating the electric heating coil or chilled water valve.

The humidifier in the CRS unit is controlled by a moisture controller. The moisture controller can also modulate the chilled water valve for dehumidification by means of a low signal selector. The supply units are designed and controlled to deliver a constant volume of supply air.

The CRRA fan will operate in conjunction with the CRS fan. This fan maintains positive pressure in the duct to the CRS fan. With the mode switch in the O.A. position, and upon receiving a LOCA or a high radiation signal, automatic closure of isolation dampers diverts fresh air to the CREF system. Following isolation, the CREF unit is started automatically, and its airflow is continuously monitored and indicated on a local panel.

Filter differential pressures and airflow for each CRS unit are indicated in the main control room. The temperature controller for the heating and cooling coils, the moisture controller for humidity control, and the airflow controllers for modulating the fan's inlet vanes all indicate on a remote panel.

The chilled water for the cooling coils in each unit is supplied by a Seismic Category I, independent, Chilled Water Supply System. The chilled water system is interlocked with the supply air fan so that

the water chiller cannot operate without the fan being energized. The chilled water system is described in Section 9.2.7.

Failure of an operating supply fan is annunciated in the main control room and trips its Chilled Water System. The standby chilled water and air systems then start automatically. Isolation of control circuits is provided between the redundant trains to ensure that the single failure criterion is met.

9.4.1.2.2 Control Area Exhaust System

The excess ventilation air from the CRS unit is exhausted to the outdoors by the CAE system. The CAE system, except for the isolation and tornado dampers, is not safety-related, and a failure of this system does not impact any safety-related system or prevent a safe reactor shutdown. System arrangement is shown on Plant Drawing M-78-1.

Since the control room may be directly exposed to the outside environment through the CAE system, fail-closed, safety-related, redundant isolation dampers in series are installed in the CAE duct. These isolation dampers are automatically closed by high outside air radiation or LOCA signals.

9.4.1.2.3 Control Room Emergency Filter System

The CREF system consists of two 100 percent filter trains, each supplied by a separate Class 1E power source. Each CREF filter unit consists of a prefilter, electric heating coil, upstream high efficiency particulate air (HEPA) filters, charcoal adsorber, and downstream HEPA filters, as shown on Plant Drawing M-78-1. The filter unit is located downstream of the CREF supply fan. Each CREF unit is capable of handling 4000 cfm of air, either entirely returned from the main control room area or a combination of 3000 cfm returned air mixed with 1000 cfm of outside air. Each CREF train operates in series with one CRS unit.

Each filter train is connected to the common Seismic Category I duct system that serves the control room area. Redundant outside air inlet plenums are located within the Seismic Category I control structure.

The CREF normally does not operate; however, in the unlikely event a LOCA occurs or when a high radiation level is detected at the outside air intake, the main control room outside air is automatically diverted through the CREF when the mode switch is in the outside air position. When the CREF system is in operation, the volume of air flowing through it is continuously indicated on a remote panel. The CREF supply fans are designed and controlled to deliver a constant airflow quantity. Low flow or a loss of airflow in the CREF automatically trips and isolates the operating CREF train(s) and alarms in the main control room. High differential pressure across the upstream HEPA filter is also alarmed in the main control room.

9.4.1.2.4 Control Equipment Room Supply System

The CERS system maintains design conditions in the control area HVAC equipment room, diesel area HVAC equipment room, electrical access inverter area, control equipment room and mezzanine, cable spreading room, battery rooms, and electrical equipment room. It consists of two 100 percent capacity air handling units, each supplied by a separate Class 1E power source. Each CERS unit includes a fan, chilled water coils, an electric heating coil, 55 percent ASHRAE dust spot efficient prefilters, and 80 to 85 percent ASHRAE dust spot efficient high efficiency afterfilters, and is shown on Plant Drawing M-78-1. The CERS unit is actuated by manual switches in the main control room and is connected to a common Seismic Category I duct system.

A portion of the air supplied to the electrical equipment room by the CERS system is transferred to the battery rooms, which are also directly supplied by the CERS system. The mixed supply air and

transfer air is then exhausted from the battery rooms by an exhaust fan of the CABE system. All other supply air is returned to the CERS unit, where it is mixed with a fixed amount of outside air and then heated or cooled, as required, to maintain the design space temperatures. The CERS system operates during normal, shutdown, and abnormal plant operation and is automatically connected to the emergency power supply in the event of LOP to ensure operation of the system.

Supply air temperature for the CERS unit is controlled by a temperature controller modulating the electric heating coil or chilled water valve.

Filter differential pressures and airflow for each CERS unit are indicated in the main control room. The temperature controller for the heating and cooling coils, and the airflow controllers for modulating the fan's inlet vanes, all indicate on a local control panel.

Electric duct heaters in the supply air to the battery rooms are controlled by room thermostats and airflow switches. This maintains the room temperature within acceptable limits.

The chilled water cooling coils in each CERS unit are supplied by the same Seismic Category I, independent, Chilled Water Supply System that serves the CRS system. The Chilled Water System is interlocked with the supply air fan so that the water chiller cannot operate without the fan being energized. The Chilled Water System is described in Section 9.2.7.

Failure of the operating supply fan is annunciated in the main control room and trips its chilled water system. The standby chilled water and the standby supply air systems then start automatically. Isolation of control circuits is provided between redundant trains to ensure that the single failure criterion is met.

9.4.1.2.5 Control Area Battery Exhaust System

The CABE system is comprised of two 100 percent capacity fans, each supplied by a separate Class 1E power source. The CABE fans are started by handswitches, one in a "run" position and the other in an "auto" position, functioning as a standby. Both switches are located at local control panels. The system runs continuously during normal, shutdown and abnormal plant operation.

The duct from each battery room is connected to a common Seismic Category I tornado-protected exhaust duct system. Upon failure of the operating fan, the standby fan is automatically started and an alarm is actuated locally and in the control room. Isolation of control circuits is provided between the redundant fans to ensure that the single failure criterion is met.

The makeup air for the battery rooms is introduced by the CERS system. The CABE system discharges through a missile shielded roof exhaust vent to the outdoors.

9.4.1.2.6 Control Area Smoke Exhaust System

One 100 percent capacity CASE fan is normally at standby to exhaust smoke and fumes in the event of a fire in the control area of the Auxiliary Building. The hand control switch and associated indicating lights for the CASE fan and automatic damper are located on a local control panel.

Smoke from an affected floor area is purged by manually opening the appropriate local shutoff damper and its associated fire damper, if activated, and starting the CASE fan after the fire is extinguished. Smoke is exhausted through a missile shielded roof exhaust vent.

9.4.1.2.7 Wing Area Supply System

The WAS system is designed to deliver sufficient quantities of outside air to the wing area and maintain the space within the

specified design temperatures. Two 50 percent capacity WAS air handling units filter and heat a constant quantity of outside air. Each supply unit contains a 20 percent ASHRAE 52-76 dust spot efficient roll-type prefilter, 80 to 85 percent ASHRAE dust spot efficient high efficiency afterfilters, a steam heating coil, and a fan.

Although the WAS system is not safety-related, the equipment runs continuously during normal plant operation and is connected to a non-Class 1E motor control center (MCC) that can be energized manually from a diesel generator in the event of LOP.

Handswitches are located on a local control panel so that the WAS system can be energized manually. High and low supply air temperature and differential pressure for each filter bank is indicated and alarmed at a local control panel.

Temperature controllers and airflow controllers are indicated at a local control panel. Low airflow alarms are provided at a local control panel. A summary alarm to the control room is provided for all local panel alarms.

Supply units are designed and controlled to deliver a constant airflow. All WAS system ductwork is seismically supported. During winter, the temperature controller at the discharge side of the supply air fan will modulate the steam supply to the coil.

9.4.1.2.8 Wing Area Exhaust System

The WAE supply air is exhausted to the outdoors by two 50 percent capacity exhaust fans. Although the WAE system is not safety-related, the equipment runs continuously during normal plant operation and is connected to a non-Class 1E MCC that can be energized manually from a diesel generator in the event of LOP. The WAE system is energized ahead of the WAS system. All WAE system ductwork is seismically supported.

Handswitches are located on a local control panel so that WAE system can be energized manually.

Low airflow alarms are provided at a local control panel. The WAE fans are designed and controlled to deliver a constant airflow.

9.4.1.3 Safety Evaluation

All safety-related control area and control room HVAC systems are designed to maintain functional integrity during a design basis accident (DBA). Each safety-related system is provided with redundant equipment and controls to maintain uninterrupted service for personnel comfort and instrument functions. All equipment is located within the control area of the Auxiliary Building, a Seismic Category I structure. During LOP, standby power is available from the standby diesel generators (SDGs) for the continued operation of all safety-related equipment.

The single failure criterion for active safety-related equipment is met by using redundant equipment and controls and automatically switching from an operating system to a standby system upon detection of an active failure. Isolation of control circuits is provided between redundant trains to ensure that the single failure criterion is met. Active equipment such as fans, controls, dampers, pumps, and chillers are redundant. The redundant systems provided for the control area HVAC systems ensure that control area environmental limits are not exceeded for continued reliable equipment performance.

For failure mode and effect analysis, see Tables 9.4-2 through 9.4-5 for safety-related modes of operation.

All components of the safety-related control area HVAC systems meet the Seismic Category I requirements.

The control room HVAC system is designed to maintain environmental quality within the space, as specified for habitability and control

operation under normal and abnormal plant conditions. All equipment in the system is designed to Seismic Category I requirements, except the humidification equipment. Control room habitability is further discussed in Section 6.4.

A Radiation Monitoring System is provided in each outside air intake to detect high radiation and initiate measures to ensure that personnel safety and equipment functions are not impaired, and that the requirements of 10CFR20 are satisfied as discussed in Section 12.3.4. In the event that high radiation is detected at the intakes, the normal outside air supply to the system is diverted through the control room emergency filter train before being delivered to the main control room when the mode switch is in the outside air position. All isolation dampers except those on the emergency outside air intake are automatically closed. Also, the main control room operator may elect to go to a 100 percent recirculation mode, if it is required. These operations will be annunciated in the main control room.

The main control room emergency filter train and the control room shielding envelope are designed to limit the occupational dose level as required by GDC 19 of 10CFR50. All safety-related control area HVAC systems comply with ANSI N509 and N510.

The introduction of a predetermined controlled quantity of outside air maintains the control room and the other areas served by the control room supply system at a positive pressure with respect to surrounding areas. This positive pressure is maintained during all of the plant operating conditions, except when the system is manually selected for the 100 percent recirculation mode.

When the control room HVAC system is manually selected to be in the 100 percent recirculation mode, pressurization cannot be maintained and the control room will be at equilibrium pressure. The following design features will minimize inleakage to the control room:

- The control room boundary is a low leakage structure

- All penetrations through the boundary are sealed.

- All doors at the boundary are gasketed.

- All CRS and CREF ducts with internal negative pressure are gas-tight welded construction.

- Two bubble tight isolation dampers in series are provided in each normal outside air intake duct.

  The non-Q CAE system is automatically shutdown and isolated to prevent a negative pressure from being created in the control room.

A smoke removal system is provided with a capability of purging any of the floor areas, except Elevation 137 feet. In the event of smoke at Elevation 137 feet, this elevation may be purged by the CAE system.

Refer to the following sections for further safety considerations included in the design of the safety-related control area HVAC systems:

1. Protection from wind and tornado effects - Section 3.3

2. Flood design - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1

7. Toxic Chemicals - Section 2.2.3.1.3.

9.4.1.4 Tests and Inspections

The CRS, CERS, CREF, and CABE systems and their components are tested in a program consisting of the following:

1. Factory and in-situ qualification tests (see Table 9.4-6)

2. Onsite preoperational testing (see Section 14)

Written test procedures establish minimum acceptable values for all tests. Test results are recorded as a matter of performance record, thus enabling early detection of faulty operating performance.

All equipment is factory inspected and tested in accordance with the applicable equipment specifications, codes, and quality assurance requirements. Refer to Table 9.4-6 for details of inspection and testing.

Tests are discussed further in Section 6.4.

9.4.1.5 Instrumentation Requirements

The control switches and the associated status indicating lights of the safety-related CRS system, CERS system, and CREF units are located in the main control room. Control switches and the associated status indicating lights for safety-related CABE fans and all nonsafety-related equipment are located on local control panels or are locally mounted (unit heaters only). Refer to Section 7.6 for further information about instrumentation requirements.

The control switches and the associated status indicating lights of the isolation dampers for all safety-related systems are located in the main control room. The redundant isolation dampers are always in series and are designed to fail safe in the closed position.

Safety-related equipment failures or events, such as low airflow or high filter pressure for the CRS, CERS, and CREF systems, are

alarmed in the main control room. Position indication of the isolation dampers is provided in the main control room. CABE fans and nonsafety-related equipment failures or events are alarmed at local control panels with one common trouble alarm for each panel retransmitted to the main control room.

In addition, the following conditions for the CRS and CREF systems are alarmed in the main control room:

1. High smoke concentration in the outside air

2. Alert radiation concentration in the outside air

3. High radiation concentration in the outside air

4. Outside air radiation detection systems failure

5. High temperature (preignition) in the charcoal adsorber of the CREF

6. High-high temperature (ignition) in the charcoal adsorber of the CREF

7. High pressure differential across the upstream HEPA filter of the CREF

8. Normal outside air supply isolation damper closed, in the absence of control area isolation signals

9. Loss of control power to the electronic instruments

10. High humidity level in the CREF system

11. High and low temperature in the supply air of the CRS.

Control room alarms are provided for high and low supply air temperature, and high filter differential pressure, in the CERS system.

Fan running status, tornado damper status, and isolation channel power availability are monitored by the control room integrated display system.

Instruments of the safety-related systems are seismically and environmentally qualified and redundant to meet the single failure criterion. In particular, the CREF system is instrumented to comply with the requirements of Regulatory Guide 1.52. Airflow in these systems is indicated and alarmed (loss of flow) in the main control room. Airflow in the CREF system is recorded. Upstream HEPA filter pressure differentials are recorded and alarmed (high pressure differential) in the main control room.

9.4.1.6 SRP Rule Review

In this SRP section, Acceptance Criterion II.5 refers to Regulatory Guide 1.52, which, in Position C.2.a, states that engineered safety features (ESF) atmosphere cleanup systems should include demisters prior to prefilters.

On HCGS, demisters are used only where moisture infringement presents a potential problem. The CREF has no demisters, since the units will always operate with the same amount of recirculation room air to maintain the relative humidity at the CREF inlet below 64 percent.

Position C.2.j of Regulatory Guide 1.52 states that the ESF atmosphere cleanup systems should be designed and installed in a manner that will permit replacement of a cleanup train as an intact unit, or as a minimum number of segmented sections without removal of individual components to maintain radiation exposures as low as reasonably achievable during maintenance.

On HCGS, the ESF atmosphere cleanup systems such as the CREFs, include design features that will reduce radiation exposure during routine maintenance and testing. The cleanup trains, however, are not designed to be removed as intact units or in segmented sections. The requirement of this regulatory guide line is impractical for very large units.

On HCGS, it is not anticipated that the cleanup systems will be serviced immediately after a DBA.

9.4.2 Reactor Building Heating, Ventilating, and Air Conditioning

This section covers all areas within the Reactor Building structure, except the space cooling within the primary containment

The Reactor Building Heating, Ventilating, and Air Conditioning (HVAC) Systems include the following:

1. Reactor Building Ventilation System (RBVS)

2. Filtration, Recirculation, and Ventilation System (FRVS)

3. Containment Prepurge Cleanup System (CPCS)

4. Equipment Area Cooling System (EACS)

5. Steam Tunnel Cooling System (STCS)

6. Electric unit heaters.

The Reactor Building FRVS has common ductwork with RBVS and operates after a postulated loss-of-coolant accident (LOCA), fuel handling accident, or high radioactivity in the Reactor Building and is described in detail in Section 6.8. The steam venting system is described in Section 6.2.3.

9.4.2.1 Design Bases

The FRVS and EACS, and the associated ductwork of the Reactor Building HVAC systems, are safety-related. The remaining portion of the ductwork within the Reactor Building boundary is not safety-related, but it is seismically designed and analyzed to ensure that it does not damage equipment and systems that are safety-related. Safety classifications are shown on Plant Drawings M-76-1, M-83-1 and M-84-1. Reactor Building isolation dampers and equipment compartment steam flooding isolation dampers are also safety-related. The Reactor Building HVAC systems are designed to accomplish the following objectives during normal and abnormal operating conditions, from startup to full power to shutdown, and including design basis accidents:

1. Provide filtered outside air supply and high efficiency particulate air (HEPA) filtered air exhaust for at least one air change per hour for the Reactor Building during normal plant operation. Provide greater ventilation rate to the refueling floor during refueling operation (normal conditions).

2. Maintain air flow from areas of lesser contamination to areas of greater potential contamination (normal and abnormal conditions).

3. Maintain space temperatures in areas served by the RBVS within acceptable limits.

4. Maintain space temperatures so that the minimum temperature is not below 40°F, except for a minimum of 70°F in the standby liquid control (SLC) area (normal conditions).

5. Maintain the Reactor Building at a negative pressure with respect to the outdoors to prevent any uncontrolled release of contaminated air to the outdoors (normal and abnormal conditions).

6. Provide cleanup and purge ventilation air for the primary containment (normal conditions).

7. Provide ventilation and cooling (or heating) to the ECCS pump compartments and steam tunnel (normal and abnormal conditions).

8. Limit offsite doses in the event of a Reactor Building accident to values less than the limits allowed by 10CFR50.67 for the FRVS, as described in Section 6.8 (abnormal conditions).

9. Provide radiation monitoring in the Reactor Building exhaust (normal and abnormal conditions), and isolate the RBVS upon a high radiation signal (abnormal conditions). Details of the process and airborne radiation monitoring system are discussed in Sections 11.5 and 12.3.4.

10. Provide a transit time for the exhaust air from the radiation monitors to the RBVS isolation dampers which is greater than the damper closing time plus the radiation monitor response time (normal and abnormal conditions).

11. Isolate the Reactor Building and start the FRVS automatically upon receipt of the Reactor Building isolation signal, such as a LOCA (abnormal conditions).

12. Isolate supply and exhaust ducts of compartments containing high energy pipes after a pipe break (abnormal conditions).

13. Design the Reactor Building HVAC system with redundant equipment, including air handling units, isolation dampers, and actuators to meet the single active failure criterion for the safety related systems (normal and abnormal conditions).

14. Design the redundant Class 1E power supplies that serve the Reactor Building HVAC safety-related systems, including damper motor actuators to meet IEEE 279 and IEEE 308 (abnormal conditions).

15. Design the HVAC isolation dampers, actuators, FRVS, and EACS systems to comply with Seismic Category I requirements.

16. The safety-related systems are located within the Seismic I and tornado protected Reactor Building.

The meteorological conditions considered in the design of the FRVS and EACS are provided in Table 9.4-22.

Monitoring of radiation levels in the spent fuel pool area is discussed in Section 11.5.

9.4.2.2 System Description

The airflow diagram for the Reactor Building HVAC systems is shown on Plant Drawing M-76-1, and the control diagram for the reactor building HVAC systems is shown on Plant Drawings M-83-1 and M-84-1. System design parameters are listed in Tables 9.4-7 and 9.4-8.

Chilled water to the air cooling coils in the RBVS and STCS is supplied by the Turbine Building Chilled Water System, and the

Safety Auxiliaries Cooling System (SACS) pump room unit coolers are supplied by the control area chilled water system, as described in Section 9.2.7. Cooling water to the air-cooling coils in the EACS is supplied by the SACS, as described in Section 9.2.2. Steam for building heating is supplied to the RBVS by the conventional auxiliary boilers, as described in Section 9.5.9.

Access from the outdoors to the heating and ventilating equipment rooms is through air locks, with airtight doors on the potentially contaminated side and conventional doors on the clean side.

9.4.2.2.1 Reactor Building Ventilation System

9.4.2.2.1.1 Reactor Building Ventilation System Supply

The supply system for the Reactor Building Ventilation System (RBVS) includes an outdoor air intake, low efficiency filters, high efficiency filters, steam heating coils, chilled water cooling coils, three 50 percent capacity fans, two butterfly isolation dampers in series at the Reactor Building penetration, distribution ductwork with dampers, duct heaters, supply air outlets, and associated controls and instrumentations.

The supply equipment for the RBVS is located in the Auxiliary Building and supplies conditioned 100 percent outdoor air to all levels of the Reactor Building year round.

Supplementary heating for the HPCI pump room, RCIC pump room, and SLC area is provided by local electric duct heaters in the supply air ducts and is controlled by individual room thermostats to maintain the minimum design temperature.

9.4.2.2.1.2 Reactor Building Ventilation System Exhaust

The exhaust system for the RBVS includes distribution ductwork, exhaust inlets dampers, two butterfly isolation dampers in series at the Reactor Building penetration, low efficiency filters, HEPA

filters, three 50 percent capacity fans, discharge ductwork connecting to the plant vent, radiation monitor, and associated controls and instrumentations.

The exhaust equipment for the RBVS is located in the Auxiliary Building and exhausts air from equipment compartments and those compartments with higher potential for radioactive contamination.

9.4.2.2.2 Containment Prepurge Cleanup System

Before the drywell and torus are purged by the RBVS, the drywell and torus atmosphere is first recirculated by the Containment Prepurge Cleanup System (CPCS), as required, to reduce the level of atmospheric radioactivity to within radiological effluent technical specification limits. This system is located inside the reactor building, connected in parallel with the RBVS ductwork, and consists of supply and return air isolation dampers, low efficiency filters, electric heating coil, HEPA filters, charcoal filters, high efficiency filters, and a centrifugal fan with modulating discharge damper. After the prepurge cleanup process, the RBVS provides supply and exhaust air to and from the drywell and torus for purge purposes.

9.4.2.2.3 Equipment Area Cooling System

Each EACS unit cooler recirculates and cools within its respective ECCS compartment and is capable of removing the total compartment heat load. Two 100 percent capacity coolers are provided per compartment. Each unit consists of a cabinet with a cooling coil and a direct drive vaneaxial fan. The unit coolers are mounted adjacent to the pumps they serve.

9.4.2.2.4 Steam Tunnel Cooling System

The Steam Tunnel Cooling System (STCS) provides supplementary cooling for the main steam pipe tunnel during normal plant

operation. This system is located above the main steam pipe tunnel and consists of one full capacity unit cooler provided with two redundant vaneaxial fans, two redundant chilled water cooling coils, and associated controls and instrumentation. The primary ventilation and cooling is provided by RBVS supply and exhaust.

9.4.2.2.5 Electric Unit Heaters

At grade elevation and above, supplementary heating is provided by electric unit heaters that are controlled by individual local thermostats.

9.4.2.2.6 Normal System Operation

During normal plant operation, the Reactor Building HVAC systems maintain the design air quality temperatures and pressure in the reactor building and is started locally. The RBVS provides a constant flow rate of outdoor air to and from all levels in the reactor building. Dampers at the exhaust fans are modulated to maintain negative pressure in the Reactor Building.

The supply system for the RBVS is provided with two air temperature controllers (one for heating and one for cooling) to control the temperature of the air leaving the fans at approximately 60°F during summer and winter. Chilled water flow through the cooling coils is modulated by three-way mixing valves. The cooling coils are used only during high outside air temperature. The chilled water-cooling coils are protected from freezing by a low temperature switch mounted downstream of the steam coil. The electric duct heaters are energized by room temperature indicating controllers, to reheat the supply air, as required to maintain the HPCI pump room and RCIC pump room at 60°F, and the standby liquid control room at 70°F.

Two of three 50 percent capacity fans of the supply and exhaust systems for the RBVS operate during normal plant operation. When low flow is detected at an operating fan, the respective standby fan

starts automatically. Upon failure of a fan or any of its dampers, the design airflow pattern is not affected. During refueling operations, manual duct dampers are repositioned, and at least two of three RBVS supply and exhaust fans will be operated to provide a greater ventilation rate to the refueling floor.

If the RBVS exhaust fails to establish airflow, an automatic lockout of the RBVS supply results.

After the containment atmosphere is cleaned up by the CPCS, as required, the RBVS purges the containment at a rate of 9000 cfm. Outside filtered air is supplied to the containment by the RBVS supply header. The purge exhaust air from the containment is filtered through the exhaust system HEPA filters of the RBVS and directed to the plant vent.

The RBVS exhaust ducts and exhaust plant vent are equipped with a radiation sampler. A high radiation level in the exhaust plant vent is alarmed in the main control room and initiates isolation of the Reactor Building.

The EACS unit coolers for the ECCS compartments are actuated by a room temperature switch. With the exception of the HPCI Pump Room Cooler, the lead cooler starts automatically when the room temperature exceeds 110°F. The standby cooler starts automatically when the room temperature exceeds 115°F or when the lead cooler fails. The lead HPCI Pump Room cooler starts automatically when the room temperature exceeds 107°F. The HPCI Pump Room standby cooler starts automatically when the room temperature exceeds 111°F or when the lead cooler fails. Each cooler is also provided with a hand switch in the local panel for manual operation. When pumps and coolers are deenergized, the RBVS supply and exhaust air maintain the design conditions in the ECCS pump compartments.

To avoid direct release of building atmosphere to the outside, isolation dampers are located in the supply duct and return duct penetration through the walls of the railroad bay. These dampers interlock with the receiving bay door to prevent the door from being opened until the dampers are closed. After the door is closed, the

dampers are opened by a local manual switch. The dampers are closed by the same switch. In the unlikely event that any damper is open and the door is not closed, it will be alarmed at the computer.

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The STCS provides supplementary cooling to the steam pipe tunnel with a local air recirculating cooler and distribution ductwork. The cooler consists of two full capacity chilled water coils and two full capacity vaneaxial fans. Failure of the operating fan will automatically start the redundant fan. The entering and leaving air temperatures of the water coil and fan running status are indicated at the computer with a high air temperature alarm.

9.4.2.2.7 Abnormal Operation

Any significant release of radioactive material within the Reactor Building is controlled by the FRVS. Upon receipt of a LOCA or a refueling floor/Reactor Building high radiation signal, the Reactor Building ventilation isolation dampers isolate the reactor building within 7 seconds and start the FRVS automatically. This rapid response time limits uncontrolled release of radioactivity to the environment. Releases during this short time period are below 10CFR50.67 limits. The FRVS serves as a barrier to the release of radioactive contamination to the environment by maintaining the building at a negative pressure. Containment and reactor building isolation dampers are automatically closed, and the RBVS, CPCS, and STCS systems are deenergized.

Unit coolers in safeguard equipment areas such as residual heat removal (RHR), CSS, RCIC and SACS are actuated automatically when room temperatures increase to the thermostat setpoint of 110°F. If the lead cooler fails to maintain the room temperatures, a standby cooler starts automatically when the room temperature exceeds 115°F. The HPCI Pump Room coolers function in the same manner but thermostat setpoints are 107°F and 111°F, respectively. Should a low flow condition occur in the running lead cooler, the standby cooler starts automatically and alarms in the main control room. Should room temperature exceed 150°F on alarm will be actuated in the main control room.

In the event of LOP:

1. The RBVS supply and exhaust fans are automatically restarted and continue to operate on standby diesel power. Chilled water and heating steam are stopped.

2. The FRVS remains available on standby diesel power.

3. Electric unit heaters are stopped.

4. The EACS unit coolers remain available on standby diesel power.

5. The containment prepurge cleanup system is deenergized.

6. All containment isolation dampers are automatically closed but remain available for actuation from the control room.

7. Electric duct heaters are available.

8. The Steam Tunnel Cooling System is deenergized.

In the event of a low flow undetected leak from process piping within the Reactor Building, the RBVS supply and exhaust systems continue to operate until high airborne radioactivity is detected or the building is isolated.

Two isolation dampers in series are provided on each supply and exhaust duct for compartments containing high energy piping, as shown on Plant Drawing M-84-1. Each group of dampers is provided with pressure differential and temperature switches to close the group of dampers when high pressure or temperature develops inside the room.

The failure of an isolation damper in a closed position results in both a loss of ventilation for the equipment compartment affected, and a high room temperature alarm. Each trouble alarm on the local control panel is alarmed in the main control room as a panel group

alarm. Indicating lights on the local panel identify the failed damper, which can be manually reset to the open position.

9.4.2.3 Safety Evaluation

The safety design criteria applicable to the safety-related systems are discussed in the following sections:

1. Wind and tornado protection - Section 3.3

2. Flood design - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design conditions - Section 3.11.

Redundant radiation monitors are provided in the exhaust duct of the refueling area and the exhaust duct of the Reactor Building. A high radiation signal from any monitor or a LOCA signal automatically isolates the Reactor Building ventilation penetrations and energizes the FRVS. The exhaust air transit time between the refueling area monitors and the RBVS exhaust system isolation dampers is greater than the combined time of damper closure and the monitor response. The exhaust air transit time is 12 seconds, and the combined monitor response and damper closing time is within 11 seconds.

The isolation dampers used for Reactor Building ventilation penetrations isolation are redundant (two in series powered from separate electrical channels), fail closed, butterfly type, and operated by a spring loaded air cylinder.

All manual control hand switches for safety-related building isolation dampers are located in the control room, and the

individual room isolation dampers are located on the local HVAC control panels.

The Reactor Building is automatically isolated, and the FRVS is actuated upon receipt of any one of the following signals:

1. High radiation in the refueling area exhaust ducts

2. High radiation in the Reactor Building exhaust ducts

3. LOCA signal, as applied to the HVAC isolation signal, consisting of low reactor water level (level 2) and high drywell pressure

4. A manual signal from the main control room.

Any of the above isolation signals results in the following automatic sequence for the Reactor Building:

1. Close normally open isolation dampers (two in series separating the safety-related and nonsafety-related portions of each system)

2. Upon initiation of isolation damper closure, trip all running RBVS fans

3. Open normally closed isolation dampers (two in parallel) on each duct connecting the FRVS fans and filters to the ventilation system duct used in the recirculation mode of operation

4. Start the FRVS and maintain the Reactor Building temperature and pressure, as described in Section 6.8.

The steam flooding isolation dampers also have an active safety-related function in the Reactor Building HVAC system. The function of the dampers is to contain the steam resulting from a

pipe break within the equipment compartment in which the break occurs, and to prevent the spread of the steam through HVAC openings or ductwork into adjacent spaces. The dampers are normally open, redundant series mounted, fast closing, counterweighted back pressure dampers. Closure of the dampers is actuated by a pressure switch sensing the rise in pressure created by the discharge of fluid from a broken pipe.

Any operational degradation of ventilation system components can be detected by direct status indication, e.g., indicating lights for damper position or fan running status, or can be determined from alarms, e.g., abnormal temperature or differential pressure, so that corrective action can be taken during normal plant conditions.

All unit coolers, ductwork, supports, and other system components meet Seismic Category I requirements. Active components of safety-related equipment are redundant, meet single failure criteria, and have standby power supply from Class 1E diesel generators.

The RBVS system intake louvers and exhaust vents located in the Auxiliary Building are not safety-related; therefore, no provisions for missile protection are made for these portions, as no safety equipment is exposed to missiles.

All nonsafety-related panel-mounted instruments and controls, including fan manual switches, are installed on local control panels. A group alarm from each panel is annunciated in the main control room.

9.4.2.4 Tests and Inspections

The Reactor Building HVAC systems and components are tested in a program consisting of the following:

1. Onsite preoperational testing. See Section 14.

2. Surveillance testing will be done in accordance with and to the frequency specified in Position C.5.c of Regulatory Guide 1.140.

Written test procedures establish minimum acceptable values for all tests. Test results are recorded as a matter of performance record, thus enabling early detection of faulty performance.

All equipment is factory inspected and tested in accordance with the applicable equipment specifications, codes, and quality assurance requirements.

9.4.2.5 Instrumentation Requirements

Controls, indications, and alarms for the RBVS supply and exhaust systems are located on a local ventilation control panel in the Auxiliary Building service area fan room. Any alarm actuation on the local panel will cause a common trouble alarm actuation in the main control room. The status indication is also available at the computer.

FRVS controls and alarms for the recirculation and vent systems are located on the control console in the main control room.

Control actuation and alarms for the CPCS is located on a control console in the main control room.

Controls for the EACS coolers are located on local control panels in the reactor building. Status indication and any alarm is transmitted to the main control room computer.

Electric duct heaters are controlled by local thermostats.

Unit heaters are controlled by local thermostats.

The steam tunnel unit coolers is actuated and alarmed on the local control panel. High tunnel temperature is indicated in the control room computer.

Equipment air lock isolation dampers are opened by a local hand switch when the equipment rollup door is closed. There is a computer alarm when the door and the dampers are both open.

Hand switches for the safety-related room isolation dampers are located on local HVAC control panels. Status indicating lights for the isolation dampers are located on the local HVAC control panels, and the common trouble alarm in the main control room.

The following specific alarms and indications are annunciated in the main control room:

1. Equipment status for safety-related equipment that may require operator action. Refer to Section 7.3 for safety-related equipment alarm locations

2. High radiation in refueling area or reactor building exhaust ducts, and the downscale signal from radiation monitors

3. Closure of any of the steam flooding isolation dampers at high energy pipe compartments

4. Group alarm from each HVAC local control panel that has local alarm

5. Manually induced inoperability of safety-related equipment

6. Preignition temperatures of safety-related charcoal filters

7. Ignition temperatures for safety-related and nonsafety-related charcoal filters

8. High or low pressure in the Reactor Building.

In addition, the following conditions are alarmed or indicated on the local HVAC control panels and transmitted to the main control room as a panel summary trouble alarm:

1. Equipment status for nonsafety-related equipment and safety-related equipment that does not require operator action. Refer to Section 7.3 for safety-related alarm locations

2. Preignition nonsafety-related charcoal filter temperature

3. High differential pressure across filters in nonsafety-related equipment

4. Low air flow, low air temperature, and high air temperature in the nonsafety-related equipment

5. Roll filter media runout condition for nonsafety-related equipment

6. Circuit breaker motor overload for nonsafety-related equipment.

All instruments and controls performing safety-related functions are qualified to Seismic Category I requirements and are environmentally qualified, as discussed in Section 3.11.

The redundancy and separation of instrumentation and controls conform to the redundancy and separation of the equipment they control or monitor.

9.4.2.6 SRP Rule Review

In this SRP section, Acceptance Criterion II.3 refers to Regulatory Guide 1.52, which, in Position C.2.a, states that engineered safety

features (ESF) atmosphere cleanup systems should include demisters prior to prefilters, and HEPA filters ahead of and following the adsorbers.

At HCGS, demisters are used only where moisture impingement presents a potential problem. In particular, the FRVS vent system filtration units are not provided with demisters because they are located downstream of the FRVS recirculation system filtration units that have demisters.

Also, there are no HEPA filters before the carbon adsorbers in the FRVS vent system filtration units, because these units are downstream of the HEPAs in the FRVS recirculation system filtration units.

Position C.2.j, of Regulatory Guide 1.52, states that the ESF atmosphere cleanup systems should be designed and installed in a manner that will permit replacement of a cleanup train as an intact unit, or as a minimum number of segmented sections without removal of individual components, to maintain radiation exposures as low as is reasonably achievable (ALARA) during maintenance.

At HCGS, the ESF atmosphere cleanup systems, such as the FRVS vent system filtration units and the FRVS recirculation system filtration units, include design features that will reduce radiation exposure during routine maintenance and testing. The cleanup trains, however, are not designed to be removed as intact units or in segmented sections. The requirement of this regulatory guideline is impractical for very large units.

At HCGS, it is not anticipated that the cleanup systems will be serviced immediately after a DBA.

Acceptance Criterion II.3, Regulatory Guide 1.140, Position C2.b states that the flow rate of a single atmosphere cleanup train should be limited to approximately 30,000 cfm.

At HCGS, the 30,000 cfm capacity limit per cleanup train is exceeded on some of the exhaust systems of normal ventilation exhaust systems. In particular, the RBVS exhausts 48,000 cfm per each filter plenum.

9.4.3 Auxiliary Building Service and Radwaste Area Ventilation Systems

The following systems are described in this section:

1. Service Area Supply (SAS) System
2. Service Area Exhaust (SAE) System
3. Remote Shutdown Panel (RSP) Room System
4. Chemical Laboratory Exhaust (CLE) System
5. Technical Support Center Supply (TSCS) System
6. Technical Support Center Emergency Filters (TSCEF) System
7. Radwaste Area Supply (RWS) System
8. Radwaste Area Exhaust (RWE) System
9. Radwaste Area Tank Filter (RWTF) System
10. Solid Radwaste Supply (SRWS) System
11. Solid Radwaste Exhaust (SRWE) System.

9.4.3.1 Design Bases

9.4.3.1.1 Auxiliary Building Service Area

The Auxiliary Building service area Heating, Ventilating, and Air Conditioning (HVAC) System maintains the design ambient conditions for personnel and equipment. The Auxiliary Building service area HVAC system is not safety-related.

The Auxiliary Building service area HVAC system is designed to operate during normal plant conditions and accomplish the following objectives:

1. Provide a constant supply of filtered conditioned air year round to maintain the following design temperatures:

    a. Offices: 68°F minimum to 80°F maximum

    b. Controlled and uncontrolled instrument shops, chemistry laboratory, sample room, counting room, personnel lockers, toilets, and showers: 68°F minimum to 80°F maximum

    c. Laundry rooms: 60°F minimum to 85°F maximum

    d. Equipment rooms: 60°F minimum to 104°F maximum

    e. Record and file storage vaults: 60°F minimum to 95°F maximum

    f. Showers and toilets: 68°F minimum to 85°F maximum

    g. Controlled corridors: 68°F minimum to 80°F maximum

    h. Uncontrolled corridors: 60°F minimum to 80°F maximum

i. Decontamination area and access control and monitor station: 68°F minimum to 80°F maximum

2. Maintain airflow from areas of lesser potential contamination to areas of greater potential contamination

3. Provide high efficiency particulate air (HEPA) filters for all air exhausted from chemistry laboratories, storage areas, laundry rooms, and the counting room, which have the greatest potential for contamination

4. Discharge all potentially contaminated exhaust air to the north and south plant vents and monitor it for radioactivity

5. Design for non-Seismic Category I requirement

6. Provide no standby capacity in the SAS or SAE systems

7. Provide 100 percent standby capacity in the CLE system

8. Operate from normal power sources only, except for the CLE system, which is non-Class 1E powered, backed by the standby diesel generator (SDG)

9. Stop the SAS and SAE fans in the event of LOP. The CLE fan can be restarted manually

10. Continue the SAS and SAE operation in the event of a loss-of-coolant accident (LOCA) with offsite power available.

9.4.3.1.2 Auxiliary Building Radwaste Area

The Auxiliary Building radwaste area HVAC systems maintain air temperatures and quality for proper operation and maintenance of radwaste equipment during normal and abnormal plant conditions. The

Auxiliary Building radwaste areas' HVAC systems, are not safety-related.

9.4.3.1.2.1 Normal Modes of Operation

The Auxiliary Building radwaste area HVAC systems are designed to accomplish the following objectives during normal plant conditions:

1. Provide a supply of all outdoor air, filtered and conditioned, with the RWS system; provide a filtered exhaust from the gaseous and liquid radwaste areas with the RWE system; provide a separate supply of all outdoor air, filtered and conditioned to the solid radwaste area with the SRWS system; provide 100 percent filtered exhaust from the solid radwaste area with the SRWE system; provide a filtered exhaust from the radwaste tanks with the RWTF system

2. Maintain airflow from areas of lesser potential contamination to areas of greater potential contamination

3. Maintain the radwaste areas within the following design temperatures:

    a. General areas, pump rooms, and solid radwaste processing compartments: minimum 40°F to maximum 104°F

    b. Filter and tank compartments and evaporator rooms: minimum 40°F to maximum 115°F

    c. Offgas holdup pipe compartments and recombiner rooms: minimum 40°F to maximum 115°F

    d. Offices and control room: minimum 68°F to maximum 80°F

e. Battery room: minimum 72°F to maximum 82°F

f. Charcoal tank rooms (off-gas system): 65°F ± 3°F

g. Battery charger room: minimum 40°F to maximum 85°F

h. Machine shops and access areas: minimum 40°F to maximum 100°F

i. Control panel and MCC rooms: 40°F minimum to 104°F maximum

j. Cable tray areas: 40°F minimum to 104°F maximum

k. Auxiliary panel room and equipment access areas: 40°F minimum to 100°F maximum

l. Corridors: 40°F minimum to 90°F maximum.

4. Maintain the above areas, except unrestricted machine shop, at a slightly negative pressure with respect to the outdoors, to prevent uncontrolled exfiltration

5. Provide HEPA filters for all the air exhausted from the areas, except for the following non-contaminated general areas:

   a. Unrestricted shop

   b. Toilet

6. Provide HEPA and charcoal filtration for gases vented from radwaste tanks and potentially contaminated drain sumps

7. Discharge all potentially contaminated air of the RWE system to the south plant vent and monitor it for radioactivity

8. Discharge all potentially contaminated air of the SRWE system to the north plant vent and monitor it for radioactivity

9. Operate the SRWS and SRWE systems from normal power sources only.

9.4.3.1.2.2 Abnormal Modes of Operation

The Auxiliary Building radwaste area HVAC system is designed to operate in the following manner during abnormal plant conditions:

1. In the event of a loss of offsite power (LOP), all radwaste area HVAC systems automatically stop and close down. The RWS, RWE, and RWTF fans, RWTF heating coils, and the 24 volt battery room duct heater can be restarted manually from local control panels following restoration of non-Class 1E power backed by the SDGs. The SRWS and SRWE fans are not backed by the SDGs.

2. In the event of a LOCA with offsite power available, the RWS and RWTF fans, RWTF heating coils and the 24 volt battery room duct heater automatically stop and close down. However, they can be restarted manually from local control panels following restoration of non-Class 1E power backed by the SDGs.

3. In the event of a LOCA coincident with LOP, all radwaste area HVAC equipment automatically stops and shuts down, however, the HVAC equipment backed by the SDG system could be restarted manually.

4. Upon detection of high radioactivity in the radwaste area exhaust air, the control room operator is warned by an alarm and may stop any or all radwaste ventilation systems. The systems continue to operate unless interrupted.

The radwaste ventilation system is not designed for automatic isolation. The analysis in Section 15.7 imposes activity inventory limitations on radwaste system components, which will limit any associated radiological effluent from the radwaste system. These activity limits result in potential accident doses (with no credit for filtration), which are a small fraction of 10CFR50.67 guidelines.

Any excess activity above Technical Specification limits will result in radwaste ventilation exhaust high radiation alarms. However, dose releases during accident or normal conditions will be lower and controlled more effectively by using the filtration capabilities of the radwaste ventilation system than by isolating it.

5. The event of fire in the Auxiliary Building radwaste areas is discussed in Section 9.5.1, Fire Protection.

9.4.3.1.3 Remote Shutdown Panel Room

The RSP room HVAC system maintains air temperature, quality, and humidity for the proper operation of controls and equipment that can be used to safely shut down the plant if the main control room is unusable. The RSP system is not safety-related. It is designed to:

1. Provide a continuous supply of filtered and conditioned air from one 100 percent capacity supply unit.

2. Maintain a year round temperature of 76°F ± 2 in the room.

3. Maintain the relative humidity level between 40 percent and 60 percent.

4. Maintain the RSP room at a slightly positive pressure to prevent infiltration of fire, smoke, fumes, and airborne radioactivity from surrounding room areas.

5. Provide chilled water to the redundant cooling coils of the RSP unit from the safety-related chilled water system.

6. Be non-Seismic Category I, except for the cooling coils and housing of the RSP unit.

7. In the event of LOP, the RSP HVAC equipment stops automatically; however, it could be restarted manually, since this HVAC equipment is non-Class 1E connected to the SDG bus.

8. In the event of a LOCA coincident with LOP, the RSP system stops and closes down automatically; however, the system could be manually restarted.

9. In the event of a LOCA with offsite power available, the HVAC equipment is tripped automatically to stop; however, it could be restarted manually.

9.4.3.1.4 Technical Support Center

The Technical Support Center (TSC) HVAC System maintains the TSC at design ambient conditions for personnel comfort and safe equipment operation. The system is designed to operate during normal and abnormal plant conditions. It is designed to:

1. Provide a continuous supply of filtered and conditioned air to the TSC.

2. Maintain the TSC at 78±2°F in summer and 68±2°F in winter.

3. The ventilation system is set up to achieve a TSC relative humidity level between 20 percent and 50 percent. To accommodate humidity controller transient change during load upset, low and high humidity alarm set-points at 20 and 60 percent respectively have been evaluated to be acceptable.

4. Maintain the TSC at a slightly positive pressure to minimize infiltration of airborne radioactivity from surrounding areas.

5. Provide chilled water to the cooling coils of the TSCS unit from the safety-related chilled water system.

6. Be non-Seismic Category I, except for the cooling coils and housing of the TSCS unit.

7. In the event of LOP, TSCS and TSCEF units stop automatically; both units are non-Class 1E equipment backed by an SDG bus and could be manually restarted.

8. In the event of a LOCA coincident with LOP, both TSCS and TSCEF units stop and close down automatically; however, power could be manually restored from the SDG.

9. In the event of a LOCA with offsite power available, both HVAC units are tripped automatically to stop; however, they could be manually restarted.

9.4.3.2 System Description

9.4.3.2.1 Auxiliary Building Service Area

The Auxiliary Building service area HVAC system is shown schematically on Plant Drawing M-79-0. System design parameters are listed in Table 9.4-9. The chilled water system supplying the cooling coils of the SAS units is described in Section 9.2.7. The steam system for the heating coils of the SAS units and unit heaters is described in the Auxiliary Boiler System, Section 9.5.9. The instrumentation and controls, shown on Plant Drawing M-93-0, are considered an integral part of the HVAC system.

The SAS units are located in the turbine building heating and ventilating equipment rooms. The SAE fans and the CLE units are located in the auxiliary building service and radwaste area HVAC equipment rooms, respectively. Unit heaters are located in areas with outdoor exposure.

Conditioned air is supplied throughout the Auxiliary Building service area by the SAS units. Some air from the uncontrolled areas is returned to the SAS, reconditioned, and recirculated. The rest of the air flows from the uncontrolled areas to the controlled areas of the Auxiliary Building and is exhausted by the SAE fans and the CLE units. SAE system air is discharged to the south plant vent, and CLE system air is discharged to the north plant vent. The discharge from each plant vent is sampled by radiation monitors, as discussed in Section 12.3.4.

9.4.3.2.1.1 Service Area Supply

The SAS system includes two half capacity air handling units consisting of a low efficiency filter, high efficiency filter, fan with inlet vanes and motor, steam heating coil, humidifier, and chilled water coil.

Return air from uncontrolled areas of the Auxiliary Building is mixed with a fixed amount of outside air, and is supplied via the duct distribution system to offices, conference rooms, locker rooms, chemistry laboratories, shops, corridors, access control areas, and HVAC equipment rooms. The quantity of outdoor air introduced is sufficient to make up all the air discharged by the exhaust systems.

Each SAS unit is started by a local hand switch that also opens the isolation dampers. The SAS fans are interlocked with the SAE fans so that at least one SAE unit must be running before a supply fan can start. Both SAE fans must be running before both SAS fans can start. Chilled water is supplied from the nonsafety-related chilled water system as discussed in Section 9.2.7. Steam is supplied from the auxiliary boiler system as discussed in Section 9.5.9.

9.4.3.2.1.2 Service Area Exhaust

The SAE system includes two 50 percent capacity constant volume fans with motors and dampers. These fans discharge through a common duct to the south plant vent. The SAE fans exhaust offices, locker

rooms, shower and drying areas, toilets, shops, storage areas, and HVAC equipment rooms.

The service area is designed and postulated to be a clean, noncontaminated area.

Fans are started manually by local handswitches that also open the isolation dampers. Normally, both fans are running.

9.4.3.2.1.3 Chemical Laboratory Exhaust

The CLE system consists of two 100 percent capacity constant volume filter plenums and fans with motors. One plenum and a fan are on standby. The CLE is ducted to the north plant vent and is sampled by a radiation monitor. The filter plenums include low efficiency filters and HEPA filters. The CLE units exhaust air from the controlled and clean chemistry laboratories, atomic absorption unit chemical storage room, counting room, controlled corridor, technical nuclear shop, controlled laundry storage, wet and dry laundry, in addition to the respirator, sort table, dryer, canister and valve room which are exhausted through an in-line booster fan and high efficiency filter.

The CLE system exhausts air from the chemistry laboratories through fume hoods that draw the majority of exhaust air from the laboratory rooms; the remainder is supplied by the RWS air system, as discussed in Section 9.4.3.2.2.1. The controlled hot chemistry laboratory is maintained at a slightly negative pressure to limit exfiltration of fumes and vapors to the surrounding areas. Each fume hood is equipped with local flow indicators and manual inlet and outlet dampers.

The CLE fans are started manually by local handswitches that also open the filter/fan isolation dampers. One fan will be in the "run" position, and the other will be in the "auto" position. If the operating fan fails, it is deenergized and the standby fan is

started. The CLE booster fan is started manually by a wall mounted local handswitch.

Any normal and abnormal source contribution from the chemical laboratory exhaust system will be small, with releases within the limits specified in 10CFR20 and the ALARA guidelines of Appendix I of 10CFR50.

In the event of plant vent monitor annunciation, portable detectors will be used in the service area and chemical laboratory to locate the potential source of contamination. A local area radiation monitor detector also exists in the chemistry laboratory area. Any dose releases from the chemical laboratory will be lower and better controlled by using the filtration capability of the chemical laboratory exhaust ventilation system rather than by isolating it.

9.4.3.2.1.4 Auxiliary Building Service Area Heating

The minimum space design temperatures are maintained by steam heating coils in the SAS units, local steam unit heaters, and electric reheat coils in the SAS ductwork.

The steam heating coils temper the SAS supply air temperature to 60°F during cold weather.

The unit heaters are actuated by local handswitches with thermostats that cycle the fans.

Electric reheat coils are installed in SAS supply ducts serving offices, conference rooms, locker rooms, and the chemical laboratories. Each duct reheat coil is controlled by a room thermostat to reheat as required, the supply air to a group of rooms. Reheat coils are automatically deenergized upon loss of airflow.

9.4.3.2.2 Auxiliary Building Radwaste Area

The Auxiliary Building radwaste area HVAC systems are shown schematically on Plant Drawing M-91-0. System design parameters are listed in Table 9.4-10. The chilled water system supplying the cooling coils of the SRWS and RWS units is described in Section 9.2.7. The steam systems for the heating coils of the SRWS and RWS units and unit heaters are described under the Auxiliary Boiler System, Section 9.5.9. The instrumentation and controls, shown on Plant Drawing M-92-0, are considered an integral part of the RWTF, RWS, and SRWS systems.

The RWS units are located in a ventilation equipment room on the roof of the Auxiliary Building. The RWE units and the SRWS units are located in the ventilation equipment room within the Auxiliary Building. The RWTF units are located in the Auxiliary Building radwaste area. The SRWE units are located near the service area within the Auxiliary Building. Room recirculation units are located in or near the spaces they serve within the radwaste area. The toilet and unrestricted shop exhaust fans are located on the roof of the Auxiliary Building. Unit heaters, unit coolers, and duct heating and cooling coils are located throughout the radwaste area in or near the spaces served.

Conditioned outside air is supplied to the radwaste area by RWS system and the SRWS system. Air flows from the least radioactive areas to areas of greater potential contamination. Air is exhausted by the RWE system and the SRWE system. The quantity of outside air introduced into the building is sufficient to make up all the air discharged by the exhaust systems. Gases vented from radwaste tanks and sumps is collected and filtered through the RWTF units and then exhausted through the RWE system. The RWE system discharges to the south plant vent after it is monitored, and the SRWE system discharges to the north plant vent. The discharge from each plant vent is sampled by radiation monitors, as discussed in Section 12.3.4. Air from the unrestricted machine shop and the

toilet room is exhausted directly to the outdoors by the unrestricted shop exhaust fan and the toilet exhaust fan.

9.4.3.2.2.1 Radwaste Area Supply System

The RWS system includes two 50 percent capacity filter plenums with heating and cooling coils connected to fans with motors. Each plenum includes an outside air isolation damper, low efficiency filter, high efficiency filter, steam heating coil, and chilled water coil. The supply fans include inlet vanes and are connected to discharge isolation dampers.

The RWS system distributes 100 percent outside air to three distinct areas:

1. The liquid and gaseous radwaste areas

2. The solid radwaste area control room

3. Miscellaneous areas, such as machine shops, cable tray areas, and laboratory hoods.

The RWS fans and their isolation dampers are controlled by local handswitches. Normally, both fans are operating. The supply fans are interlocked with the RWE fans so that at least two exhaust fans must be operating before a supply fan can start. The remaining supply fan starts only when all three RWE exhaust fans are running. When a RWS fan starts, its respective isolation dampers open.

9.4.3.2.2.2 Radwaste Area Exhaust System

The RWE system includes three 33-1/3 percent capacity filter plenums and fans with motors. Each filter plenum includes low efficiency and HEPA filters. These fans exhaust the liquid and gaseous radwaste area, restricted machine shop, electric equipment areas, pipe chases, and RWTF system.

Fans are started manually by local handswitches that also open the fan isolation dampers. Normally, all three fans run; however, at least one RWS fan must be running, before the third RWE fan can be started.

9.4.3.2.2.3 Radwaste Tank Filter System

The Radwaste Tank Filter (RWTF) System includes two 100 percent capacity filter plenums with low efficiency filters, electric heating coils, HEPA and charcoal filters, fire protection water nozzles, high efficiency filters, and fans with motors. Gases vented from tanks and sumps that are potentially contaminated are collected and filtered through the tank vent filter unit and then exhausted through the RWE system.

Fans are started manually by local handswitches that also open the fan isolation dampers. Normally, one fan operates while the other is on standby. The RWTF fans are interlocked with the RWE fans, so that at least one RWE fan must be running before a RWTF fan can start. Upon failure of the operating RWTF fan, the one on standby is started manually.

An electric heating coil upstream of the charcoal adsorber limits the relative humidity of the gases flowing through the RWTF unit. The temperature of the upstream face of the charcoal adsorber is shown by a local temperature indicator. The charcoal adsorber unit is the tray type furnished with test cartridges.

Fire protection water deluge systems for the charcoal filters are described in Section 9.5.1. The RWTF fan is automatically tripped upon deluge system initiation, and the electric heating coil is deenergized.

9.4.3.2.2.4 Solid Radwaste Area Supply System

The Auxiliary Building Solid Radwaste Area Supply (SRWS) System includes two, 50 percent capacity units that contain low and high

efficiency filters, steam heating coils, chilled water coils, and fans with motors. Each unit is provided with automatic isolation dampers. The SRWS supplies high heat spaces and the lesser contaminated areas with 100 percent conditioned outdoor air.

The SRWS units and their isolation dampers are controlled by local handswitches. Normally, both units are operating. Each SRWS fan is interlocked with a SRWE fan, so that the exhaust fan must be running before a supply fan can start. When a supply unit starts, its respective isolation dampers open.

The Chilled Water System supplying the SRWS units is from the non-Q chillers and is described in Section 9.2.7. The steam system supplying the steam coils in the SRWS units is described under the auxiliary boiler system, Section 9.5.9.

9.4.3.2.2.5 Solid Radwaste Exhaust System

The Solid Radwaste Exhaust (SRWE) System includes two 50 percent capacity filter plenums and fans with motors. Each filter plenum includes low efficiency and HEPA filters. The system discharges to the north plant vent. The discharge is monitored by a radiation monitor, as discussed in Section 12.3.4. More air is exhausted by the SRWE system than is supplied by the SRWS system to ensure against air exfiltration from SRW areas to the surrounding areas of lower potential radioactivity.

Fans and their isolation dampers are controlled by local handswitches. When the fans start, their respective dampers open. Normally, both exhaust fans are operating.

9.4.3.2.2.6 Room Recirculation Units, Toilet, and Unrestricted Shop Exhaust

The three room recirculation units, which serve the solid radwaste control room and two offices, are air handling units containing a low efficiency filter, electric heating coil, chilled water cooling

coil, and a fan with motor. The units condition the recirculated air from the room with outdoor air supplied by the RWS system. Each air handling unit is actuated by a local handswitch. The fan runs continuously once the unit is actuated.

The toilet room exhaust fan and the unrestricted shop exhaust fan operate continuously. A local handswitch starts and stops each fan, and it also opens and closes a motorized isolation damper.

9.4.3.2.2.7 Unit Heaters, Unit Coolers, Duct Heating Coils, and Duct Cooling Coils

Locally mounted unit heaters prevent temperatures from dropping below the design minimum temperatures in the solid radwaste area and the unrestricted machine shop. The unit heaters are actuated by local hand switches with thermostats that cycle the fan on and off.

Locally mounted unit coolers provide supplementary cooling for the cable tray area rooms in radwaste area, Elevation 87 feet. Each unit cooler is actuated by a manual switch mounted in a local control panel. A room thermostat cycles the fan to maintain the design area temperature. Chilled water supplied from the non-Q chilled water flows through the cooling coil whether or not the fan is in operation.

An electric heating coil and a chilled water cooling coil are located in the RWS ducts serving the battery room and the battery charger room in the radwaste area, Elevation 87 feet. An electric heating coil and a chilled water cooling coil are also located in the RWS duct serving the auxiliary panel room, Elevation 124 feet. The chilled water is supplied from the non-Q chilled water system described in Section 9.2.7.

9.4.3.2.3 Remote Shutdown Panel Room

The RSP room HVAC unit is shown schematically on Plant Drawing M-79-0. System design parameters are listed in Table 9.4-11. The safety-related Chilled Water System supplying the cooling coils in the unit is described in Section 9.2.7. The instrumentation and

controls shown on Plant Drawing M-93-0 are considered an integral part of the RSP HVAC unit.

The RSP room HVAC unit is located in the auxiliary building corridor, adjacent to the RSP room. The unit consists of one 100 percent capacity air handling unit containing low and high efficiency filters, an electric heating coil, two 100 percent capacity redundant cooling coils, an electric humidifier, and a fan with motor.

Return air from the RSP room is mixed with a constant amount of outside air and supplied through the RSP unit to the room. The fan is started by a local handswitch.

9.4.3.2.4 Technical Support Center

The TSC system is shown schematically on Plant Drawing M-79-0. System design parameters are listed in Table 9.4-11. The safety-related chilled water system supplying the cooling coils of the TSCS unit is described in Section 9.2.7. The instrumentation and controls shown on Plant Drawing M-93-0 are considered an integral part of these systems.

The TSCS unit is a low velocity modular type air handler. The TSCS unit is located in the mechanical room above the reactor building roof, at elevation 153 feet and consists of a 100 percent capacity direct drive centrifugal fan with inlet vanes, low efficiency and high efficiency filters, electric steam humidifier, two 100 percent capacity chilled water cooling coils, and electric heating coil. The unit runs continuously to supply a constant volume of filtered and conditioned air. The TSCEF unit, also located in the mechanical room, consists of a direct drive centrifugal fan with inlet vanes, electric heating coil, low efficiency prefilters, upstream HEPA filters, charcoal filters, and downstream HEPA filters.

1. Normal operating mode - In the normal operating mode, the TSC air supply unit supplies a fixed quantity of outside air mixed with a fixed quantity of return air from the air

conditioned space. Cooling, heating, and humidification are modulated independently to maintain design requirements.

2. Recirculation mode - If excessive radiation is detected in the TSC outside air supply, the recirculation mode can be selected manually. In this mode of operation, the outside air dampers will close, and the HVAC system will operate with maximum design air recirculation through the TSCEF unit and the TSCS unit.

3. Pressurization mode - The operator can also select the pressurizing mode, whereby outside air is added to the recirculation air entering the TSCEF unit. A positive pressure will then be maintained in the TSC area to prevent infiltration of contaminated air from the surrounding areas.

4. In the event of LOP or LOCA, the TSC HVAC equipment will be restarted manually after the SDG bus is energized.

9.4.3.3 Safety Evaluation

9.4.3.3.1 Auxiliary Building Service Area

The Auxiliary Building Service Area HVAC System has no safety-related functions. Failure of the system does not compromise any safety-related system or component, or prevent a safe shutdown of the plant. This system is designed to maintain air flows from areas of lower to areas of greater radioactivity potential.

9.4.3.3.2 Auxiliary Building Radwaste Area

The Auxiliary Building Radwaste Area HVAC System has no safety-related functions. Failure of the system does not compromise any safety-related system or component, or prevent a safe shutdown

of the plant. This system is designed to maintain air flows from areas of lower to areas of greater radioactivity potential.

9.4.3.3.3 Remote Shutdown Panel Room

The RSP room HVAC system is not safety-related. This ventilation system is powered by non-Class 1E sources under normal plant conditions, and by an SDG in the event of LOP and a LOCA. It is designed to maintain the air flows from RSP room to the surrounding areas to minimize infiltration. The RSP room is to be used only when the main control room is unusable for plant shutdown. The RSP room air handling unit is not redundant, but is served by two loops of a safety-related Chilled Water System. Evaluation of the RSP room HVAC system, with respect to the aspects listed below is discussed in the following sections:

1. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

2. Environmental design - Section 3.11

3. Fire protection - Section 9.5.1.

9.4.3.3.4 Technical Support Center

The TSC HVAC system has no safety-related functions. Failure of the system does not impact any safety-related system or component, or prevent a safe shutdown of the plant. The HVAC system is designed to prevent infiltration from the surrounding areas of potentially higher contamination level to the TSC room areas.

9.4.3.4 Tests and Inspections

9.4.3.4.1 Auxiliary Building Service Area

All Auxiliary Building Service Area HVAC System equipment is inspected and tested during manufacture, installation, and startup.

Air and water flows are measured, adjusted, and balanced to design requirements using calibrated instruments. All equipment and instruments are accessible for periodic visual inspection, calibration, and local testing. During normal operation, the instrumentation provides warning of equipment malfunction and of abnormal conditions. The CLE HEPA filter units are tested in accordance with ANSI N510.

9.4.3.4.2 Auxiliary Building Radwaste Area

All Auxiliary Building Radwaste Area HVAC System equipment is inspected and tested during manufacture, installation, and startup. Air and water flows are measured, adjusted, and balanced to design requirements using calibrated instruments. All equipment and instruments are accessible for periodic visual inspection, calibration, and local testing. During normal operation, the instrumentation provides warning of equipment malfunction and abnormal operating conditions. The RWTF charcoal filter units, and the RWE and SRWE HEPA filter units are tested in accordance with ANSI N510.

9.4.3.4.3 Remote Shutdown Panel Room

The system is preoperationally tested in accordance with the requirements of Section 14.

9.4.3.4.4 Technical Support Center

The system is preoperationally tested in accordance with the requirements of Section 14. The HEPA and charcoal filters of the TSCEF unit are tested in accordance with ANSI N510.

9.4.3.5 Instrumentation Requirements

9.4.3.5.1 Auxiliary Building Service Area

Except for unit heater and duct heater switches and room thermostats, which are local, all control actuation, indicators, and

alarms are incorporated in control panels located in HVAC equipment rooms in the Auxiliary and Turbine Buildings.

Any one or more of the following alarms at the local HVAC panel will also alarm in the main control room as a summary panel trouble alarm:

1. Airflow failure (each fan)

2. High differential pressure across the combined filter banks in the SAS and CLE plenums

3. SAS roll filter media runout

4. SAS high supply air temperature (warning of cooling coil failure)

5. SAS low supply air temperature (warning of heating coil failure).

The Auxiliary Building Service Area HVAC System includes sensors, controllers, switches, and indicators that automatically perform the following functions:

1. Automatically start or stop the CLE fans

2. Open and close isolation dampers

3. Advance SAS roll filter media

4. Modulate SAS and CLE fan inlet vanes

5. Modulate SAS steam heating or chilled water cooling coil control valves

6. Modulate SAS electric humidifier heater and water level control valves

7. Modulate SAS duct heaters

8. Start and stop local steam unit heaters

9. Indicate air temperatures, filter differential pressures, and supply air flows.

9.4.3.5.2 Auxiliary Building Radwaste Area

Except for unit heater, duct heater, roof exhaust fans, and duct cooling coil switches and thermostats, which are local, all control actuation, indicators, and alarms are incorporated in control panels located in HVAC equipment rooms in the Auxiliary Building. Any one or more of the following alarms at the local HVAC panel, will also alarm in the main control room as a summary panel trouble alarm:

1. Airflow failure (each fan)

2. High pressure differential across the combined filter banks in the RWS and SRWS systems

3. High pressure differential across the combined filter banks in the RWE, RWTF, and SRWE systems

4. RWS and SRWS roll filter media runout

5. Supply air low and high temperature in the RWS and SRWS systems (warning of heating and cooling coil failure, respectively)

6. Unit cooler room high temperature (indicating unit cooler failure)

7. High RWTF charcoal filter humidity (upstream of the charcoal filter).

The Auxiliary Building radwaste area HVAC systems include sensors, controllers, switches, and indicators that automatically perform the following functions:

1. Start or stop all fans

2. Open and close isolation dampers

3. Advance the RWS and SRWS roll filter media

4. Modulate fan volume control dampers in the SRWE and RWTF systems; maintain a constant airflow by modulating the fan's inlet vanes in the SRWS, RWS, and RWE systems.

5. Modulate steam heating or chilled water cooling coil control valves in the RWS and SRWS systems

6. Modulate the RWS duct heater

7. Control the RWTF electric heater

8. Start and stop steam unit heaters and unit coolers

9. Indicate air temperatures, filter differential pressures, and supply air flows.

9.4.3.5.3 Remote Shutdown Panel Room

All control actuation, indicators, and alarms are incorporated in a local control panel, in the Auxiliary Building, near the RSP room HVAC unit. Any one or more of the following alarms at the local HVAC control panel, will also alarm in the main control room as a summary panel trouble alarm:

1. Airflow failure

2. High differential pressure across the combined filter banks

3. Room high temperature (warning of cooling coil failure)

4. Room air low temperature (warning of heating coil failure).

The RSP room HVAC system includes sensors, controllers, switches, and indicators that automatically perform the following functions:

1. Start and stop the RSP fan

2. Open and close isolation dampers

3. Modulate the chilled water cooling coil control valves

4. Modulate the electric heating coil and electric humidifier

5. Indicate air temperatures, humidity, filter differential pressure, and supply airflows.

9.4.3.5.4 Technical Support Center

All alarms, handswitches, temperature and moisture indicators, temperature transmitters, and airflow switches are located in the HVAC control panel, in the mechanical room of the TSC, and on the roof of the reactor building. All other control instruments or indicators are mounted locally on the equipment or the ductwork. The mode switch for system control (off-normal, pressurizer, recirculate) is located in the central alarm station of the TSC, elevation 132 feet. Any one or more of the alarms annunciated at the local HVAC control panel are also transmitted to the main control room as a summary-panel trouble alarm.

TSCS unit controls and instrumentation include:

1. Local differential pressure indicators for each filter bank, with high differential pressure switch and alarm for the combined filter banks.

2. Local airflow failure switch and alarm for the TSCS fan.

3. Return air temperature indicator-controller with local high-low alarms to modulate the output of the electric heating coil and the chilled water coil valves.

4. Return air humidity indicator-controller with local high-low alarms, and supply air high limit override indicator controller for controlling the output of the electric humidifier.

5. A common mode switch for changeover from the normal mode to the recirculation or the pressurization mode, or the stop mode, for both TSCS and TSCEF units.

6. A smoke detector located in the outside air intake duct to the TSCS unit, annunciated at the fire protection system status panel in the main control room.

7. A radiation monitor located in the outside air intake duct to the TSC unit annunciated in the main control room.

TSCEF unit controls and instrumentation include:

1. Local differential pressure indicators for each filter bank, with a high differential pressure switch and alarm for the combined filter banks.

2. Local airflow controller for the discharge duct to modulate the fan inlet vanes for constant air volume.

3. Local airflow failure switch and alarm for the TSCEF fan.

4. Local temperature indicator for the TSCEF charcoal filter.

5. High flow switch actuated by a flow transmitter in the deluge fire protection system for the charcoal filter to trip the TSCEF fan.

6. Humidity indicator controller and high humidity alarm for controlling the output of the TSCEF electric heating coil.

9.4.3.6 SRP Rule Review

Acceptance Criterion II.3 refers to Regulatory Guide 1.140, which, in Position C.2.a, states that atmosphere cleanup systems, installed in normal ventilation exhaust systems should consist of the following sequential components: HEPA filters before adsorbers, adsorbers, fans, and interspersed ducts, dampers, and related instrumentation.

At HCGS, the atmosphere cleanup units in the normal ventilation exhaust systems do not include all the sequential components required by Regulatory Guide 1.140. In particular, the radwaste area fume hoods and chemistry lab are exhaust systems have only prefilters and HEPA filters and no adsorbers. Adsorbers are not needed in this system to vent offsite dose limitations.

Acceptance Criterion II, Regulatory Guide 1.140, Position C.2.b states that the flow rate of a single atmosphere cleanup train should be limited to approximately 30,000 cfm.

At HCGS, the 30,000 cfm capacity limit per cleanup train is exceeded on some of the exhaust systems of normal ventilation exhaust systems. In particular, the RWE system fans are set to provide a nominal 33,800 cfm per each filter plenum.

9.4.4 Turbine Building Ventilation System

The function of the Turbine Building Ventilation System (TBVS) is to maintain the design air temperatures, quality, and flow direction in

the Turbine Building during normal plant operations. This system is not safety-related.

9.4.4.1 Design Bases

The TBVS is designed to operate during normal plant conditions and accomplish the following objectives:

1. Provide a year round supply of filtered and tempered air for all areas of the building

2. Maintain air flow from areas of lesser to areas of greater radioactivity potential

3. Maintain building spaces at or below the following maximum temperatures during normal operating conditions:

   a. General areas: 104°F

   b. Electrical equipment rooms: 104°F

   c. Mechanical equipment rooms: 120°F

   d. Main steam tunnel-auxiliary building area: 130°F

   e. Battery charger room: 110°F

4. Maintain a building temperature at or above 55°F during normal operation, and 40°F during shutdown, except in the battery room, and the battery charger room, where the minimum temperature is 40°F during all normal conditions.

5. Maintain the building at a slightly negative pressure to minimize exfiltration to the outside atmosphere

6. Discharge all potentially radioactive exhaust air through the monitored south plant vent

7. Provide ventilation equipment to the recirculation pump motor generator sets and local coolers in high heat areas

8. Provide recirculation from the Turbine Building Exhaust (TBE) System to the Turbine Building Supply (TBS) System during winter to minimize the heating load. (The TBS heating coil is sized for a purge mode condition using all outside air, in case recirculation is unacceptable, e.g., due to smoke.)

   The TBS and TBE systems will be normally operated in the purge mode at all times with winter recirculation to be permitted in the future upon installation of automatic controls that respond to airborne contamination levels.

9. Provide 50 percent standby capacity for the supply/exhaust fans in the TBS and TBE system, and a minimum of 50 percent standby capacity for the unit coolers in areas where a loss of cooling would interfere with the turbine generator cycle. When the third exhaust fan is placed in service, the TBE system has no standby capacity.

9.4.4.2 System Descriptions

The air flow diagram for the TBVS is shown on Plant Drawing M-75-1. System equipment design parameters are listed in Tables 9.4-12 and 9.4-13. Cooling water is supplied to the supply air and recirculation units cooling coils by the nonsafety-related Chilled Water System described in Section 9.2.7. The instruments and controls are shown on Plant Drawing M-82-1.

Some recirculation units are supplied by the Turbine Auxiliary Cooling Water System described in Section 9.2.2.

Steam and hot water are provided to the supply air and unit heater heating coils by the Plant Auxiliary Steam System described in Section 9.5.9.

The Turbine Building supply equipment and associated exhaust fans are located in the heating and ventilating equipment room at Elevation 171 feet. This room also contains the recirculation pump motor generator set ventilating unit. Unit coolers are installed in the condenser area at Elevations 68 and 102 feet. Unit coolers for the mezzanine pipe chase are also at Elevation 102 feet. Unit coolers for the primary condensate pump room are located at Elevation 77 feet. Unit coolers for the secondary condensate pump room are located at Elevation 54 feet. Unit coolers for the feedwater heater rooms are located at Elevation 102 feet. The battery room supply and exhaust fans are located outside the battery room at Elevation 102 feet. The oil room exhaust fans are located at Elevation 171 feet. Individual unit coolers and unit heaters are located in the areas that they serve, as indicated on Plant Drawings M-75-1 and M-82-1.

Airflow is routed from nonradioactive personnel access areas to areas of progressively increasing potential contamination prior to final exhaust. Openings between adjacent areas of differing radioactive potential are minimized to maintain proper air direction.

The TBS system normal mode of operation is 100 percent once through outdoor air, winter recirculation will be permitted in the future as described in Section 9.4.4.2.1.

A minimum outdoor air quantity introduced into the building via the Turbine Building Supply System during winter is sufficient to ensure proper direction of airflow to the potentially contaminated areas.

9.4.4.2.1 Turbine Building Supply System

The TBS system consists of outside air louvers, outside air dampers having a minimum open position, low and high efficiency filters, a steam heating coil, a chilled water cooling coil, and three 50 percent capacity constant volume supply fans. Two of the three fans normally run to supply filtered, heated, or cooled air, as

required, to all levels of the turbine building. The third fan is standby. The standby supply fan starts automatically upon failure of an operating fan. Each supply fan is provided with a pneumatically operated shutoff damper at the discharge. The system runs with 100 percent outside air (purge mode) during normal operation. An automatic interlock between the purge switch and radiation monitors in the exhaust air stream from the condenser compartments and main steam tunnel will be provided. The system will modulate from 100 percent capacity outside air at maximum summer outside temperature to about 33-1/3 percent capacity outside air at minimum winter outside temperature when the automatic interlock is operational. A bypass duct with a backdraft damper is provided so that outside air can be induced into the building by operating exhaust fans when the supply fans are not in operation.

The TBS fans are started by handswitches located on a local control panel. Normally, two out of three fans are running. The supply fans are interlocked with the TBE and Turbine Building compartment exhaust (TBCE) fans so that at least two TBE and one TBCE fan must be running before any supply fan starts. The heating and cooling coils are modulated by a temperature controller in the supply air stream.

9.4.4.2.2 Turbine Building Exhaust System

The TBE system consists of three 50 percent capacity centrifugal fans and ductwork. Normally, two of the three fans are in operation, with the third fan in standby. The third exhaust fan may be turned on at the operator’s discretion, and as necessary to maintain negative pressure and reduce temperature in the turbine building. Each exhaust fan is provided with manually operated inlet vanes and a pneumatically operated shutoff damper at the discharge. The exhaust fans draw air from the least radioactive areas of the turbine building as well as from some of the high heat areas. During normal operation the TBE system will discharge directly to the outdoors through the south plant vent stack. Upon completion of the modifications to the TBS system, as indicated in Section 9.4.4.2.1, the exhaust air from the TBE system will be permitted to partially return to the TBS while in the modulating

mode. The TBE fans are started by handswitches on a local control panel. The standby fan starts automatically upon failure of an operating fan.

9.4.4.2.3 Recirculation Pump Motor Generator Ventilation System

The Motor Generator Ventilation (MGV) System draws outside air through louvers, control dampers, and low and high efficiency filters, and discharges it directly into the air cooled motors and generators. Each of the two 100 percent supply fans has pneumatically operated inlet vanes to maintain a constant flow rate, and a pneumatically operated shutoff discharge damper at the discharge. One fan normally runs while the other is standby. Each fan is designed to supply enough air for both motors and generators. When only one motor generator set is running, the air path to the idle motor generator set may be closed manually, and the inlet vanes of the supply fan may be partially closed to reduce the air flow to the running motor generator set. Air discharged from the motor generator sets is exhausted to the outdoors or partially recirculated during winter by temperature controls. The MGV fans are started by handswitches located on a local control panel. The standby fan starts automatically upon failure of the operating fan.

9.4.4.2.4 The Turbine Building Battery Room Supply System

The Turbine Building Battery Room Supply (TBBS) System draws outside air through louvers, electrically operated shutoff control dampers, a low efficiency filter, electric heating coil, and two 100 percent capacity centrifugal fans. The air is discharged directly into the battery and battery charger rooms.

Control switches for the fans are located on a local control panel. The TBBS system is put into operation by manually starting one fan and placing the other fan on standby mode. The standby fan starts automatically upon failure of the operating fan. The electric heating coil is controlled by a temperature indicator and switch located in the room.

9.4.4.2.5 Turbine Building Battery Room Exhaust System

The Turbine Building battery room exhaust (TBBE) System consists of two 100 percent capacity fans, electrically operated discharge dampers, and duct work. One fan is continuously exhausting the battery and battery charger room to the outdoors at a constant volume. Control switches for the fans are located on a local control panel. The TBBE system is put into operation by placing one fan in auto-lead and the other fan in auto mode. The TBBE fans will not start until the TBBS fans are running. The standby fan starts automatically upon failure of the operating fan. Supply air for this system comes from the TBBS system.

9.4.4.2.6 Turbine Building Oil Storage Room Exhaust System

The Turbine Building Oil Storage Room Exhaust (TBOE) System consists of two 100 percent capacity fans, a pneumatically operated shutoff damper at each fan discharge, and ductwork. One fan is continuously exhausting the chemical sump and pumps room, oil interceptor room, lube oil receiving and storage room, electrohydraulic control (EHC) room and surrounding area, lube oil reservoir room, reactor feed pump turbine (RFPT) lube oil reservoir and cooler rooms, and RFPT lube oil purifier room to the south vent at a constant volume. Control switches for the fans are located on a local control panel. The TBOE system is put into operation by manually starting one fan and placing the other fan on standby mode. The standby fan starts automatically upon failure of the operating fan. Infiltration air for this system is induced into each of these rooms from the TBS system.

9.4.4.2.7 Turbine Building Compartment Exhaust System

The TBCE system exhausts air at constant volume from the potentially highest radioactive areas, such as the condensate demineralizer cells, primary condensate pump room, feed water heater rooms, vacuum pump room, air ejector rooms, steam seal evaporator room, reactor feed pump rooms, resin regeneration room, steam packing exhaust room, off-gas tunnel, sampling station, and pipe chases to the south plant vent. The system consists of two 100 percent capacity fans, a

pneumatically operated shutoff damper at each fan discharge, and duct work. One fan operates continuously while the other is standby.

Control switches for the fans are located on a local control panel. The TBCE system is put into operation by manually starting one fan and placing the other fan on standby mode. The standby fan starts automatically upon failure of the operating fan. Infiltration air is induced into these rooms from the TBS system.

9.4.4.2.8 Unit Coolers

Recirculating unit coolers using Turbine Auxiliaries Cooling System (TACS) water are provided in the condenser compartment and mezzanine pipe chase. Recirculating unit coolers using chilled water are provided in the primary condensate pump room, secondary condensate pump room, and feedwater heater rooms. The unit coolers are started using handswitches located on a local control panel. Where standby coolers, as shown in Table 9.4-12, are provided, the standby cooler starts automatically upon failure of an operating unit.

9.4.4.2.9 Unit Heaters

Steam and hot water unit heaters maintain the design minimum temperatures of 55°F in the condenser compartment, lube oil reservoir room, stairways, elevator machine room, Elevation 102-foot access area, Elevation 120-foot access area, Elevation 137-foot access area and operating floor, and HVAC equipment room. Each unit heater is started using a local handswitch that is part of a local thermostat. The thermostat controls only the fan.

9.4.4.3 <u>Safety Evaluation</u>

The TBVSs have no safety-related functions. They are designed to maintain air flows from clean areas to potentially contaminated areas, and from areas of low level contamination to areas of potentially higher level contamination. Ventilation system releases

will be monitored at the south plant vents in compliance with GDC 60 and 64.

Where a system is provided with a redundant fan, failure of an operating fan automatically starts the standby fan to maintain continuity of ventilation.

The exhaust air through the TBE system and the TBCE system is monitored separately for radioactivity prior to reaching the south plant vent, in order to generally locate the source of potentially unacceptable plant releases. Upon detection of high radiation, alarms are annunciated locally, and in the main control room. To locate the specific origin of any abnormal radiation releases, portable radiation monitors will be used. Refer to Section 11.5 for a description of the Radiological Monitoring System (RMS).

The recirculation mode in the Turbine Building will be permitted in the future upon installation of automatic controls that respond to airborne contamination levels. At the present, the TBVS will operate in the purge mode at all times.

Evaluation of the TBVS, with respect to fire protection is discussed in Section 9.5.1.

9.4.4.4 Tests and Inspections

All major components are tested and inspected as separate components prior to installation, and as integrated systems after installation, to ensure design performance. Duct work system air flows are measured and adjusted to meet design requirements within ±10 percent, and all instruments are calibrated to the design setpoints. The systems are preoperationally tested in accordance with the requirements of Section 14.

Periodic inspections and measurements are made of air flows, water flows, air and water temperatures, filter pressure drops, controls

positions, etc, to verify the design condition, in order to ensure operability and integrity of the systems for normal plant operation.

9.4.4.5 Control, Instrumentation, and Monitoring

All control actuation, indicators, and alarms for normal plant operation are located in local control panels in the turbine building ventilation equipment room. Any one or more alarms at a local control panel will also alarm in the main control room as a single alarm.

Controls and instrumentation for the various TBVSs include the following:

1. TBS system:

   a. Heating and cooling temperature indicators and controls for the entering mixed air and leaving supply air temperature

   b. Low and high temperature switches and alarms for the heated and cooled supply air

   c. Differential pressure indicator, differential pressure switch, and high alarm for the air filters and a media runout switch with alarm for the roll filter

   d. Airflow indicator and control for supply fan capacity

   e. Airflow failure switch and alarm for each supply fan, with summary panel trouble alarm to control room computer

   f. Purge mode handswitch and indication

2. TBE system:

   a. Airflow failure switch and alarm for each exhaust fan, with summary panel trouble alarm to control room computer

3. MGV system:

   a. Supply air temperature indicator, and control, with high and low temperature alarms, for mixing outdoor air with discharge air

   b. Airflow failure switch and alarm for each supply fan, with summary panel trouble alarm to the control room computer

   c. Discharge air temperature indicator and high temperature alarm for each motor and generator

   d. Airflow indicators and controls for constant flow through each motor and generator

   e. Differential pressure indicator, high differential pressure switch, and alarm for the air filters

4. TBCE system:

   a. Airflow failure switch and alarm for each exhaust fan, with summary panel trouble alarm to the control room computer

   b. Exhaust air temperature indicator and high temperature alarm

5. TBBS system:

   a. Differential pressure indicator for the filter

   b. Airflow failure alarms to the control room computer for each supply fan

   c. Room temperature indicator and control for heating

   d. Supply low air temperature alarm to the control room computer

6. TBBE and TBOE systems:

   a. Airflow failure switch and alarm for each exhaust fan in each system with indication to the control room computer for the TBBE fans

7. Unit coolers:

   a. Airflow failure alarm to the control room computer for each cooler

   b. Ambient temperature indication and high temperature alarm to the control room computer for each location

8. Unit heaters:

   a. Thermostat with handswitch for each heater.

Two radiation detection elements are provided. One (RE-4827) monitors airborne radioactivity exhausted by the TBE system, and the other (RE-4456) monitors airborne radioactivity exhausted by the TBCE system before they discharge to the south plant vent. In addition, the south plant vent is provided with a Radiological Monitoring System (RMS). Refer to Section 11.5 and Plant Drawing M-26-1.

9.4.4.6 SRP Rule Review

Acceptance Criterion II.3 also refers to Regulatory Guide 1.140, which, in Position C.2.a, states that atmosphere cleanup systems installed in normal ventilation exhaust systems should consist of the following sequential components: HEPA filters before adsorbers, adsorbers, fans, and interspersed ducts, dampers, and related instrumentation.

At HCGS, the atmosphere cleanup units in the normal ventilation exhaust systems do not include all the sequential components required by Regulatory Guide 1.140. In particular, the turbine building equipment compartment exhaust system has been designed with a provisional filter plenum which, at present, does not include filters. Calculations show that concentrations of airborne radioactivity inside the Turbine Building, as well as at site boundary locations, will be well below allowable limits even without filters.

9.4.5 Primary Containment Ventilation Systems

Ventilation of the primary containment (drywell and torus) is provided by three systems: the Drywell Air Cooling System, the Containment Prepurge Cleanup System (CPCS), and the Reactor Building Ventilation System (RBVS). The Drywell Air Cooling System removes heat from the drywell during normal plant operation, plant shutdown, and certain abnormal conditions.

The capability to purge the drywell and torus is provided by the CPCS and the RBVS, as described in Section 9.4.2.

9.4.5.1 Design Bases

The design bases for the Drywell Air Cooling System are as follows:

1. During normal reactor operation, limit the average air temperature inside the drywell to 135°F maximum, with no location over 150°F, and 135°F maximum around the recirculating pump motors. Localized hot-spots above elevation 162'0" are permissible (no EQ components are at or above this elevation in the Drywell) provided average Drywell temperature does not exceed 135°F.

2. During scram, but without loss of offsite power (LOP), limit the maximum ambient temperature in the area under the reactor vessel to 165°F or lower, for up to 30 minutes.

3. During normal reactor operation, prevent concrete structures within the drywell from exceeding their maximum design temperature specified in Section 3.8.2.

4. During normal shutdown operation, limit the air temperature inside the drywell to 104°F maximum and 40°F minimum by use of the RBVS purge mode.

5. In the event of LOP and reactor scram, limit the ambient temperature inside the drywell as shown in Figure 3.11-2.

6. The single failure of an active or passive component in the system cannot result in a complete failure of the system.

7. The drywell air cooling system is not a safeguard system for a loss-of-coolant accident (LOCA), but can be powered from the standby diesel generators (SDGs) (non-Class 1E power) in the event of LOP.

8. The supports and hangers of all ventilation components inside the drywell are designed to Seismic Category I requirements.

9. Moisture removed from fan coil units is piped to the drywell floor drain sump and is monitored to aid in drywell leak detection during normal plant condition.

9.4.5.2 System Description

The Drywell Air Cooling System includes eight unit coolers, each of which contains two 100 percent cooling coils and two 100 percent fans. The operating configuration of fans and cooling coils is dictated by the drywell temperature limits. Any configuration of fans and cooling coils is acceptable. The design parameters for the unit coolers are listed in Table 9.4-14. When a fan is in standby, the standby fan starts automatically when a low air flow condition exists, as sensed by a pressure differential switch on the operating unit cooler. During normal plant conditions, cooling water is supplied to the unit coolers from the nonsafety-related Chilled Water System described in Section 9.2.7. Chilled water is normally supplied to only one of the two redundant cooling coils, although both coils can be supplied with water if additional cooling is needed to maintain temperature limit.

In the event of LOP, the cooler fans and controls are automatically sequenced on non-Class 1E diesel generator power.

In the event of LOP and failure of the nonsafety-related Chilled Water System, the cooling water for the unit coolers is switched automatically to the Reactor Auxiliaries Cooling System (RACS) water supply. The RACS is described in Section 9.2.8. RACS water can be supplied simultaneously to both cooling coils in each unit cooler if additional cooling is needed to maintain temperature limit.

The drywell unit coolers are located in the lower section of the drywell, between the 90 and 128-foot elevations, and are arranged around the circumference of the drywell. Four of the unit coolers are provided with ductwork on both the suction and discharge sides, while the remaining four unit coolers have discharge duct work only. The duct work in the drywell head area is removable for refueling activities.

The unit coolers, as shown on Plant Drawing M-77-1, serve specific areas of the drywell as follows:

1. Two unit coolers supply air to the control rod drive (CRD) area inside the reactor pedestal and to the annular area between the reactor vessel and the reactor shieldwall.

2. Three unit coolers supply air to the refueling bellows area, the top of the reactor shieldwall, and the drywell head area.

3. Three unit coolers supply air to the lower elevations in the vicinity of the reactor recirculation pumps.

4. Ducted return air to the unit coolers is taken from the refueling bellows area and the drywell head area.

The unit coolers are provided with two speed motors for operation at low speed (1750 rpm) during the drywell and torus integrated leak rate testing (ILRT), and at high speed (3500 rpm) during normal conditions.

All coolers are operated manually from the main control room. The controls are shown on Plant Drawing M-86-1. All operating modes for the drywell coolers are shown in Table 9.4-15.

9.4.5.3 Safety Evaluation

Each of the cooling water supply and return lines through the drywell wall is provided with two isolation valves, one inside and one outside.

In the event of a LOCA signal, with or without LOP, the cooler fans stop automatically, and cooling water flow is isolated automatically.

The Drywell Air Cooling System is not safety-related. Only the supports for system components inside the drywell are specified, designed, and installed in accordance with Seismic Category I requirements, as defined in Section 3.7.

Environmental design of the Drywell Air Cooling System is discussed in Section 3.11.

9.4.5.4 Tests and Inspections

Fans are rated in accordance with standards of the Air Movement and Control Association (AMCA). Duct work is tested for structural integrity and leakage during installation. All air and water flows are tested and balanced to provide design quantities within a tolerance of plus or minus 10 percent. Coil assemblies are pneumatically tested at 188 psig under water. Inservice inspection is discussed in Section 5.2.4, and Sections 14 and 16.

9.4.5.5 Instrumentation Applications

The Drywell Air Cooling System is capable of being operated remotely from the main control room. During normal plant operations, all operations are performed manually, with the exception of automatic startup of a standby cooler fan when an operating fan fails. Each unit cooler fan, cooling coil control valve, water source diversion valve, and isolation valve is provided with a separate handswitch in the main control room.

A pressure differential switch is provided across each unit cooler fan to indicate fan operation. Failure of an operating fan alarms in the main control room and automatically starts the standby fan.

Air temperature is monitored both upstream and downstream of the cooling coils in each unit cooler. Computer indication of a high downstream temperature alarms in the main control room. Additional temperature elements located throughout the drywell monitor local

drywell air temperatures. Temperature computer indication for these locations is provided in the main control room.

9.4.5.6 SRP Rule Review

Justifications for deviations with SRP Section 9.4.5, Engineered Safety Feature (ESF) Ventilation Systems, are presented in SRP Sections 9.4.1 and 9.4.2, which address the specific ESF ventilation systems of HCGS.

9.4.6 Standby Diesel Generator Area Ventilation Systems

9.4.6.1 Design Bases

The Standby Diesel Generator (SDG) Area Ventilation Systems maintain a suitable operating environment for the SDG rooms, the safety- and nonsafety-related battery rooms, switchgear rooms, SDG fuel oil storage rooms, electrical chases, corridors in the diesel area, and the SDG Class 1E panel room during all modes of plant operation. The heating, cooling, and ventilating systems for the SDG area consist of both safety-related and nonsafety-related systems. The seismic classification and corresponding codes and standards that apply to the design of the system are discussed in Section 3.2.

The heating, cooling and ventilation systems for the standby diesel generator area is designed to maintain the following space temperatures during normal plant operations, based on outside design temperature of 94°F dry bulb/78°F wet bulb.

1. 104°F maximum in the H&V equipment rooms, corridors, electrical chases, diesel fuel tank rooms and the diesel generator recirculation fan rooms.

2. 120°F maximum in the diesel generator rooms when the diesel generators are energized.

3. 85°F maximum in the control equipment rooms, inverter rooms, battery charger rooms and the diesel generator control rooms.

4. 90°F maximum in the switchgear rooms.

5. 77°F±3°F in the battery rooms.

The meteorological conditions considered in the design of Diesel Area Safety-Related Battery Room Exhaust System, Switchgear Room Cooling Systems, Diesel Area Class 1E Panel Room Supply System and SDG Room Recirculation System are provided in Table 9.4-22.

9.4.6.2 System Description

The SDG area is provided with the separate ventilation systems listed below and shown on Plant Drawings M-85-1 and M-88-1. Equipment design parameters are listed in Table 9.4-16. The systems are:

1. Diesel Area Supply System - This system is nonsafety-related. It is composed of two 50 percent capacity heating and ventilating units. It supplies air to the SDG area corridor, stairwells, and the electrical chases. Outside air is taken from a Seismic Category I plenum and passed through an automatic outside air intake damper, low efficiency and high efficiency filters, an electric heating coil, a centrifugal supply fan provided with automatic inlet vanes, and an automatic supply air shutoff damper.

The Diesel Area Supply System is started by local handswitches. A flow controller is provided to maintain constant airflow automatically by modulating the inlet vanes at each fan. The automatic inlet and discharge shutoff dampers open when the fan starts.

The low flow switch actuates an alarm upon low airflow and stops the operating fan. Alarms are also provided for high pressure differential across the filters.

The SDG rooms receive air from the SDG area corridor through a 4-foot by 3-foot louver, which is equipped with a fire damper. The air is drawn out of the SDG rooms by the SDG area exhaust system. The air supplied to the corridor is heated to 60°F during cold weather. If the electric heater fails to maintain this temperature, a low supply air temperature to the diesel area supply units alarms at 40°F on a local panel and is indicated at the main control room annunciator panel. The operator response to this alarm will be to investigate and initiate corrective action associated with the HVAC system failure.

The SDG area corridor and rooms will be above the 40°F alarm setpoint of the SDG area supply ventilation due to the large thermal capacitance of the SDG corridor and rooms. Residual heat in the corridor and SDG rooms, including the SDG keepwarm systems, will allow operation and/or maintenance personnel time to:

a. Restore the normal SDG area heating system

b. Raise and maintain SDG room temperature using portable heating systems.

In the unlikely event that the standby diesel engine keepwarm system fails and system temperatures fall to the

low temperature point, an alarm will be sounded in the control room. Operating/maintenance personnel will be dispatched to investigate and remedy the problem. If the engine keepwarm system is unable to be returned to service and/or the HVAC fails to keep the room at the proper temperature, the engine can be started to maintain temperatures in the standby range until corrective maintenance is completed.

It is anticipated that the diesel engines will start or operate at temperatures below the specified low temperature. Similar equipment has performed successfully in more severe climates.

2. Diesel Area Exhaust System - This system is nonsafety-related. It exhausts air from the SDG area corridors, SDG fuel oil storage rooms, electrical chases, the SDG rooms, and the SDG recirculation system equipment rooms supplied by the Diesel Area Supply System. The diesel area exhaust system consists of two 50 percent capacity vaneaxial fans. Each fan is provided with manual variable pitch blades and an automatic discharge shutoff damper. The Diesel Area Exhaust System is started by local handswitches.

   Upon loss of airflow, the low flow switch for each fan actuates an alarm on a local panel and stops the operating fan. The automatic discharge shutoff damper opens when the fan starts.

3. Diesel area safety-related battery room exhaust systems - There are four battery rooms at elevation 146 feet, and two battery rooms at Elevation 163 feet 6 inches, all of which are safety-related.

   Each battery room at Elevation 146 feet is provided with a 100 percent capacity separate centrifugal exhaust fan that

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discharges to the outdoors. Makeup air to the battery rooms is provided by the switchgear room cooling system. Each fan is provided with a manual inlet shutoff damper, an automatic discharge damper shutoff and a tornado protection check damper. During loss of offsite power (LOP), the fans are automatically connected to Class 1E power from the respective SDG they serve. A low flow computer input actuates an alarm in the main control room upon loss of airflow. The discharge shutoff damper automatically opens when the fan starts. The fans are started by handswitches located on the local panel.

The two safety-related battery rooms at Elevation 163 feet 6 inches are provided with two 100 percent capacity exhaust fans. Makeup air to these battery rooms is provided by the diesel area Class 1E panel room supply system. Each fan is provided with a manual inlet shutoff damper and an automatic discharge shutoff damper, and a tornado protection damper. During LOP, the fans are automatically connected to emergency Class 1E power from the SDG. The automatic discharge shutoff damper opens when the fan starts. A low flow computer input actuates an alarm in the main control room upon loss of airflow, and starts the redundant fan automatically. The fans are started by handswitches located on the local panel.

4. Diesel area nonsafety-related battery room exhaust system - The two nonsafety-related battery rooms at Elevation 163 feet 6 inches are provided with two 100 percent capacity exhaust fans. Each fan has a manual inlet shutoff damper, and an automatic discharge shutoff damper, and a tornado protection damper. Makeup air to these battery rooms is provided by the diesel area Class 1E panel room supply system. A low flow computer input actuates an alarm in the main control room upon loss of airflow, and automatically starts the redundant fan. The automatic discharge damper opens when the fan starts. The

fans are started by handswitches located on the local panel.

5. Switchgear room cooling systems - These are safety-related systems. Each of the four switchgear rooms is provided with one Seismic Category I, full capacity air cooling unit that has a centrifugal supply fan, a tornado protection check damper at its outside air intake duct, a low efficiency filter, and two 100 percent capacity chilled water cooling coils. The air cooling unit can be isolated by the automatic outside air shutoff damper and by manual dampers located in the discharge and return ducts. A mixture of outside air and return air enters the switchgear room unit cooler for processing. The conditioned air is supplied to the switchgear room, battery charger room, battery room, and SDG control room of each respective SDG. Cooling coils are supplied with chilled water from the safety-related control area chilled water system. Chilled water piping is arranged so that one coil in each unit receives chilled water from loop A, and the other coil receives chilled water from loop B. During LOP, the cooling units are automatically connected to Class 1E power from the respective SDG that they serve. Each unit cooler can be started by a handswitch located at the local panel.

   The low flow switch for each fan actuates an alarm at the local panel, and in the main control room upon loss of airflow, and stops the operating fan. Alarms are also provided for high pressure differential across the filter and for high or low return air temperature.

6. Diesel area Class 1E panel room supply system - This system is safety-related and supplies conditioned air to the four battery rooms, nine inverter rooms, and two heating, ventilating and air conditioning (HVAC) rooms at Elevation 163 feet, and the elevator machine room at

Elevation 178 feet. It is composed of two 100 percent capacity HVAC units. One unit runs while the other is on standby. The standby unit will automatically start upon failure of the operating unit. Outside air for each unit is taken from a separate Seismic Category I plenum. Each unit has a low and a high efficiency filter, an electric heating coil, a chilled water coil, and a centrifugal supply fan provided with automatic inlet vanes. The outside air return duct and discharge air ducts are provided with automatic shutoff dampers. The outside air duct is also provided with a tornado protection check damper. A flow controller is provided that ensures a constant air volume. The cooling coil is supplied with chilled water from the auxiliary building control area chilled water system. Water piping is arranged so that the coil of one unit receives chilled water from loop A and the coil of the other unit receives chilled water from loop B. During LOP, the units are automatically connected to emergency Class 1E power from the SDG. Each unit cooler can be started by a handswitch located at the local panel.

The low flow switch actuates a local alarm upon loss of airflow and starts the standby units. Local alarms are also provided for high pressure differential across the filter and high or low discharge air temperature. The return air temperature is indicated on the computer in the main control room.

7. SDG Room Recirculation System - This is a safety-related system. Each of the four SDG rooms is provided with two fans and two coil assemblies. Under ordinary operating conditions, these coolers are fully redundant, each capable of providing 100% of the cooling requirement for the SDG rooms. During periods of operation when the ultimate heat sink temperature is elevated such that the post-accident SACS temperature will exceed 95°F, both coolers are required to be available for service.

Each cooling coil receives its water supply from the Safety Auxiliaries Cooling System (SACS), either from loop A or from loop B. The fans are connected to the Class 1E power supply from the respective SDG they serve. The system is designed to cool and recirculate the

air in the SDG rooms. The SACS water supply is throttled through control valves at the inlet to the coils at a flow rate that is dependent upon the cooling requirements.

Assuming the single failure of one source of cooling water (which is SACS water), the plant operators will manually realign the cooling source to the unaffected loop to provide cooling water for all four diesel generator HVAC systems. During periods of operation when the ultimate heat sink temperature is elevated such that the post-accident SACS temperature will exceed 95°F, with one inoperable SACS loop, the valves controlling the SACS cooling water to the SDG room coolers are aligned to 25% open. This will ensure both that adequate cooling occurs in the SDG rooms, and that there is sufficient remaining flow to satisfy all safety-related loads cooled by SACS.

SDG room recirculation systems are normally interlocked to start with the respective SDG. They may be manually started from handswitches located at the local panel. The "auto lead" fan runs when the SDG runs or room temperature is high. The "auto standby" fan runs if the "auto lead" fan fails, or when the SDG runs and room temperature is high. The operating fan continues to run for 45 minutes after the SDG stops running.

The low flow switch across the operating fan actuates an alarm upon loss of airflow and stops the operating fan. An alarm is also provided for high or low room air temperature. The room temperature is displayed and alarmed in the main control room.

8. Battery room supply - Electric duct heaters are provided for all battery rooms. Those heaters that serve safety-related battery rooms are safety-related. Those heaters that serve nonsafety-related battery rooms are nonsafety-related.

The duct heaters, controlled by individual thermostats, normally provide a 77°±3°F room air temperature. During LOP, duct heaters for safety-related battery rooms are automatically connected to emergency Class 1E power.

9. Unit heaters - Unit heaters with electric coils are controlled by individual thermostats. Each thermostat with a built-in handswitch is normally set at 60°F to provide heat to the heating and ventilating equipment rooms and the corridors.

9.4.6.3 Safety Evaluation

Each of the SDG area safety-related ventilation systems (diesel area battery room exhaust, switchgear room cooling, diesel area Class 1E panel room supply, and SDG room recirculation), is located within the Seismic Category I tornado and missile protected Auxiliary Building. These safety-related ventilation systems are designed to Seismic Category I requirements, except for the space high temperature switches and main control room annunciators.

During normal plant operation, the SDG area ventilation systems operate, as follows, to maintain the equipment integrity:

1. The Diesel Area Supply System operates continuously to provide filtered and tempered outdoor air to maintain satisfactory ambient conditions.

2. The Diesel Area Exhaust System exhausts air continuously from all spaces supplied by the diesel area supply system.

3. The Switchgear Room Cooling System runs continuously to provide cooling and ventilation for the switchgear room, SDG control room, battery room, and battery charger room. Each cooler has two independent cooling coils.

4. The Battery Room Exhaust Systems exhaust air continuously from the battery rooms.

5. The Diesel Area Class 1E Panel Recirculation System runs continuously to provide cooling and ventilation for the control equipment room, inverter rooms, and battery rooms at Elevation 163 feet. This system is composed of two 100 percent capacity HVAC units. If one unit fails, the redundant unit automatically starts.

6. The battery room electric duct heaters operate only if the room temperature in the battery room drops below 77°F ± 3°F.

7. The unit heaters run only when the room temperature drops to 60°F.

8. The SDG room recirculation system operates concurrently with the diesel engines to provide continuous cooling to the SDG rooms. Each of the four SDG rooms is provided with two cooling units. If the lead unit fails, the second unit automatically starts.

In the event of a loss-of-coolant accident (LOCA), all systems continue to operate as outlined above unless shut down by the control room operator.

Upon LOP, the diesel area supply system, diesel area exhaust system, and the nonsafety-related battery room exhaust fans stop running. The safety-related battery room exhaust fans battery room duct heaters (except the duct heaters for nonsafety-related battery rooms), Class 1E panel supply unit, and the switchgear room cooling fans continue to run on Class 1E power. The diesel generator room recirculating system is actuated automatically when its respective SDG is energized, and the unit heaters stop running.

The SDG area corridor and SDG rooms will be above the 40°F alarm set point of the SDG area supply ventilation due to the large thermal capacitance of the SDG corridor and the SDG rooms. The residual heat in the corridor and the SDG rooms, including the SDG keepwarm systems, will allow the operation and/or maintenance personnel time to:

1. restore normal SDG area heating system,

2. raise and maintain SDG room temperature using portable heating systems.

If in the unlikely event the standby diesel engine keepwarm system fails and the system temperatures fall to the low temperature point, an alarm will be sounded in the control room. Operating/maintenance personnel will be dispatched to investigate and remedy the problem. If the engine keepwarm system is unable to be placed back into service and/or the HVAC fails to keep the room at the proper temperature, the engine can be started to maintain temperatures in the standby range, until corrective maintenance is completed.

It is not anticipated that the diesel engines would not start or operate at temperatures below the specified low temperature. Similar equipment has performed successfully in much more severe climates.

For a failure modes and effects analysis, see Table 9.4-17. Evaluation of the safety-related SDG ventilation systems with respect to the following is discussed in the following sections:

1. Protection from wind and tornado effects - Section 3.3

2. Flood protection - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1.

The SDG area nonsafety-related ventilation systems (diesel area supply, diesel area exhaust, nonsafety-related diesel area battery room exhaust, duct heaters, and unit heaters) have no impact on safety-related functions. Failure of these systems does not compromise any safety-related system or component or prevent a safe shutdown of the plant. All nonsafety-related systems have Seismic

Category I supports at locations where failure of that system may cause damage to a safety-related system.

9.4.6.4 Tests and Inspections

The SDG area safety-related ventilation systems are preoperationally tested in accordance with the requirements of Section 14.

All SDG area HVAC equipment is inspected and tested during manufacture, installation, and startup. Air and water flows are measured and adjusted to within ± 10 percent of the design requirements with calibrated instruments.

9.4.6.5 Instrumentation Requirements

All control actuation, indications, and alarms, except for the unit heaters and duct heaters, are located in the local control panels in the diesel area HVAC equipment rooms. When a diesel area HVAC alarm is indicated on the local panel, a panel summary trouble alarm is indicated at the main control room annunciator panel.

The following abnormal conditions are alarmed:

1. Any fan failures

2. High differential pressure across the filters in the diesel area Class 1E panel room supply units, diesel area supply units, and the switchgear room unit coolers

3. High temperature in any SDG room

4. Low airflow to any battery room

5. Low or high supply air temperature in the Class 1E panel room or diesel area supply units

6. High or low return air temperature for switchgear room unit coolers, and diesel area panel room supply units

7. High or low exhaust temperature for Class 1E battery rooms.

9.4.7 Service Water Intake Structure Ventilation Systems

The Service Water Intake Structure (SWIS) Ventilation Systems are designed to maintain appropriate design temperatures within the intake structure and the traveling screen motor room.

9.4.7.1 Design Bases

1. The SWIS ventilation systems are safety-related.

2. The ventilation systems for the service water pump rooms and the traveling screen motor room are designed to Seismic Category I specifications.

3. The ventilation systems for the service water pump rooms and the traveling screen motor room are designed with sufficient redundancy to meet the single failure criterion.

4. The ventilation systems for the service water pump rooms and the traveling screen motor room are powered from the Class 1E standby diesel generators (SDGs) in the event of loss of offsite power (LOP).

5. The ventilation components are located in Seismic Category I structures that are tornado, missile and flood protected.

6. The two pump rooms in the intake structure are individually ventilated and heated to maintain a year round temperature range of 104°F maximum, and 60°F,

minimum. The year round temperature range for the traveling screen motor room is the same as for the pump rooms. To alert for temperatures approaching freezing, the Low Temperature Alarm setpoint is set at 45° F for the two pump rooms and 40° F for the Traveling Screen Motor Room.

7. The ventilation systems are designed to permit periodic inspection and local testing during normal power operation.

The meteorological conditions considered in the design of the SWIS ventilation system are provided in Table 9.4-22.

9.4.7.2 System Description

The SWIS ventilation systems are shown schematically on Plant Drawings M-81-0 sheet 1 and M-95-0. The equipment design data are listed in Table 9.4-18.

9.4.7.2.1 Intake Structure Ventilation System

The Intake Structure Ventilation System is an Engineered Safety Feature (ESF) System. The two redundant intake structure pump rooms are each provided with separate and identical ventilation capability consisting of two 100 percent capacity supply fans and two 100 percent capacity exhaust fans. One supply and one exhaust fan normally operate with one supply and one exhaust fan on standby. The supply and exhaust openings in each pump room are tornado and missile protected. During winter operation, exhaust air is recirculated through a return air damper to use the pump motor heat.

The outdoor air intake dampers are designed to fail closed to prevent freezing. Electric unit heaters are provided for winter shutdown freeze protection.

9.4.7.2.2 Traveling Screen Motor Room Ventilation System

The Traveling Screen Motor Room Ventilation System is an ESF system. The room is provided with two 100 percent capacity supply fans, each

with motorized outside air intake and return air dampers and one common exhaust opening with backdraft damper. One supply fan operates continuously, and the other is on standby. The intake and exhaust openings are tornado and missile protected. During winter operation, room air is recirculated through the return air damper to use the traveling screen motor heat.

Electric unit heaters are provided for winter shutdown freeze protection.

9.4.7.3 Safety Evaluation

Each safety-related service water pump compartment is ventilated and heated by two separate, completely independent, full capacity systems. The fans and controls are located in Seismic Category I structures that are tornado, missile, and flood protected. The ventilation systems are powered from normal power sources during power generation, and by Class 1E SDGs on LOP sources. The electric unit heaters are not required during design basis accidents (DBAs), when the station service water pumps and traveling screens operate.

These safety-related ventilation systems are designed to Seismic Category I requirements. They maintain the space temperatures above freezing and below the continuous duty ambient rating for ESF electrical equipment located in the compartments.

For the Service Water System failure modes and effects analysis, see Table 9.4-19. Evaluation of the intake structure ventilation systems with respect to the following aspects, is discussed in the following sections:

1. Protection from wind and tornado effects - Section 3.3

2. Flood protection - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1.

9.4.7.4 Tests and Inspections

The SWIS ventilation systems are preoperationally tested in accordance with the requirements of Section 14.

9.4.7.5 Instrumentation Requirements

Instrumentation for the SWIS ventilation systems is as follows:

1. SWIS pump room ventilation system - Each intake structure pump room ventilation system is controlled locally. The system is started manually or automatically. When in the auto mode, a high temperature room switch will start and stop each ventilation system set (supply and exhaust fan). In addition to the fan start and stop temperature switches, a high-low temperature switch is located in each pump room. The temperature switch alarms locally and activates a common trouble alarm in the main control room. A room thermostat modulates the outdoor, return, and exhaust air dampers to control space temperature.

   If a running supply fan indicates low airflow, both supply and exhaust fans stop and the standby combination of fans are started automatically by their respective high temperature switch.

2. Traveling Screen Motor Room Ventilation System - The Traveling Screen Motor Room Ventilation System is controlled locally. The system is started manually. Room thermostats actuate the outdoor and return air dampers to

control space temperature. A high-low room temperature switch alarms locally and in the main control room on a common trouble alarm. If a running fan indicates low airflow, it stops, and the standby fan starts automatically when its starting mode is in "auto."

3. Electric unit heaters - Electric unit heaters are controlled by individual wall-mounted thermostats with built-in "on-off-auto" switches.

9.4.8 Miscellaneous Structures Ventilation Systems

Miscellaneous structures include the following buildings:

1. Cooling tower instrument shelter
2. Circulating water Cl_2 analyzer station
3. Service water Cl_2 analyzer station
4. Circulating water Chemical Control Building
5. Service water Chemical Control Building
6. Fuel oil foam and transfer pumphouse
7. Fuel oil transfer house
8. Blowdown outfall instrument shelter
9. Deleted
10. Auxiliary boiler, domestic water pretreatment, and yard electrical substation building
11. Asphalt storage tank and Boiler Building.
12. Circulating Water Pump House Pump Room.
13. Circulating Water Pump House Switchgear Room.

The ventilation systems for these structures are not safety-related.

9.4.8.1 Design Bases

The ventilation systems of miscellaneous structures are designed to function during normal plant operations and perform the following functions:

1. Maintain space temperatures within design limits suitable for equipment and for human comfort, as follows:

Miscellaneous Structures	Winter Minimum °F	Summer Maximum °F
Items 1 through 8, 10, 11 and 13	60	104
Items 9 and 12	40	104

(the above items are in Section 9.4.8)

2. Alarm abnormal building temperatures, loss of ventilation airflow, and high air filter pressure drop locally on the control panel, with a common trouble alarm transmitted to the main control room and the computer (for items 9., 10., and 11. in Section 9.4.8).

9.4.8.2 System Description

9.4.8.2.1 Cooling Tower Instrument Shelter

The cooling tower instrument shelter is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is drawn in through two manually operated louvers, one in the door and one in the wall. The shelter is heated by one electric unit heater controlled by a thermostat.

9.4.8.2.2 Circulating Water $C1_2$ Analyzer Station

The circulating water $C1_2$ analyzer station is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is drawn in through two manually operated louvers, one in the door and one in the wall. The station is heated by one electric unit heater controlled by a thermostat.

9.4.8.2.3 Service Water $C1_2$ Analyzer Station

The service water $C1_2$ analyzer station is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is drawn in through two manually operated louvers, one in the door and one in the wall. The station is heated by one electric unit heater controlled by a thermostat.

9.4.8.2.4 Circulating Water Chemical Control Building

The circulating water chemical control building is ventilated by two 50 percent capacity, wall mounted exhaust fans, each controlled by a thermostat. Outside air is drawn in through six manually operated louvers, two in the doors and four in the walls. The building is heated by four electric unit heaters, each controlled by a thermostat.

9.4.8.2.5 Service Water Chemical Control Building

The service water chemical control building is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is drawn in through three manually operated louvers, one in the door and two in the walls. The building is heated by two electric unit heaters, each controlled by a thermostat.

9.4.8.2.6 Fuel Oil Foam and Transfer Pumphouse

The fuel oil foam and transfer pumphouse is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is

drawn in through three manually operated louvers, one in the door and two in the walls. The pumphouse is heated by two electric unit heaters, each controlled by a thermostat.

9.4.8.2.7 Fuel Oil Transfer House

The fuel oil transfer house is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is drawn in through two manually operated louvers, one in the door and one in the wall. The transfer house is heated by one electric unit heater controlled by a thermostat.

9.4.8.2.8 Blowdown Outfall Instrument Shelter

The blowdown outfall instrument shelter is ventilated by one wall mounted exhaust fan controlled by a thermostat. Outside air is drawn in through two manually operated louvers, one in the door and one in the wall. The shelter is heated by one electric unit heater controlled by a thermostat.

9.4.8.2.9 Section Deleted

9.4.8.2.10 Auxiliary Boiler, Domestic Water Pretreatment, and Yard Electrical Substation Building

The boiler control, domestic water pretreatment, and substation rooms are each provided with roof mounted supply units discharging a constant quantity of air into their respective spaces. There are no standby capacity supply units. The boiler control room and the substation room employ two supply units each, while the water treatment room is served by one supply unit. Mixing dampers are incorporated to vary the supply of outside air from a preset minimum to the full capacity rate. Varying quantities of outside air and room air are supplied by each unit in response to a room thermostat. Electric heating coils are contained within all supply units to maintain the minimum design temperature while the minimum outside air is being supplied. A separate room thermostat controls the heating coil in each supply unit.

Each room is provided with a 100 percent capacity gravity relief vent to discharge the varying amounts of exhaust air. Backdraft dampers are provided at the relief ventilator outlets.

Ventilation systems for the auxiliary boiler domestic water pre-treatment and yard electrical sub-station buildings are shown schematically on Plant Drawings M-95-0 and M-81-0 sheet 2. Major equipment design parameters for all the miscellaneous structures are listed in Table 9.4-20.

9.4.8.2.11 Asphalt Storage Tank and Boiler Building

The asphalt storage tank and boiler building is ventilated by two 50 percent capacity wall exhaust fans. Outside air is drawn into the structure through two louvers and electric motor operated dampers. Each wall exhaust fan is provided with a backdraft damper. Four electric unit heaters, controlled by individual thermostats, provide sufficient heat to maintain the minimum design temperature. The ventilation system for the asphalt storage tank and Boiler Building is shown schematically on Plant Drawing M-81-0 sheet 1.

9.4.8.2.12 Circulating Water Pump House Pump Room

The circulating water pump house pump room is ventilated by four 100% capacity 2-speed wall exhaust fans, one per pump area. The low speed (30,000 cfm) is used during the winter and the high speed (60,000 cfm) is used during the summer. Outside air is drawn into the pump room through louvers with electro-hydraulic actuated dampers. The wall exhaust fan is provided with a discharge shutter. The pump room is heated by eight electric unit heaters controlled by individual thermostats.

9.4.8.2.13 Circulating Water Pump House Switchgear Room

The switchgear room is provided with two 100% supply units. Each supply unit has mixing dampers to vary the outside air from a preset minimum to the full supply rate. Electric heating coils are contained within the supply units to provide heating should the heat release from the equipment within the room provide inadequate to maintain the minimum design temperature. The room exhaust air is discharged through two 50% capacity roof relief vents.

9.4.8.3 Safety Evaluation

The ventilation systems for the miscellaneous structures are not safety-related. Failure of these systems does not compromise any safety-related system or components, or prevent a safe shutdown of the plant.

9.4.8.4 Test and Inspections

Equipment is tested and inspected before and after installation to verify its operation and capacity. System operability is demonstrated by use during normal plant operation.

9.4.8.5 Instrumentation Requirements

Instrumentation requirements for the ventilation systems are as follows:

1. The ventilation systems of the structures listed in Items 1 through 8 of Section 9.4.8 are controlled by local thermostats and handswitches that can override the thermostat. There are no ventilation system alarms for these structures.

2. Deleted

3. The auxiliary boiler domestic water pretreatment and yard electrical substation building is provided with local panel-mounted alarms for room high/low temperatures and for fan failures, with a common trouble alarm transmitted to the main control room and computer.

4. The asphalt storage tank and storage building is provided with local panel mounted alarms for room high/low temperatures and for fan failures, with a common trouble alarm transmitted to the main control room and computer.

TABLE 9.4-1

CONTROL ROOM AND CONTROL BUILDING HVAC SYSTEMS DESIGN PARAMETERS

	Safety-Related Items				
Items	Control Room Supply Units	Control Room Return Air Fans	Control Room Emergency Filter Units	Control Equipment Room Supply Units	Control Area Battery Exhaust Fans
Type	Air handling	Individual fans	Air handling	Air handling	Individual fans
Quantity	2 units	2 fans	2 units	2 units	2 fans
Flow rate, each (cfm)	18,500	18,500	4,000	59,500	3,000
Fan					
Type	Centrifugal	Vane axial	Centrifugal	Centrifugal	Centrifugal
Drive	Direct	Direct	Direct	Direct	Direct
No. of fans per unit	1	1	1	1	1
No. of running fans	1	1	1	1	1
Static pressure, each (in.)	6.2	4.40	13.25	8.5	4.2
Motor hp, each	40	30	25	250	5
Cooling coil (chilled water)					
No. of coils per unit	2	NA	NA	4	NA
Cooling capacity, total (Btu/h)	821,600	NA	NA	3,290,000	NA
Heating coils (electric)					
No. of coils per unit	1	NA	1	1	NA
Heating capacity, each (Btu/h)	307,170	NA	44,370	341,300	NA
Filters (low efficiency type)					
Quantity and size (in.) per unit	2-24" x 24" x 6"	NA	4-24" x 24" x 6"	4-24" x 24" x 6"	NA
Pressure drop (in. w.g.)					
Clean	0.35	NA	0.11	0.35	NA
Dirty	1.0	NA	1.0	1.0	NA
Efficiency (percent)	55	NA	55	55	NA
Filters (high efficiency type)					
Quantity and size (in.) per unit	2-24" x 24" x 12"	NA	NA	2-24" x 24" x 12"	NA
Pressure drop (in. w.g.)					
Clean	0.50	NA	NA	0.45	NA
Dirty	1.0	NA	NA	1.0	NA
Efficiency (percent)	80 to 85	NA	NA	80 to 85	NA
Filters (HEPA)					
Pressure drop (in. w.g.)	NA	NA		NA	NA
Clean	NA	NA	1.0	NA	NA
Dirty	NA	NA	3.0	NA	NA
Efficiency (percent)	NA	NA	99.97	NA	NA

Items	Control Room Supply Units	Control Room Return Air Fans	Control Room Emergency Filter Units	Control Equipment Room Supply Units	Control Area Battery Exhaust Fans
	Safety-Related Items				
Charcoal adsorber					
Type	NA	NA	All welded, gasketless, vertical	NA	NA
Depth, in.	NA	NA	4	NA	NA
Filter media	NA	NA	Impregnated activated carbon	NA	NA
Pressure drop (in. w.g.)	NA	NA	1.40	NA	NA
Efficiency					
Removing inorganic iodine (percent)	NA	NA	99	NA	NA
Removing organic iodine (percent)	NA	NA	99	NA	NA

Item	Control Area Exhaust Fan	Control Area Smoke Exhaust Fan	Wing Area Supply Unit	Wing Area Exhaust Fan
	Non-Safety Related Items			
Type	Individual fan	Individual fan	Air handling	Individual fan
Quantity	2	1	2	2
Flow rate, each (cfm)	2,500	8,500	19,700	18,000
Fan				
Type	Centrifugal	Vaneaxial	Centrifugal	Centrifugal
Drive	Belt	Direct	Belt	Belt
No. of fans per unit	1	1	1	1
No. of running fans	1	On standby	2	2
Static pressure, each (in.)	1.75	1.75	6.0	1.75
Motor hp, each	2	5	50	20
Cooling coils				
No. of coils per unit	NA	NA	NA	NA
Cooling capacity, each (Btu)	NA	NA	NA	NA
Heating coils (steam)				
No. of coils per unit	NA	NA	1	NA
Heating capacity, each (Btu)	NA	NA	1,188,000	NA

Item	Control Area Exhaust Fan	Control Area Smoke Exhaust Fan	Wing Area Supply Unit	Wing Area Exhaust Fan
	Non-Safety Related Items			
Filter (low efficiency type)				
Quantity and size (in.)	NA	NA	2-112" x 72"	NA
Pressure drop (in. w.g.)				
Clean	NA	NA	0.10	NA
Dirty	NA	NA	0.50	NA
Efficiency (percent)	NA	NA	85	NA
Filters (high efficiency type)				
Quantity and size (in.)	NA	NA	2-24" x 24" x 12"	NA
Pressure drop (in. w.g.)				
Clean	NA	NA	0.50	NA
Dirty	NA	NA	1.0	NA
Efficiency (percent)	NA	NA	80 to 85	NA

TABLE 9.4-2

CONTROL ROOM AND CONTROL BUILDING HVAC SYSTEMS
CONTROL ROOM SUPPLY SYSTEM
FAILURE MODE AND EFFECT ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency	Power supply	Total LOP	None. The systems are redundant and are powered from separate standby diesel generators	Alarm in the main control room	No loss of safety function. Automatic restart on SDG power
Emergency (LOCA or LOCA + LOP)	Supply fan	Loss of one fan	None. The standby unit automatically starts	Alarm in the main control room (airflow failure)	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Fans outlet dampers	Damper fails and closes	None. The dampers are designed to fail safe in the closed position. When the damper fails closed, it trips and isolates its associated fan and the standby unit automatically starts	Alarm in the main control room (airflow failure)	No loss of safety function
Emergency (LOCA LOCA + LOP, or high radiation in outside air)	Isolation dampers	Damper failure	None. The two isolation dampers are in series and are designed to fail safe in the closed position. Only one damper is needed to close and effectively isolate	Damper position indication in the main control room	No loss of safety function, CREF system automatically starts.
Emergency (LOCA, LOCA + LOP, or high radiation in outside air)	CREF discharge air damper	Damper fails to open when initiated and remains closed	None. Low air flow trips its associated fan. The redundant HVAC system is put into operation	Alarm in the main control room (air flow failure)	No loss of safety function.

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
		Damper fails in open position during system operation	None. The CREF system will continue in operation		No loss of safety function
Emergency (LOCA LOCA + LOP, or high radiation in outside air)	CREF unit outside air intake damper	Damper fails to open when initiated and remains closed	None. Start the redundant HVAC/CREF train for room pressurization, or the system will be on 100 percent recirculation mode.	Damper position indication in the main control room	No loss of safety function
		Damper fails to intermediate open position during system	HVAC/CREF system will continue in operation. If recirculation mode is to be selected, the redundant HVAC/CREF system will be placed in operation	Damper position indication in the main control room	No loss of safety function
Emergency (LOCA, LOCA + LOP, or high radiation in outside air)	CREF unit room air recirculation damper	Damper fails to open when initiated and remains closed.	None. Low air flow trips its associated fan. The redundant HVAC system is put into operation for recirculation mode	Alarm in the main control room (air flow failure)	No loss of safety function
		Damper fails to intermediate open position during system operation	HVAC/CREF will continue in operation		No loss of safety function
Emergency (LOCA or radiation in outside air with or without LOP)	Cooling coils	Loss of cooling coil due to leaks or rupture	None. The redundant full capacity unit train is put into operation	Eventual loss of chilled water alarmed in the main control room	No loss of safety function

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency (LOCA or radiation in outside air with or without LOP)	Electric heating coils	Failure of heating coil	None. The electric heating coils are not required to operate during emergency operation	Temperature indicators at the duct and in remote control panels	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Control room return air fans	Loss of one fan	None. The standby fan automatically starts	Alarm in the main control room (air flow failure)	No loss of safety function

TABLE 9.4-3

CONTROL ROOM AND CONTROL BUILDING HVAC SYSTEMS
CONTROL ROOM EMERGENCY FILTER SYSTEM
FAILURE MODE AND EFFECT ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency	Power supply	Total loss of offsite power (LOP)	None. The systems are redundant and are powered from separate standby diesel generators	Alarm in the main control room	No loss of safety function
Emergency (high outside air radiation or LOCA)	Fans	Loss of one fan	Upon a LOCA signal, both fans start automatically. Loss of one fan would leave one CREF train in operation. Upon a high radiation signal, the redundant train will be started by manual actuation delineated in operating procedures.	Alarm in the main control room	No loss of safety function
Emergency (high outside air radiation or LOCA)	Fan outlet dampers	Damper failure	None. The dampers designed to fail open. The standby train will be started by manual actuation	Alarm in the main control room	No loss of safety function
Emergency (high outside air radiation or LOCA)	Charcoal absorbers	High temperature (ignition temperature)	None. Preignition temperature is alarmed in the control room. At a higher temperature (ignition), the fire protection deluge water valves are opened, the whole train is tripped and isolated and the standby train automatically starts	Preignition and ignition alarms in the control room	No loss of safety function

TABLE 9.4-3 (Cont)

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency (high radiation or LOCA)	Prefilter, downstream, and upstream HEPA filters	High differential pressure across any of these components	None. If any of these filters is completely clogged, airflow will be lost and the standby unit will automatically start	Local differential pressure indicators. Pressure differential across the upstream HEPA filter is recorded and alarmed in the control room in compliance with Regulatory Guide 1.52	No loss of safety function
Emergency (high radiation or LOCA)	Electric heating coil	Heater failure	None. The standby unit is manually actuated on failure of the running unit	Fan status-indicating lights in the control room	No loss of safety function

TABLE 9.4-4

CONTROL ROOM AND CONTROL BUILDING HVAC SYSTEMS
CONTROL EQUIPMENT ROOM SUPPLY SYSTEM
FAILURE MODE AND EFFECT ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency	Power supply	Total loss of offsite power (LOP)	None. The systems are redundant and are powered from separate standby diesel generators	Alarm in the main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Fan outlet dampers	Loss of one fan	None. The standby unit automatically starts	Alarm in the main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Fans, outlet dampers (HD-9603)	Damper fails and closes	None. The dampers are designed to fail safe in the closed position. When the damper fails closed, it trips and isolates its associated fan and the standby unit automatically starts	Alarm in the main control room	No loss of safety function
Emergency (LOCA or LOCA +LOP)	Cooling coils	Loss of cooling due to leaks or rupture	None. The redundant full capacity unit train is put into operation	Eventual loss of chilled water alarm in the main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Electric heating coils	Failure of heating coil	None. The electric heating coils are not required to operate during emergency operation	Temperature indicators at the duct and in remote control panels	No loss of safety function

TABLE 9.4-5

CONTROL ROOM AND CONTROL BUILDING HVAC SYSTEMS
CONTROL AREA BATTERY EXHAUST SYSTEM
FAILURE MODE AND EFFECT ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On The System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency	Power supply	Total loss of offsite power (LOP)	None. The systems are redundant and are powered from separate standby diesel generators	Alarm in the main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Fans	Loss of one fan	None. The standby unit automatically starts	Alarm at the remote control panel	No loss of safety function
Emergency or LOCA + LOP)	Fan outlet dampers	Damper fails and closes	None. The dampers are designed to fail safe in the closed position. When the damper fails closed, it trips and isolates its associated fan and the standby fan automatically starts	Alarm in the remote control panel	No loss of safety function

TABLE 9.4-6

CONTROL ROOM AND CONTROL BUILDING HVAC SYSTEMS
TESTS AND INSPECTIONS

1. GENERAL

a. Safety-related components are designed, fabricated, installed, and tested under quality assurance requirements, in accordance with Appendix B to 10CFR50.

b. For systems that must perform a safety-related function, periodic inservice testing of fans, valves, controls, and instrumentation in the systems is performed. Motor operated valves and dampers are tested by opening and closing the valve or damper. Temperature, differential pressure readings, and flow capacity are recorded.

c. Equipment in Seismic Category I systems is required by specification to meet the seismic requirements for this project. Before each equipment item is shipped, the supplier of that item is required to submit an adequate analysis or applicable test data as evidence of seismic compliance.

d. Components designed to meet Seismic Category I requirements are subjected to a program of vendor shop and field testing.

e. Standby units are tested at periodic intervals to verify the operation of essential features. Periodic tests of the activation circuitry and the system components are conducted during normal plant operation.

2. FANS

Centrifugal, propeller, and vaneaxial fans are shop tested in accordance with the AMCA Standard Test Code for Air Moving Devices, Bulletin 210. Vaneaxial fans are tested again in the field for flow and pressure requirements, where blade setting adjustments are made to correct flow rates, where necessary.

3. MOTORS

Motors are built, designed, rated, and tested in accordance with NEMA-MG-1. Seismic Category I motors are certified for the NEMA tests required in Publication No. MG-1.

4. COOLING COILS

Cooling coils are furnished in accordance with ASHRAE 33 and ARI 410. Chilled water coils are hydrostatically and pneumatically tested. Seismic Category I coils are seismically qualified by analysis or testing on a shaker table.

5. HEATING COILS

The electric heating coils are furnished in accordance with the requirements of UL 1096 and the National Electric Code, Article 424. The electric heating coils are installed according to the National Fire Protection Association Pamphlets 90A and 90B. The steam heating coil is furnished in accordance with ASHRAE 33 and ARI 410.

6. HIGH EFFICIENCY AIR FILTERS (SUPPLY AIR)

The particulate filters are UL Class 1 approved under UL 900. The filter efficiency and performance is in accordance with ASHRAE Standard 52-76. The airflow resistance of the high efficiency

filters is 0.50 inch w.g. (clean) and 1.0 inch w.g. (dirty) at rated flow (500 fpm). The filters have an efficiency rating of 80 to 85 percent by dust spot test on atmospheric dust.

7. LOW EFFICIENCY PREFILTERS (USED IN SERIES WITH HEPA FILTERS)

The prefilters are certified to meet standards for UL Class 1 filters. Airflow resistance of the prefilters at rated flow is 0.35 inch w.g. (clean). Prefilters have an efficiency rating of 55 percent minimum by the NBS dust spot test.

8. HEPA FILTERS

a. Qualification Tests Before Installation

1. HEPA filters meet the construction, material, test and qualification requirements of military specification MIL-F-51068 and have fiberglass media conforming to the requirements of military specification MIL-F-51079.

2. Radiation resistance of filter media meets the requirements of MIL-F-51079.

3. The assembled filters are type-tested in accordance with UL 586, High-Efficiency Air Filter Units, to minimize fire hazards. The filters are approved UL Class 1.

4. Each filter is tested for flow resistance at rated flow. The filter resistance is not to exceed the rated pressure drop of 1 inch w.g. under this condition.

5. Each filter design and combination of materials of construction is qualified by testing at least two of the size and design to rough handling in accordance with Method 105.9 of MIL-STD-282 for 15 min. at 3/4 in. total amplitude and a frequency of 200 Hz, with pleats and filter faces in a vertical orientation, without visible damage or loss of filtration efficiency, as determined by testing.

6. Filters are subjected to acceptance tests made by the manufacturer. The filter efficiency is no less than 99.97 percent when tested with monodispersed, thermally generated DOP aerosol having a mean particle size of 0.3 micron.

7. Filters selected at random from the manufacturer's production line are subjected to moisture, overpressure resistance, and filter dust loading tests in order to initially qualify the filters. The moisture and overpressure resistance tests are performed in accordance with MIL-F-51068.

8. Each filter is individually tested by the manufacturer at 100 percent and 20 percent of the rated capacity to IES Standard CS-1.

b. Preoperational Tests for Acceptance (Performed in Filter Train Housing)

1. Visual and performance checks of the housing and mounting frames are made in the field in accordance with Sections 5, 6, and 7 of ANSI N510 to check for

conformance with design specifications. Nonconforming items are rejected and replaced with acceptable equipment.

2. After installation, inplace testing of the HEPA filter bank is conducted in accordance with Section 10 of ANSI N510-1980. The tests are conducted at the rated airflow, using the DOP aerosol test equipment, test procedures, and test reports specified in ANSI N510-1980. The percentage penetration of less than 0.05 percent verifies acceptability of the filter bank. An engineered safety feature air filtration system satisfying this condition can be considered to warrant a 99 percent removal efficiency for particulates in accident dose evaluations. When leaks exist that would result in an inability to meet the specified system parameters, they are located and repaired by increasing the filter's gasket compression or by filter replacement. The system is then tested again to ensure conformance with acceptance criteria.

9. <u>CARBON ADSORBERS</u>

Carbon adsorbers are tested as follows:

a. Qualification Tests Before Installation

1. Representative samples, taken from each batch of carbon used for filling the adsorbers, are tested per the requirements of Regulatory Guide 1.52, Position C-6 for adsorption efficiencies of molecular iodine (elemental), and methyl iodide (organic). The performance requirements are given in Table 5-1 of ANSI N509. For systems operating outside of primary

containment, with relative humidities controlled to 70 percent, the removal efficiencies and residence times for iodine forms are as follows:

Adsorbent Depth	Assigned Activated Carbon Decontamination Efficiencies
2 inches (0.25 res time)	95 percent elemental 95 percent organic
4 inches (0.50 res time)	99 percent elemental 99 percent organic

Tests or calculations demonstrate that the residence times shown above are met.

2. Laboratory tests on the carbon adsorbent are conducted in accordance with RDT M16-1T to determine the following:

    (a) Particle size

    (b) Ignition temperature

    (c) Apparent density

    (d) Moisture content

    (e) Carbon tetrachloride activity.

b. Inplace Testing of Adsorber

1. Each charcoal adsorber is tested for leakage using the test method presented in ANSI N510. In this test Refrigerant (R-11 or R-112) is introduced into the upstream side of the adsorber at rated airflow. A downstream concentration of less than 0.05 percent verifies an acceptable inplace leak test.

2. The installed carbon adsorber filter bank is checked for conformance to the design specifications by a visual and a performance test in accordance with ANSI N510.

10. <u>FILTER HOUSINGS</u>

In addition to the housing manufacturer's shop tests, a field performance test is conducted for each housing. The housings are designed to withstand pressures ranging from 6 to 23 inches w.g.

11. <u>FILTER INSERVICE TESTS AND INSPECTIONS</u>

a. The air filtering systems are subject to inplace testing before initial startup, at least once per 18 months thereafter, and after each HEPA filter or adsorber change, following painting, fire or chemical release in any ventilation zone communicating with the system, and following removal of an adsorber sample for laboratory testing.

b. Periodic testing of the HEPA filter banks ensures that the filter bank performance is not degraded through normal use, or during standby, to a level below that assumed in the accident analyses. Test methods and acceptance criteria are the same as or equal to those for initial acceptance of the system components. If the test results indicate that performance of a component is below the acceptance criteria, the component is repaired or replaced.

c. The following filter inservice tests and inspections are performed at regular intervals during plant life to determine that the filtration systems are functioning correctly:

 1. With the fan running, readings on the differential pressure gauges, which are mounted on the filter plenum, are observed and recorded

 2. Prefilters are replaced when the pressure drop across them reaches 1.0 inch w.g.

 3. HEPA filters are replaced when the pressure drop across them reaches 3.0 inches w.g. Where there are two HEPA filter banks in series, the second one is changed at 4 inches w.g.

 4. Field leak tests are conducted initially, every 18 months thereafter, after each partial or complete replacement, following painting, fire, or chemical release in any ventilation zone communicating with the system.

5. Field leak tests of HEPA filter banks are conducted with dioctylphtholate, and a light scattering aerosol photometer is used for measuring percentage penetration. A percentage penetration of 0.05 percent or greater requires corrective action, as stated previously

6. Corrective action after a leak test may consist of increasing the contact pressure on a seal or replacement of a filter or filters. After corrective action is taken, an additional leak test is made

7. A laboratory test is performed on the carbon adsorbent initially (before loading), every 18 months thereafter, after 720 hours of system operation, and following painting, fire, or chemical release in any ventilation zone communicating with the system. Testing conforms to Regulatory Guide 1.52 using ASTM D3803 Method A. Tests for hardness, ignition temperature, and radioactivity are not made on these samples.

12. DUCTWORK

a. Leakage tests on ductwork are conducted during construction to conform with the specified leakage criteria.

b. All air distribution systems are tested and balanced to provide design air quantities at each outlet, within a tolerance of ±10 percent

c. Seismic Category I ductwork is supported by seismically designed duct hangers

d. All Seismic Category I ductwork is seismically designed.

13. CONTROLS

a. All controls and instrumentation are tested prior to plant operation.

b. Inservice tests and inspection procedures are incorporated in the plant operations manual, and they are performed at regular intervals during the life of the plant to show that the instruments are functioning properly. Recalibration, when necessary, is made at that time.

TABLE 9.4-7

REACTOR BUILDING HVAC SYSTEMS DESIGN PARAMETERS (NONSAFETY-RELATED)

Item	RBVS Supply Units	RBVS Exhaust Units	Main Steam Pipe Tunnel Cooling Unit	CPCS
Type	Packaged unit	Fans with built-up plenums	Packaged unit	Packaged unit
Number of units	3(1)	3(1)	1	1
Flow rate each, cfm	45,500	49,550	9000	3000
Fan				
Type	Centrifugal	Centrifugal	Vaneaxial	Centrifugal
Drive	Belt	Belt	Direct	Direct
Number of fans per unit	1	1	2	1
Number of running fans	1	1	1	1
Total static pressure, each, in. w. g.	9	12	2.5	9.0
Motor hp, each	150	200	20	15
Cooling coils				
Number of coils per unit	3	NA	2	NA
Number of operating coils per unit	3	NA	1	NA
Cooling capacity, total, Btu/h	3,360,000	NA	487,500	NA
Heating coils				
Number of coils per unit	1	NA	NA	1
Heating capacity, each, Btu/h	2,864,400	NA	NA	51,150
Low efficiency filters				
Quantity	2	36	NA	3
Size, ft	6 by 10	2 by 2 by 0.5	NA	2 by 2 by 0.5
Pressure drop, in. w. g.				
Clean	0.16	0.20	NA	0.2
Dirty	0.5	1.0	NA	1.0
Efficiency(2), percent	80 to 85	45 to 60	NA	45 to 60
High efficiency filters				
Quantity	24	NA	NA	3
Size, in.	24 by 24 by 12	NA	NA	24 by 24 by 12
Pressure drop, in. w.g.				
Clean	0.4	NA	NA	0.25
Dirty	1.0	NA	NA	1.00
Efficiency(3), percent	80 to 85	NA	NA	80 to 85

Item	RBVS Supply Units	RBVS Exhaust Units	Main Steam Pipe Tunnel Cooling Unit	CPCS
HEPA filter				
Quantity	NA	36	NA	3
Size, in.	NA	24 by 24 by 12	NA	24 by 24 by 12
Pressure drop, in. w.g.				
Clean	NA	1.0	NA	1.0
Dirty	NA	3.0	NA	3.0
Efficiency(3), percent	NA	99.97	NA	99.97
Charcoal filters				
Quantity	NA	NA	NA	9
Size, in.	NA	NA	NA	24 by 24 by 27
Pressure drop, in. w.g.	NA	NA	NA	1.00
Efficiency(3), percent	NA	NA	NA	99.5 Methyl Iodide

(1) Normally two of three filter trains operate.
(2) Dust spot test by ASHRAE 52-76.
(3) By MIL Standards 282 DOP test method on 0.3 micron particles.

TABLE 9.4-8

REACTOR BUILDING HVAC SYSTEM DESIGN PARAMETERS (SAFETY-RELATED)

Item	SACS Pump Room Unit Coolers	RCIC Pump Room Unit Coolers	HPCI Pump Room Unit Coolers	RHR Pump Rooms Unit Coolers	Core Spray Pump Rooms Unit Coolers
Type	Packaged unit	Packaged unit	Packaged unit	Packaged unit	Packaged unit
Number of units	4	2	2	8	8
Flow rate, each, cfm	12,000	8,000	18,000	30,000	18,000
Fan					
Type	Vane axial	Vane axial	Vane axial	Vane axial	Vane axial
Drive	Direct	Direct	Direct	Direct	Direct
Number of fans per unit	1	1	1	1	1
Number of running fans	1	1	1	1	1
Total pressure, in. w.g.	2 (2)	1.8 (2)	2.25 (2)	2.5 (2)	2.25 (2)
Motor, hp, each	7-1/2	5	15	20	15
Cooling coil					
Number of coils per unit	1	1	1	1	1
Cooling capacity, total, Btu/h	550,000 (3)	137,000 (3)	311,000 (3)	448,500 (3)	311,000 (3)
Filters					
Quantity	NA (1)	NA (1)	NA (1)	NA (1)	NA (2)
Efficiency	NA	NA	NA	NA	NA

(1) Two-inch thick "throw away" roughing filters construction filters only; no filters used during normal plant operations.

(2) Fan total pressure (static plus velocity pressure).

(3) Cooling capacities listed are for a given design point. Actual cooling coil performance is based on actual system parameters.

TABLE 9.4-9

AUXILIARY BUILDING SERVICE AREA HVAC SYSTEM PARAMETERS

Item	Service Area Supply (SAE) System	Service Area Exhaust (SAE) Fans	Chemistry Laboratory Exhaust (CLE) System	Steam Unit Heaters	
Type	Air-handling (blow-through)	Fan	Fan and filter housing	Steam coil with fan	Steam coil with fan
Number of units	2	2	2	7	3
Number operating	2	2	1	-	-
Flow rate,each,cfm	29,390	20,510	8,530	-	-
Fan					
Type	Centrifugal	Centrifugal	Centrifugal	Propeller	Propeller
Quantity per unit	1	1	1	1	1
Motor/hp/drive	75/belt	40/belt	20/belt	1/4/direct	1/4/direct
Static pressure, in. w.g.	8.3	3.5	9.5	N/A	N/A
Heating coil					
Type	Steam	-	-	Steam	Steam
Number of coils per unit	1	None	None	1	1
Capacity, each, Btu/h	1,403,500	-	-	100,000	25,000
Humidifier					
Type	Pan (electric coil)	-	-	-	-
Quantity per unit	1	None	None	None	None
lb/h water evaporation	287	-	-	-	-
Cooling coil					
Type	Chilled water	-	-	-	-
Number of coils per unit	1	None	None	None	None
Capacity, each, Btu/h	1,971,000	-	-	-	-
Filters					
Type	Roll type, low efficiency/high efficiency		Low efficiency HEPA	-	-
Pressure drop, in. w.g. (clean-dirty)	0.1-0.5/0.5-1.0		0.2/1.0/1.0-3.0	-	-
Efficiency(1)(2)(3)	85%(2) 80-85%(1)		45-60%(2)/99.97%(3)	-	-

TABLE 9.4-9 (cont)

Item	Electric Duct Reheat Coils						CLE Booster Fan
Type	Reheat coil	Reheat coil	Reheat coil	Reheat coil	Reheat coil	Reheat coil	Fan
Number of units	3	3	2	4	1	2	1
Number operating	-	-	-	-	-	-	1
Flow rate,each,cfm	1600-1780	210-2760	2730-3720	800-1430	540	630-880	900
Fan	-	-	-	-	-	-	Centrex
Type	None	None	None	None	None	None	1
Quantity per unit	-	-	-	-	-	-	3/4/Belt
Motor/hp/drive							1.5
Static pressure,in. w.g.							
Heating coil							
Type	Electric-fin tube	Electric-fin tube	Electric-fin tube	Electric-fin tube	Electric-fin tube	Electric-fin tube	-
Number of coils per unit	1	1	1	1	1	1	-
Capacity,each,Btu/h	24,480	30,720	34,130	15,360	5120	10,240	-
Humidifier							
Type	-	-	-	-	-	-	-
Quantity per unit	None	None	None	None	None	None	-
lb/h water evaporation	-	-	-	-	-	-	-
Cooling coils							
Type	-	-	-	-	-	-	-
Number of coils per unit	None	None	None	None	None	None	-
Capacity, each Btu/h	-	-	-	-	-	-	-
Filters							
Type	-	-	-	-	-	-	High Efficiency
Pressure drop,in. w.g. (clean-dirty)	-	-	-	-	-	-	0.35/1.0
Efficiency(1)(2)(3)	-	-	-	-	-	-	90-95(2)

(1) ASHRAE Standard 52-76 weight arrestance.
(2) ASHRAE Standard 52-76 dust spot.
(3) By military standard 282 DOP test method on 0.30-micron particles.

TABLE 9.4-10

AUXILIARY BUILDING RADWASTE AREA HVAC SYSTEM PARAMETERS

Item	Radwaste Supply System (RWS)	Radwaste Exhaust System (RWE)	Room Recirculation Units		
			Office 3308	Maintenance Office 3307	Control Room 3343
Type	Fan filter and coil housing	Fan and filter housing	Draw-through air handler	Draw-through air handler	Draw-through air handler
Number of units	2	3	1	1	1
Number operating	2	3	1	1	1
Flow rate,each,cfm	58,220	OAV305, OBV305 33,780 OCV305 33,800 (nominal)	2700	1900	6100
Fan					
Type	Centrifugal	Vaneaxial	Centrifugal	Centrifugal	Centrifugal
Quantity per unit	1	1	1	1	1
Motor/hp/drive	100/belt	100/direct	3/belt	1.5/belt	7.5/belt
Static pressure, in. w.g.	5.0	8.85	1.5	2.0	2.0
Heating coil					
Type	Steam	-	Electric-fin tube	Electric fin tube	Electric fin tube
Number of coils per unit	1	None	1	1	1
Capacity, each, Btu/h	3,564,000	-	35,500/2-stage	27,750/1-stage	68,260-stage
Cooling coil					
Type	Chilled water	-	Chilled water	Chilled water	Chilled water
Number of coils per unit	1	None	1	1	1
Capacity, each, Btu/h	979,000	-	93,980	50,955	178,400
Filters					
Type	Roll type, low efficiency/high efficiency	Low efficiency/ HEPA	Roughing	Roughing	Roughing
Pressure drop,in. w.g. (clean-dirty)	0.40-0.50/0.53-1.0	0.20-1.0/1.0-3.0	0.33-1.0	0.33-1.0	0.33-1.0
Efficiency(1)(2)(3)	72%[2]/80-85%[2]	45-60%[2] 99.97%[3]	20-30%[2]	20-30%[2]	20-30%[2]
Charcoal absorber					
Type	-	-	-	-	-
Quantity per unit	None	None	None	None	None
Bed depth	-	-	-	-	-
Efficiency (element iodine/ methyl iodine)	-	-	-	-	-

TABLE 9.4-10 (cont)

Item	Unit Coolers: Cable Tray Area El. 87'-0"	Unit Coolers: Cable Tray Area 3201 EL. 87'-0"	Tank Vent Filter System (RWTF)	For El 102'-0" & 124'-0"	For El 172'-8.5"	North Stairwell South Vestibule
Type	Unit cooler	Unit cooler	Fan and filter housing	Hot water unit heater	Steam unit heater	Electric unit heater
Number of units	4	2	2	7	5	2
Number operating	-	1	-	-	-	-
Flow rate,each,cfm	4200	2100	1000	-	-	-
Fan						
Type	Centrifugal	Centrifugal	Centrifugal	Propeller	Propeller	Propeller
Quantity per unit	1	1	1	1	1	1
Motor hp/drive	3/belt	2/belt	7.5/belt	1/4/direct	1/4/direct	direct
Static pressure,in. w.g.	1.0	1.0	11.0	NA	NA	NA
Heating coil						
Type	-	-	Electric-fin tube	Hot water	Steam	Electric
Number of coils per unit	None	None	1	1	1	1
Capacity, each, Btu/h	-	-	12,290	75,000	25,000	25,600
Cooling coil						
Type	Chilled water	Chilled water	-	-	-	-
Number of coils per unit	1	1	None	None	None	None
Capacity, each, Btu/h	104,150	58,735	-	-	-	-
Filters						
Type	-	-	Low/high/HEPA	-	-	-
Pressure drop,in. w.g. (clean-dirty)	-	-	0.2-1.0/0.25-1.0/ 1.0-3.0	-	-	-
Efficiency(1)(2)(3)	-	-	45-60%(2)/80-85%(2) 99.97(3)	-	-	-
Charcoal absorber						
Type	-	None	Tray	-	-	-
Quantity per unit	None	-	3 tray/cell	None	None	None
Bed depth	-	-	2 in.	-	-	-
Efficiency (element-iodine/ methyl iodine)	-	-	99.9%/99.5%	-	-	-

TABLE 9.4-10

Item	Toilet Roof Exhaust Fan	Penthouse Wall Exhaust Fan, El 172'-0"	Unrestricted Shop Exhaust Fan	Battery Room Duct Heater
Type	Roof exhauster	Wall exhauster	Exhaust Fan	Duct reheat coil
Number of units	1	1	1	1
Number operating	1	1	1	-
Flow rate, each, cfm	760	12,400	20,000	400
Fan				
Type	Centrifugal	Propeller	Vaneaxial	-
Quantity	1	1	1	None
Motor hp/drive	1/4/direct	1.5/direct	15/direct	-
Static pressure, in. w.g.	0.75	0.125	2.0	-
Heating coil				
Type	-	-	-	Electric-fin tube
Number of coils per unit	None	None	None	1
Capacity, each, Btu/h	-	-	-	17,065
Cooling coil				
Type	-	-	-	-
Number of coils per unit	None	None	None	None
Capacity, each, Btu/h	-	-	-	-
Filter				
Type	-	-	-	-
Pressure drop, in. w.g. (clean-dirty)	-	-	-	-
Efficiency	-	-	-	-
Charcoal absorber				
Type	-	-	-	-
Quantity per unit	None	None	None	None
Bed depth	-	-	-	-
Efficiency (Elemental iodine/ methyl iodine)	-	-	-	-

TABLE 9.4-10

Item	Battery and Battery Charger Room Duct Cooling Coil	Solid Radwaste Supply (SRWS) System	Solid Radwaste Exhaust (SRWE) System	Auxiliary Panel Rm Duct Heater	Auxiliary Panel Rm Cooling Coil
Type	Duct cooling coil	Draw-through air handler	Fan drawing through filter housing	Duct reheat coil	Duct cooling coil
Number of units	1	2	2	1	1
Number operating	-	2	2	-	-
Flow rate, each, cfm	690	16,000	17,000	2,970	2,970
Fan					
Type	-	Centrifugal	Vaneaxial	-	-
Quantity	None	1	1	None	None
Motor hp/drive	-	50/belt	30/belt	-	-
Static pressure, in. w.g.	-	6	7.15	-	-
Heating coil					
Type	-	Steam	-	Electric-fin tube	-
Number of coils per unit	None	-	None	1	None
Capacity, each, Btu/h	-	810,000	-	64,152	-
Cooling coil					
Type	Chilled water	Chilled water	-	-	Chilled water
Number of coils per unit	1	1	None	None	1
Capacity, each, Btu/h	45,640	1,186,365	-	-	138,996
Filter					
Type	-	Roll type low efficiency/high efficiency	Low efficiency/ HEPA	-	-
Pressure drop, in. w.g. (clean-dirty)	-	0.4-0.5/0.5-1.0	0.20-1.0/1.0-3.0	-	-
Efficiency	-	72%(2)/80-85(2)	45-60%/99.97%	-	-
Charcoal absorber					
Type	-	-	-	-	-
Quantity per unit	None	None	None	None	None
Bed depth	-	-	-	-	-
Efficiency (Elemental iodine/ methyl iodine)	-	-	-	-	-

(1) ASHRAE Standard 52-76 weight arrestance.
(2) ASHRAE Standard 52-76 dust spot.
(3) By military standard 282 DOP test method on 0.30-micron particles.

TABLE 9.4-11

AUXILIARY BUILDING TECHNICAL SUPPORT CENTER REMOTE SHUTDOWN PANEL ROOM
HVAC SYSTEM DESIGN PARAMETERS

Item	TSC Supply (TSCS) System	TSC Emergency Filter (TSCEF) Unit	TSC Unit Heaters: Mechanical Room	TSC Unit Heaters: MCC Room	Remote Shutdown Panel (RSP) System
Type	Draw through air handler	Fan drawing through filter housing	Electric unit heater	Electric unit heater	Draw through air handler
Number of units	1	2	2	1	1
Flow rate, each (cfm)	14,000	4,000	-	-	1760
Fan					
Type	Centrifugal	Centrifual	Propeller	Propeller	Centrifugal
Quantity per unit	1	1	1	1	1
Motor hp/drive	25/direct	25/direct	1/10/direct	1/50/direct	5/direct
Static pressure (in. w.g.)	3.8	11.0	NA	NA	5.6
Heating coil					
Type	Electric fin tube	Electric fin tube	Electric	Electric	Electric fin tube
Number of coils per unit	1	1	1	1	1
Capacity, each (Btu/h)	102,390/3-stage	44,370/2-stage	34,130	13,650	34,130
Humidifier					
Type	Pan (electrical)	None	None	None	Pan (electrical)
Quantity per unut	1	-	-	-	1
Lb/h evaporation	20	-	-	-	6.92
Cooling coil		None	None	None	
Type	Chilled water	-	-	-	Chilled water
Number of coils per unit	2	-	-	-	2
Capacity, each (Btu/h)	409,500	-	-	-	48,200
Filters					
Type	Low efficiency/ high efficiency	Low efficiency/ HEPA	-	-	Low efficiency/ high efficiency
Pressure drop (in. w.g.) (clean/dirty)	0.35 - 1.20/ 0.55 - 1.0	0.26 - 1.00/ 1.00 - 3.00	-	-	0.35 - 1.00/ 0.50 - 1.00
Efficiency	50 - 55 percent[2]/ 80 - 85 percent[2]	45 - 60%[1]/ 99.97 percent[3]	-	-	50 - 55 percent[2]/ 80 - 85 percent[2]

Item	TSC Supply (TSCS) System	TSC Emergency Filter (TSCEF) Unit	TSC Unit Heaters Mechanical Room	TSC Unit Heaters MCC Room	Remote Shutdown Panel (RSP) System
Charcoal adsorber	None		None	None	None
Type	-	Gasketless	-	-	-
Quantity per unit	-	1	-	-	-
Bed depth	-	4"	-	-	-
Efficiency (Elemental iodine/methyl iodide)	-	99.0%/99.0%	-	-	-

(1) ASHRAE Standard 52-76 weight arrestance
(2) ASHRAE Standard 52-76 dust spot efficiency
(3) By Military Standard 282 DOP test method on 0.30 micron particles.

TABLE 9.4-12

TURBINE BUILDING VENTILATION SYSTEM EQUIPMENT DESIGN PARAMETERS

Turbine Building Supply (TBS) System

Type	Built-up unit
Number of units	1
Flow rate, cfm	172,000
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	3
Number of running fans	2
Static pressure, in. w.g.	6.5
Motor hp, each	150
Airflow, each, cfm	86,000
Heating coils	
Number of banks per unit	1
Purge coil load, Btu/h	10,700,000
Normal load, Btu/h	3,560,000
Cooling coils	
Number of banks per unit	1
Capacity, each, Btu/h	14,500,000
Prefilters	
Type	Roll Filters-Fiberglass
Efficiency	72 percent[1]

Turbine Building Supply (TBS) System

High efficiency filters	
Type	Fiberglass
Efficiency	80-85 percent(2)

Motor Generator Set Ventilation (MGV) System

Type	Built-up unit
Number of units	1
Flow rate, cfm	88,000
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	2
Number of running fans	1
Static pressure, in. w.g.	6
Motor hp, each	150
Airflow, each, cfm	88,000
Heating coils	None
Cooling coils	None
Prefilters	
Type	Fiberglass
Efficiency	45-60 percent(2)
High efficiency filters	
Type	Fiberglass
Efficiency	80-85 percent(2)

Compartment Exhaust System (TBCE)

Type	Modular package
Number of units	1
Flow rate, cfm	40,150
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per system	2
Number of running fans	1
Static pressure, in. w.g.	7
Motor hp, each	75
Airflow, each, cfm	40,150

Battery Room Supply System (TBBS)

Type	Modular package
Number of units	1
Flow rate, cfm	4200
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	2
Number of running fans	1
Static pressure, in. w.g.	3.5
Motor hp, each	5
Airflow, each, cfm	4200

Condenser Compartment Cooling Units

Heating coils	
Number of banks per unit	1
Capacity, each, Btu/h	170,650
Prefilters	
Type	Fiberglass
Efficiency	70-90 percent(1)
High efficiency filters	None

Condenser Compartment Cooling Units

Type	Packaged cooler
Number of units	6
Flow rate, each, cfm	25,000
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	1
Number of running units	4
Total pressure, in. w.g.	1.75
Motor hp, each	25
Heating coils	None
Cooling coils	
Number of coil banks per unit	1
Capacity, each, Btu/h	502,780

Condenser Compartment Cooling Units

Filters	None

Primary Condensate Pump Room Cooling Units

Type	Packaged cooler
Number of units	3
Flow rate, each, cfm	10,700
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	1
Number of running units	2(3)
Total pressure, in. w.g.	0.9
Motor hp, each	7.5
Heating coils	None
Cooling coils	
Number of coil banks per unit	1
Capacity, each, Btu/h	418,000

Filters None

Secondary Condensate Pump Room Cooling Units

Type	Packaged cooler
Number of units	3

Secondary Condensate Pump Room Cooling Units

Flow rate, each, cfm	20,800
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	1
Number of running units	2 (3)
Total pressure, in. w.g.	1.2
Motor hp, each	20
Heating coils	None
Cooling coils	
Number of coil bank per unit	1
Capacity, each, Btu/h	979,760
Filters	None

Mezzanine Pipe Chase Cooling Units

Type	Packaged cooler
Number of units	2
Flow rate, each, cfm	25,000
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	1
Number of running units	1

Mezzanine Pipe Chase Cooling Units

Total pressure, in. w.g.	1.75
Motor hp, each	25
Heating coils	None
Cooling coils	
Number of coil banks per unit	1
Capacity, each, Btu/h	502,780
Filters	None

Feedwater Heater Room Cooling Unit

Type	Packaged cooler
Number of units	3
Flow rate, each, cfm	10,700
Fan	
Type	Centrifugal
Drive	Belt
Number of fans per unit	1
Number of running units	3
Total pressure, in. w.g.	1.25
Motor hp, each	7.5
Cooling coils	
Number of coil banks per unit	1
Capacity, each, Btu/h	240,000
Filters	None

Turbine Building Exhaust (TBE) System

Type	Fan
Number of units	3
Flow rate, each, cfm	63,750
Fan	
Type	Centrifugal
Drive	Belt
Number of running units	2 normal (3 max.)
Total pressure, in. w.g.	7.6
Motor hp, each	150
Filters	None

Battery Room Exhaust (TBBE) System

Type	Fan
Number of units	2
Flow rate, each, cfm	4200
Fan	
Type	Centrifugal
Drive	Belt
Number of running units	1
Total pressure, in. w.g.	2.25
Motor hp, each	3
Filter	None

Oil Storage Room Exhaust (TBOE) System

Type	Fan
Number of units	2
Flow rate, each, cfm	17,950
Fan	
Type	Centrifugal
Drive	Belt
Number of running units	1
Total pressure, in. w.g.	3.5
Motor hp, each	20

Filters None

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(1) ASHRAE Standard 52-76 weight arrestance test.

(2) ASHRAE Standard 52-76 dust spot test.

(3) Unit coolers are normally placed in service when their respective primary/secondary condensate pump is in service.

TABLE 9.4-13

VENTILATION SYSTEM EQUIPMENT SUMMARY

Item	Number	Capacity	Motor hp	Water Steam/Flow
Steam unit heaters	12	200,000 Btu/h	0.25	215 lb/h
	8	100,000 Btu/h	0.25	110 lb/h
	12	50,000 Btu/h	0.25	55 lb/h
	9	25,000 Btu/h	0.25	28 lb/h
Electric unit heaters	4	15 kW	0.25	-
Hot water heaters	2	25,000 Btu/h	0.25	2.5 gpm
	1	50,000 Btu/h	0.25	5 gpm
	1	100,000 Btu/h	0.25	10 gpm

TABLE 9.4-14

DRYWELL UNIT COOLER DESIGN PARAMETERS

Type	Built-up (modular)
Number of unit coolers	8
Flow rate, each	9000 scfm high speed 4500 scfm low speed
Fans:	
Type	Vaneaxial
Drive	Direct
No. of fans per unit cooler	2
Total pressure, each (high speed only)	8.5 in. w.g. with return ducts; 7.0 in. w.g. without return ducts
Fan speed (high/low)	3500/1750 rpm
Motor power rating (high speed/ low speed)	20 hp/5 hp
Motor BHP (high speed/low speed)	15 hp/1.8 hp without return ducts 18 hp/2.2 hp with return ducts
Cooling coils	
No. of coils per unit cooler	2
Cooling capacity, each	821,500 Btu/h(2)
Filters	None(1)

---

(1) "Throw-away" type, 2-inch thick roughing filters are used during plant construction only. No filters are used during plant operation.

(2) Based on 143°F db/88°F wb entering air temperature and 45°F supply water temperature.

TABLE 9.4-15

OPERATING MODES FOR DRYWELL UNIT COOLERS

Conditions of Operation	Operating Coolers	Operating Coils per Cooler	Water Source	Fan Speed
Normal power operation	8	1/2[1]	CW	High
Loss of chilled water (power available)	8	1/2[1]	RACS	High
LOCA signal (without LOP)	None	NA	NA	NA
Reactor scram (normal power available)	8	1	CW	High
Loss of offsite power (LOP plus reactor scram)	8	1/2[1]	RACS	High
Design basis accident (LOCA plus LOP)	None	NA	NA	NA
Containment purge (normal shutdown)	None	NA	NA	NA
Drywell integrated leak rate test	3	1	CW	Low

(1) Cooling water is normally supplied to one coil per cooler, but it can be manually supplied to two coils when drywell temperature is high.

TABLE 9.4-16

STANDBY DIESEL GENERATOR AREA HVAC SYSTEMS DESIGN PARAMETERS

Item	Diesel Area Supply Units Nonsafety-related	Diesel Area Exhaust Units Nonsafety-related	Diesel Area Battery Rooms Exhaust Fans, Safety-related El 146'-0"	Diesel Area Battery Rooms Exhaust Fans Safety-related El 163'-6"	Diesel Area Battery Rooms Exhaust Fans Nonsafety-related El 163'-6"
Type	Air-handling	Individual fans	Individual fans	Individual fans	Individual fans
Quantity	2 units (50 percent each)	2 fans (50 percent each)	4 fans (1 fan for each of 4 rooms)	2 fans (100 percent each)	2 fans (100 percent each)
Flow rate, scfm, each	17,750	18,400	1500	1600	2900
Fan					
Type	Centrifugal	Vaneaxial	Centrifugal	Centrifugal	Centrifugal
Size, in.	29	34	14-1/4	14-1/4	16-1/2
Drive	Belt	Direct	Direct	Direct	Direct
Number of running fans	2	2	1	1	1
Static pressure, each, in.	5.5	3.0	2.0	2.0	1.25
Motor hp, each	30	25	1	1	3
Heating coils					
Number of coils per unit	5 stages	NA	NA	NA	NA
Heating capacity each, Btu/h (kw)	21,365(313)	NA	NA	NA	NA
Filters (low efficiency)	Roll type	NA	NA	NA	NA
Pressure drop, in. w.g.					
Clean	0.10	NA	NA	NA	NA
Dirty	0.5	NA	NA	NA	NA
Efficiency, percent (Based on dust spot method)	85	NA	NA	NA	NA
Filters (high efficiency)					
Number of cells	10	NA	NA	NA	NA
Size, in.	24 by 24 by 12	NA	NA	NA	NA
Pressure drop, in. w.g.					
Clean	0.50	NA	NA	NA	NA
Dirty	1.0	NA	NA	NA	NA
Efficiency, percent (Based on dust spot method)	80 to 85	NA	NA	NA	NA

TABLE 9.4-16 (Cont)

Item	Diesel Area Switchgear Room Coolers Safety-related	Diesel Generator Room Recirculating Fans Safety-related	Diesel Generator Room Cooling Coils Safety-related	Diesel Area 1E Panel Room Supply Units Safety-related
Type	Air handling	Individual fans	Cooling coils	Air-handling
Quantity	4 units (1 unit for each of 4 rooms)	8 fans (2 fans for each of 4 rooms)	8 coils (2 coils for each of 4 rooms)	2 units (100 percent each)
Flow rate, cfm, each	11,200	108,000	108,000	41,000
Fan				
Type	Centrifugal	Vaneaxial	NA	Centrifugal
Size, in.	24	66	NA	36-1/2
Drive	Direct	Direct	NA	Direct
Number of running fans	1	1	NA	1
Static pressure, each, in.	4.25	4.5	NA	7.71
Motor hp, each	25	125	NA	75
Cooling coil				
Number of coils per unit	2 (1 redundant)	NA	1	1
Cooling capacity, per coil, Btu/h	656,800	NA	2,159,600	1,849,620
Heating coils				
Number of coils per unit	NA	NA	NA	1
Heating capacity each, Btu, kW	NA	NA	NA	341,400(100)
Filters (low efficiency)				
Number of cells	5	NA	NA	24
Size, in.	24 by 24 by 6	NA	NA	24 by 24 by 6
Pressure drop, in. w.g.				
Clean	0.35	NA	NA	0.35
Dirty	1.0	NA	NA	1.0
Efficiency, percent (Based on dust spot method)	55 to 75	NA	NA	55

Item	Diesel Area Switchgear Room Coolers Safety-related	Diesel Generator Room Recirculating Fans Safety-related	Diesel Generator Room Cooling Coils Safety-related	Diesel Area 1E Panel Room Supply Units Safety-related
Filter (high efficiency)				
Quantity	NA	NA	NA	24
Size, in.	NA	NA	NA	24 by 24 by 12
Pressure drop, in. w.g.				
Clean	NA	NA	NA	0.55
Dirty	NA	NA	NA	1.0
Efficiency, percent (Based on dust spot method)	NA	NA	NA	80 to 85

TABLE 9.4-17

DIESEL AREA VENTILATION SYSTEMS FAILURE MODES AND EFFECTS ANALYSIS(1)

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On the System	Failure Mode Detection	Effect of Failure On Plant Operation
Diesel Generator Room Recirculating System					
Accident	Power supply	LOP	None. Ventilation systems are powered from their associated SDGs	Alarm in the main control room	No loss of safety function
LOCA or LOCA & LOP	Fans	Loss of one fan	None. The standby fan automically starts	Alarm at the local control panel and in the main control room	No loss of safety function
LOCA or LOCA & LOP	Cooling coils	Failure of one SACS water loop (A or B)	None. The standby coil receives its water supply from the redundant SACS water loop	High room temperature alarm. Requires manual actuation of standby fan and coil	No loss of safety function
Diesel Area Battery Room Exhaust System					
Accident	Power supply	LOP	None. Exhaust systems are powered from associated SDGs	Alarm in the main control room	No loss of safety function
LOCA or LOCA & LOP	Fans and fan outlet dampers (for 4 rooms at el 146'-0"	Loss of one fan	Loss of one DABE system and eventual loss of one SDG	Alarm in the local control panel and computer input in the main control room	No loss of safety function. The remaining three SDGs are capable of meeting all requirements for a safe shutdown of the plant
LOCA or LOCA & LOP	Fans and fan outlet dampers (for 4 rooms at el 163'-6")	Loss of one fan	None. The standby fan automatically starts	Alarm in the local control panel and main control room	No loss of safety function
Switchgear Room Cooling System					
Accident	Power supply to unit coolers	LOP	None. Cooling units are powered from associated SDGs	Alarm in the main control room	No loss of safety function

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure On the System	Failure Mode Detection	Effect of Failure On Plant Operation
LOCA or LOCA & LOP	Fan	Loss of fan	Possible overheating of one room and eventual loss of one SDG	Alarm in main control room	No loss of safety function. The remaining three SDGs are capable of meeting all requirements for a safe shutdown of the plant
LOCA or LOCA & LOP	Cooling coils	Loss of one cooling coil, due to leak, rupture, or flow restriction, or due to failure of one chilled water loop, A or B	None. The redundant cooling coil is put into operation	High return air temperature alarm at the local control panel. Eventual loss of chilled water, alarm in the main control room	No loss of safety function
Diesel Area 1E Panel Room Supply System					
Accident	Power supply to unit coolers	LOP	None. Supply unit is powered from separate SDGs	Alarm in the main control room	No loss of safety function
LOCA or LOCA & LOP	Fans	Loss of one fan	None. The standby unit automatically starts	Alarm at the local control panel	No loss of safety function
LOCA or LOCA & LOP	Inlet, discharge, and recirculation dampers	Damper fails and closes	None. The dampers are designed to fail safe in the closed position; when the damper fails closed, it trips and isolates its associated fan, and the standby fan automatically starts	Alarm at the local control panel	No loss of safety function
LOCA or LOCA & LOP	Cooling coils	Loss of cooling coil due to leak, rupture, or flow restriction	None. The redundant full capacity unit train is manually put into operation	A high supply air temperature alarm and eventual loss of chilled water alarm in the main control room	No loss of safety function

TABLE 9.4-18

SERVICE WATER INTAKE STRUCTURE VENTILATION SYSTEM EQUIPMENT DESIGN PARAMETERS

Item	Intake Structure Ventilation System	Traveling Screen Motor Room Ventilation System	MCC Room
Fan			
Type	Vane axial	Vane axial	None
Number of units	8	2	-
Flow rate, each, scfm	60,000	6000	-
Seismic category	1	1	-
Drive	Direct	Direct	-
Total pressure, in. w.g.	2.88	0.85	-
Motor horsepower, each	40	2	-
Electric unit heater			
Number of units	7	4	2
Flow rate, scfm	525	750	280
Capacity, each, kW	10	15	4

TABLE 9.4-19

SERVICE WATER INTAKE STRUCTURE VENTILATION SYSTEM
FAILURE MODES AND EFFECTS ANALYIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on Safeguard Equipment	Failure Mode Detection	Effect of Failure on Plant Operation
Emergency	Entire system	Loss of offsite power	None. All H&V systems are powered from onsite Class 1E power (standby diesel generators)	Alarm locally and in main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Ventilation fans	Loss of one fan	None. Standby fan combination designed for 100 percent of cooling load. Automatic start on high room temperature	Alarm locally and in main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Intake, exhaust, and return dampers	Loss of dampers in one system	None. 100 percent Standby fan combination with separate dampers available. Automatic start on high room temperature	Alarm locally and in main control room	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Instruments	Failure of instrument(s) in one system	None. Standby fan combination with separate dampers available. Automatic start on high room temperature	High or low temperature alarm locally and in main control room by standby instruments	No loss of safety function

TABLE 9.4-20

DESIGN PARAMETERS OF HVAC SYSTEMS

Item	a. Cooling Tower Blowdown Instrument Shelter Ventilation	a. Cooling Tower Blowdown Instrument Shelter Heating	b. Circulating Water Cl_2 Analyzer Station Ventilation	b. Circulating Water Cl_2 Analyzer Station Heating
Type	Wall-mounted exhaust fan	Unit heater	Wall-mounted exhaust fan	Unit heater
Number of units	1	1	1	1
Flow rate, each	100 scfm	-	200 scfm	-
Fan				
Type	Propeller	Propeller	Propeller	Propeller
Drive	Direct	Direct	Direct	Direct
Number of fans per unit	1	1	1	1
Number of running fans	1	1	1	1
Total static pressure, each, in.	0.125	-	0.125	-
Motor hp, each	1/50 (estimated)	1/50 (estimated)	1/25 (estimated)	1/50 (estimated)
Cooling coil	-	-	-	-
Heating coils	-	Electric	-	Electric
Capacity, each	-	5000 Btu/h	-	5000 Btu/h
Filters	-	-	-	-

Item	c. Service Water Cl_2 Analyzer Station Ventilation	c. Service Water Cl_2 Analyzer Station Heating	d. Circulating Water Chemical Control Building Ventilation	d. Circulating Water Chemical Control Building Heating
Type	Wall mounted exhaust fan	Unit heater	Wall mounted exhaust fan	Unit heater
Number of units	1	1	2	4
Flow rate, each	200 scfm	-	625 scfm	-
Fan				
Type	Propeller	Propeller	Propeller	Propeller
Drive	Direct	Direct	Direct	Direct
Number of fans per unit	1	1	1	1
Number of running fans	1	1	1	1

TABLE 9.4-20 (Cont)

Item	c. Service Water Cl_2 Analyzer Station Ventilation	c. Service Water Cl_2 Analyzer Station Heating	d. Circulating Water Chemical Control Building Ventilation	d. Circulating Water Chemical Control Building Heating
Total static pressure, each, in.	0.125	-	0.125	-
Motor hp, each	1/25 (estimated)	1/50 (estimated)	1/10 (estimated)	1/50 (estimated)
Cooling coil	-	-	-	-
Heating coils	-	Electric	-	Electric
Capacity, each	-	5000 Btu/h	-	5000 Btu/h
Filters	-	-	-	-

Item	e. Service Water Chemical Control Building Ventilation	e. Service Water Chemical Control Building Heating	f. Fuel Oil Foam and Transfer Pumphouse Ventilation	f. Fuel Oil Foam and Transfer Pumphouse Heating
Type	Wall mounted exhaust fan	Unit heater	Wall mounted exhaust fan	Unit heater
Number of units	2	2	2	2
Flow rate, each	550 scfm	-	200 scfm	-
Fan				
Type	Propeller	Propeller	Propeller	Propeller
Drive	Direct	Direct	Direct	Direct
Number of fans per unit	1	1	1	1
Number of running fans	1	1	1	1
Total static pressure, each, in.	0.125	-	0.125	-
Motor hp, each	1/10 (estimated)	1/50 (estimated)	1/25 (estimated)	1/50 (estimated)
Cooling coil	-	-	-	-
Heating coils	-	Electric	-	Electric
Capacity, each	-	5000 Btu/h	-	5000 Btu/h
Filters	-	-	-	-

Item	g. Fuel Oil Transfer House Ventilation	g. Fuel Oil Transfer House Heating	h. Blowdown Outfall Instrument Shelter Ventilation	h. Blowdown Outfall Instrument Shelter Heating
Type	Wall mounted exhaust fan	Unit heater	Wall mounted exhaust fan	Unit heater
Number of units	1	1	1	1
Flow rate, each	200 scfm	-	200 scfm	-
Fan				
Type	Propeller	Propeller	Propeller	Propeller
Drive	Direct	Direct	Direct	Direct
Number of fans per unit	1	1	1	1
Number of running fans	1	1	1	1
Total static pressure, each, in.	0.125	-	0.125	-
Motor hp, each	1/25 (estimated)	1/50 (estimated)	1/25 (estimated)	1/50 (estimated)
Cooling coil	-	-	-	-
Heating coils	-	Electric	-	Electric
Capacity, each	-	6000 Btu/h	-	6000 Btu/h
Filters	-	-	-	-

Item	j. Auxiliary Boiler Control Room Ventilation	j. Auxiliary Boiler Control Room Exhaust	j. Substation Room Ventilation	j. Substation Room Exhaust
Type	Supply air handling unit	Relief ventilator	Supply air handling unit	Relief ventilator
Number of units	2	1	2	1
Flow rate, each	13,000 scfm	26,000 scfm	10,000 scfm	20,000 scfm
Fan				
Type	Axial	-	Axial	-
Drive	Direct	-	Direct	-
Number of fans per unit	2	-	2	-
Number of running fans	1	-	1	-
Total static pressure, each, in.	0.75	0.15	0.75	0.15
Motor hp, each	7.5	-	5	-
Cooling coil	-	-	-	-
Heating coils	Electric	-	Electric	-
Capacity, each	40 kW	-	12 kW	-
Filters	Low efficiency	-	Low efficiency	-

Item	j. Domestic Water Pretreatment Room Ventilation	j. Domestic Water Pretreatment Room Exhaust	k. Asphalt Storage Tank and Boiler Building Ventilation	k. Asphalt Storage Tank and Boiler Building Heating
Type	Supply air handling	Relief ventilator	Wall mounted exhaust fan	Unit heater
Number of units	1	1	2	4

Item	j. Domestic Water Pretreatment Room Ventilation	j. Domestic Water Pretreatment Room Exhaust	k. Asphalt Storage Tank and Boiler Building Ventilation	k. Asphalt Storage Tank and Boiler Building Heating
Flow rate, each	9000 scfm	9000 scfm	12,000/6000 scfm	525
Fan				
Type	Axial	-	Dual speed wall propeller	Propeller
Drive	Direct	-	Belt	Direct
Number of fans per unit	1	-	2	1
Number of running fans	1	-	2	1
Total static pressure, each, in.	0.75	0.15	0.25	-
Motor hp, each	5	-	1-1/2	16 watts
Cooling coil	-	-	-	-
Heating coils	Electric	-	-	-
Capacity, each	58 kW	-	-	7 1/2 kW
Filters	-	-	-	-

Item	l. Circulating Water Pump House Ventilation	l. Circulating Water Pump House Heating	m. Circulating Water Pump House Switchgear Room Ventilation	m. Circulating Water Pump House Switchgear Room Exhaust
Type	Wall mounted exhaust fan	Ceiling mounted horizontal unit heater	Supply air handling unit each with electric heating coil	Relief ventilator
Number of units	4	8	2	2
Flow rate, each	30,000/60,000 cfm	750 cfm	15,000 cfm	7,500 cfm
Fan				
Type	Axial	Axial	Axial	-
Drive	Belt	Direct	Direct	-
Number of fans per unit	1	1	1	-
Number of running fans	1	1	1	-
Total static pressure, each, in.	0.50	-	0.95	0.10
Motor hp, each	20/5	1/10	7.5	-
Cooling coil	-	-	-	-
Heating coils Capacity, each	-	51,200 Btu/h	85.2 kW	-
Filters	-	-	-	Low efficiency

TABLE 9.4-21

AUXILIARY BUILDING CONTROL AREA HVAC SYSTEMS DAMPERS AND LOUVERS

Damper/Louver Type	Example Tag. No.	Example FSAR Figure	Function	Mechanical and Performance Characteristics
1) Outside Air Louver	-----	-----	Prevents rain, snow, etc., from being drawn into the HVAC system.	a) Consists of fixed parallel blades, bird screen, with no moving parts. b) Normal maximum air velocity is 500 fpm to 750 fpm. c) Normal differential pressure resistance is 0.25 to 0.50 in. w.g.
2) Tornado Damper	1XD9593A	9.4-1 (E-2)	Close, in the event of a sudden outside negative pressure, to prevent collapsing of HVAC duct and limit reversal of air flows.	a) Consist of two wing blades, one hinge, holding springs and seats. b) Maximum closing time is 0.25 seconds. c) Normal air velocity range is 800 fpm to 1300 fpm. d) Differential pressure drop, open, is 0.15 in. w.g. e) Leakage rate at 3 psi differential is 155 cfm (for a 14 in. wide x 12 in. high damper) and 265 cfm (for a 20 in. wide x 18 in. high damper). f) Exhaust dampers will trip (close) at 2500 to 3500 fpm. g) Intake dampers will trip on cessation or reversal of flow. h) Damper returns to open position after outside negative pressure ceases. i) Installation mounting to ductwork.
3) Manual Balancing Damper	D405A	9.4-1 (F-3)	Balance air flow in duct.	a) Consists of opposed blades, centrally pivoted, with manual external locking device. b) No leakage criteria. c) No actuator. d) Average open differential pressure drop is 0.005-0.05 in. w.g. e) Installation mounting is flange to duct.

Damper/Louver Type	Example Tag. No.	Example FSAR Figure	Function	Mechanical and Performance Characteristics
4) Bubble tight shutoff dampers	1HD-9588AA	9.4-2 (G-3)	Shut-off air flow with no leakage. (HVAC system isolation when two dampers are in series.)	a) Consists of bubble tight butterfly blade, center shaft, electric or pneumatic actuator, spring return assisted. b) Electric motor actuators max. time to open and close is 5 seconds. c) Pneumatic actuator max. time to open is 30 sec. and to close is 5 sec. d) Shutoff pressure rating is 7.5 in. w.g. to 13 in. w.g. for respective fan characteristics. e) Normal open differential pressure resistance is 0.05-0.19 in. w.g. f) Installation mounting is flange to duct.
5) Electrohydraulic shutoff dampers	HD-9595A	9.4-2 (G-3)	Shutoff the air flow.	a) Consists of parallel blades, centrally pivoted, and electrohydraulic actuator. b) Normal air velocity range is 900 fpm to 2200 fpm. c) Leakage rates at 1 in. w.g. differential are: i) Damper blade length 12 in. or less = 15 cfm/ft^2 face area. ii) Damper blade length to 24 in. = 10 cfm/ft^2 face area. iii) Damper blade length to 36 in. = 8 cfm/ft^2 face area. d) Max. time to open is 10 sec. e) Max. time to close is 15 sec. f) Normal open differential pressure resistance is 0.025-0.10 in. w.g. g) Normal shut-off pressure rating is 7.5-13.5 in. w.g. h) Type of installation is flange to duct.
6) Pneumatic shutoff dampers	HD-9599A	9.4-2 (H-8)	Same as for electrohydraulic shutoff dampers.	Same as for electrohydraulic shutoff dampers, except these are operated by pneumatic actuator which have the following characteristics: a) Opening time range is 3-10 sec. b) Closing time range is 3-10 sec. (smaller size damper will close and open between 3-5 sec. and larger size dampers will close between 5-10 sec.)

Damper/Louver Type	Example Tag. No.	Example FSAR Figure	Function	Mechanical and Performance Characteristics
7) Electro hydraulic control dampers	PDD-9587A	9.4-2 (H-2)	Modulate the air flow.	Same as for electrohydraulic shutoff damper except that: a) Damper has opposed blades. b) Actuator has a positioner to control blade position. c) Response time, leakage, shutoff rates are not applicable.
8) Fire dampers	D434 D422	9.4-1 (B-6) (D-3)	Shutoff the air flow through a duct, floor or wall in the event of a fire.	a) Consists of curtain type blade, spring, restraining straps and fusible link (or electro thermal release mechanism). b) Fusible link and electro thermal release link will close damper at 165°F. c) Maximum open differential pressure resistance is 0.1 in. w.g. d) Closed differential pressure is 10 in. w.g. e) Damper installed in sleeves with flanges connected to duct. f) Require manual reset.

TABLE 9.4-22

METEOROLOGICAL DESIGN CONDITIONS

a. Meteorological Design Conditions

All safety-related heating, ventilating and air conditioning (HVAC) systems are designed using the following meteorological design conditions:

1) Temperature (°F)

Summer:	94 dry bulb/78 wet bulb
Winter:	5 dry bulb

2) Pressure: Standard atmosphere

Barometric pressure of 29.921 inches of mercury. Systems are designed to withstand the effects of tornado depressurization and repressurization as discussed in Section 3.3.

3) Humidity:

Dewpoint temperature 72°F corresponding to summer design dry and wet bulb temperatures. Relative humidity of 100 percent is assumed for evaluating outside air intakes and ESF filter train demisters. Relative humidity of 50 percent is assumed at winter design temperature for systems incorporating humidification.

4) Wind Speed (MPH)

Wind speeds of 15 mph in winter and 7.5 mph in summer is assumed for evaluating infiltration and building transfer surface conductance. Systems are designed to withstand the effects of high wind loading as discussed in Section 3.3.

b. Basis for the Selected Values

1) Temperatures are derived from ASHRAE Handbook 1977 Fundamentals (Reference 1) Chapter 23, Table 1, "Climate Conditions for the United States". Data for the following locations listed in the table was reviewed and is summarized below:

TABLE 9.4-22 (Cont)

State and Station	Winter Design Dry Bulb 99% (°F)	Summer Design: Dry Bulb and Coincident Wet Bulb 1% (°F)	Summer Design: Wet Bulb 1% (°F)
Delaware			
Dover AFB	11	92/75	79
Wilmington AP	10	92/74	77
New Jersey			
Trenton Co	11	91/75	78
Vineland	8	91/75	78
Pennsylvania			
Philadelphia AP	10	93/75	77

The winter design temperature of 5°F is conservatively selected below the 99 percent design temperature listed above. The 99 percent represents the frequency that actual temperatures are equaled or higher, for 99 percent of the total hours in the months of December, January and February. In a normal winter there would be approximately 22 hours when the outdoor temperature would be below the 99 percent value (Reference 1).

The summer design temperatures of 94°F dry bulb and 78°F wet bulb compare favorably with the values listed above. The 1 percent represents the frequency that actual temperatures are equaled or higher, for 1 percent of the total hours in the months of June through September. In a normal summer there would be approximately 29 hours when the outdoor temperature would be above the 1 percent value (Reference 1).

2) Standard atmospheric pressure is based on barometric pressure at sea level. Minor variations from this pressure due to weather conditions and elevation do not affect HVAC design considerations.

3) The dew point is derived from the summer design 1 percent frequency dry bulb and wet bulb temperatures as discussed in b.1 above.

4) Wind speeds described in Section 9.4 are recommended values per Reference 1 to be used in heating and cooling load calculations.

c. Comparison of Design Basis with Extreme Meteorological Conditions Observed in the Region Through 1981[1].

1) Temperature (°F):

Design Basis	Onsite	Wilmington NWS
Maximum		
94	94.1	98
Minimum		
5	-1.3	-6

2) Atmospheric pressure variations are not discussed. See b.2 above.

3) Humidity-Dew point (°F) and percent Relative

Design Basis Dew Point (°F)	Design Basis Relative (%)	Table 2.3-14 Dew Point Onsite (°F)	Table 2.3-17 Relative Onsite (%)
Maximum (Summer)			
72	100	83.1	100
Minimum (Winter)			
-10	50	-12.5	15

4) Wind Speed (mph):

Design Basis	Combined Months	Table 2.3-7 Onsite Values 33ft	150ft	300ft	Table 2.3-8 Wilmington 1977-1981	1972-1981
Winter						
15	November through April	9.6	14.3	16.8	10.7	10.4
Summer						
7.5	May through October	8.3	11.5	13.5	8.5	8.4

(1) Data comparisons are from January 1977 through December 1981, consistent with the data and discussion in Section 2.3.2. Regional climatological records indicate that low temperature records were set in 1982. An onsite low temperature reading of -5.8°F was recorded during 1982. A corresponding temperature of -10°F was recorded at Wilmington NWS. The five year data base supplied and discussed in Section 2.3 exceeds NRC requirements.

d. Comparison of Design basis with Extreme (100-Year Recurrence) Meteorological Conditions

1) Temperature (°F)

Design Basis	Table 2.3-13 Wilmington NWS	NUREG/CR-1390 (100-Year Return Period)
Maximum		
94	102	108<T<112[2] Per Figure 5
Minimum		
5	-6	-24<T < 16[2] Per Figure 8

(2) T is at HCGS site

2) Atmospheric pressure variations are not discussed. See b.2 above.

3) Humidity extremes are the same as those discussed in c.3 above.

4) Wind speed extremes are discussed in Section 3.3 and are not considered in the design of HVAC systems.

REFERENCE:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), ASHRAE Handbook 1977 Fundamentals, ASHRAE, New York, NY 1977.

Figure F9.4-1 intentionally deleted.

Refer to Plant Drawing M-78-1 in DCRMS

Figure F9.4-2 intentionally deleted.

Refer to Plant Drawing M-89-1 in DCRMS

Figure F9.4-3 intentionally deleted.

Refer to Plant Drawing M-76-1 in DCRMS

Figure F9.4-4 intentionally deleted.

Refer to Plant Drawing M-83-1 in DCRMS

Figure F9.4-5 intentionally deleted.

Refer to Plant Drawing M-84-1 in DCRMS

Figure F9.4-6 SH 1-3 intentionally deleted.

Refer to Plant Drawing M-91-0 for all sheets in DCRMS

Figure F9.4-7 intentionally deleted.

Refer to Plant Drawing M-79-0 in DCRMS

Figure F9.4-8 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-93-0 for both sheets in DCRMS

Figure F9.4-9 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-92-0 for both sheets in DCRMS

Figure F9.4-10 intentionally deleted.

Refer to Plant Drawing M-79-0 in DCRMS

Figure F9.4-11 intentionally deleted.

Refer to Plant Drawing M-75-1 in DCRMS

Figure F9.4-12 intentionally deleted.

Refer to Plant Drawing M-82-1 in DCRMS

Figure F9.4-13 intentionally deleted.

Refer to Plant Drawing M-77-1 in DCRMS

Figure F9.4-14 intentionally deleted.

Refer to Plant Drawing M-86-1 in DCRMS

Figure F9.4-15 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-85-1 for both sheets in DCRMS

Figure F9.4-16 SH 1-2 intentionally deleted.

Refer to Plant Drawing M-88-1 for both sheets in DCRMS

Figure F9.4-17 intentionally deleted.

Refer to Plant Drawing M-81-0 in DCRMS

Figure F9.4-18 intentionally deleted.

Refer to Plant Drawing M-95-0 in DCRMS

Figure F9.4-19 intentionally deleted.

Refer to Plant Drawing M-81-0 in DCRMS

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection Program

The fire protection program is designed to:

1. Prevent fire from starting by using noncombustible and fire resistant materials where practicable in the plant, and to maintain safe shutdown ability by providing fixed and/or portable fire fighting equipment.

2. Detect fires quickly and annunciate in the main control room the fire location for fire brigade notification and personnel safety.

3. Suppress and extinguish those fires that occur in the shortest possible time to minimize damage and to maintain safe shutdown ability.

4. Prevent the spread of fire by using fire barriers between structures, systems, and components of safety-related systems.

5. Ensure that failure or inadvertent operation of the suppression system does not jeopardize the capability to achieve safe shutdown of the plant.

9.5.1.1 Design Bases

9.5.1.1.1 General

The overall Hope Creek Generating Station (HCGS) fire protection program is based on the evaluation of potential fire hazards throughout the plant and on the effects of postulated fires on the performance of safe shutdown functions. A detailed evaluation of

the effects of postulated fires on safety-related systems required for safe shutdown of the plant is summarized in Appendix 9A, Appendix R comparison.

Consistent with other safety requirements, structures, systems, and components, including those required for safe shutdown, are designed and located to minimize the probability and effect of fires. Noncombustible and fire resistant materials are used whenever practicable throughout the plant to minimize fire potential by lessening the duration, severity, and intensity of combustion.

Redundant safety-related components are separated from each other and the rest of the plant by 3-hour fire barriers, and/or are separated by 20 feet. Deviations are identified in Appendix 9A.

The Fire Protection System (FPS) has been designed in accordance with the NFPA standards listed in Table 9.5-1. Deviations have been identified and evaluated against specific plant conditions with the design details chosen to reflect a suitable fire protection program. Significant deviations to NFPA standards are identified in Section 9.5.1.6.

9.5.1.1.2 Redundant Fire Suppression Capability

Fire protection of areas identified as containing potential fire hazards is not dependent on a single fire suppression system. Backup capability is discussed in Section 9.5.1.2.

9.5.1.1.3 Single Failure Criteria

A single failure in the FPS does not impair the primary and backup fire suppression capability except as noted in Section 9.5.1.6.1. A single failure in the pumping system does not impair the Fire Protection Water System, due to the availability of redundant fire pumps; one is a motor driven fire pump and the other is a diesel engine-driven fire pump. A failure

in a header of one of the automatic sprinkler systems does not impair the backup hose racks, which are fed from a different header of the inplant loop, as shown on Plant Drawing M-22-0 sheets 1, 2 and 3. In addition, an onsite fire pumper shared by HCGS and Salem is available.

9.5.1.1.4 Failure or Inadvertent Operation

FPS components are designed so that a failure or inadvertent operation does not result in loss of function of plant structures or systems important to safety, except as noted in Section 9.5.1.6.30.

Wet standpipe systems and headers supplying the automatic water extinguishing system are normally pressurized. Wet pipe sprinkler systems are pressurized entirely. The FPS water system design pressure and temperature of 175 psig and 90°F, respectively, are within the guidelines specified in NUREG-0800, Section 3.6.2, for systems that do not require pipe whip protection.

Except for the piping from the tank to the master control valve, the carbon dioxide system piping is not pressurized during normal plant operation. The pressurized piping to the master control valve is located outdoors for the tank serving the safety-related areas and in the Turbine Building for the tank serving the turbine areas.

Piping located over safety-related equipment is supported such that it will not fall during a seismic event, i.e., safe shutdown earthquake (SSE), and, therefore, not impair safety-related equipment through impact. Any loss of water from the piping will not impair safety-related equipment operation.

Charged fire suppression piping located in safety-related areas meets the guidelines specified in Section 3.6.1 for moderate energy systems outside containment. For further details, see Section 3.6.1.

Automatic carbon dioxide fire suppression systems serving safety-related equipment/areas have seismically qualified components to avoid inadvertent discharge of medium during a seismic event.

The FPSs are designed to retain their original design capability for natural phenomena of less severity and greater frequency than the most severe natural phenomena (approximately once in 10 years), e.g., tornadoes, hurricanes, floods, ice storms, or small intensity earthquakes, that are characteristic of the geographic region. Since the barge docking area is remotely located from all plant buildings, an oil barge accident will not affect the FPSs. For additional service environmental evaluations, see Sections 3.3, 3.4, and 3.5.1.

Lightning arrestors have been provided on the electrical distribution system to prevent damage and fires in the plant due to lightning.

9.5.1.1.5 Fire Protection Program Implementation

The fire protection program for all plant areas within the security perimeter was fully operational prior to fuel load.

9.5.1.1.6 Power Supply for Detection and Suppression System Control Panels

Power supply for the detection and suppression system control panels is provided with a secondary power supply. The fire protection status panel in the main control room, the control panels for the early warning fire and smoke detection, and water and CO_2 suppression systems are provided with ac power from a non-Class 1E inverter. The inverter is fed by non-Class 1E batteries and non-Class 1E motor control centers (MCC's) backed by

the standby diesel generators (SDGs). Loss of offsite ac power will not prevent these panels or systems from operating as designed.

The control panels for the foam system in the fuel oil foam house and the panels for the Halon, sprinkler, and early warning sprinkler and detection systems in the administration facility, Unit 2 control area office space at Elevation 137 feet, and guardhouse are provided with normal offsite ac power and batteries located in or near the panels which meet the requirements for secondary power supply in NFPA 72D.

9.5.1.1.7 Building Materials Selection

Interior walls, partitions, structural components, thermal insulation materials, and radiation shielding materials are noncombustible. Areas containing systems or equipment required for safe shutdown are either unfinished or finished with noncombustible materials, except as noted below.

Suspended acoustical ceiling panels are Underwriters Laboratories, Inc. (UL) listed and have a flame spread, fuel contribution, and smoke development rating of 25 or less. Suspended ceiling supports are noncombustible.

The built-up roofing over metal deck roof construction is listed as Class 1 by the Factory Mutual System (FM) approved guide.

The disposable HVAC filter element in the dry waste compactor room No. 3344 in the radwaste and service area is constructed of plywood. The filter is approximately 39"x39"x25" and is in an area protected by an automatic wet sprinkler system and early warning smoke detection.

Thick floor coatings applied over concrete floor surfaces that may result in a flame spread rating greater than 50 or critical radiant flux less than 0.45 watts/sq. cm. are included in the combustible load tabulation. Experience has shown that epoxy floor coating systems are difficult to ignite, will not sustain a flame capable of propagating a fire, are not likely to contribute to early fire growth, and therefore do not constitute a significant or unusual fire risk.

9.5.1.1.8 Protection from Transformer Fires

Medium and low voltage transformers located indoors are dry and air cooled. Oil filled medium and high voltage transformers (main and station service transformers) are located outdoors near the Turbine Building and circulating water pump structure. Two hour rated fire barriers separate the turbine building and circulating water pump structure from the transformers. The circulating water pump structure contains non-safety related systems.

All main and station service transformers are provided with individual water spray systems and are separated from each other by a 1-hour fire barrier. Each transformer has a collection dike and drainage outlet for collecting transformer oil spills and fire suppression system water and draining it to the oily waste drainage system. The collection dikes are 3 feet 10 inches deep and filled with 1 1/2 inch to 2 1/2 inch crushed stone to provide a minimum 40 percent volume of voids.

9.5.1.1.9 Floor Drain Provisions

Floor drains are provided for fire protection water runoff in the event of fire water system activation, leakage, or pipe breaks. Drain lines leading from the diesel area where large quantities of oil are stored or used have normally closed manual shutoff valves to contain oil spills. The Control Equipment Mezzanine floor drains are valved normally closed to prevent CO_2 fire suppression agent dissipation. Any buildup of water/oil in these areas can be examined before opening the shutoff valve and allowing water to be drained away. Drain lines from other areas where oil might spill enter sumps below the sump water level to prevent sump fires and

to restrict the flow of air into the drain pipes. Drainage from areas where the water normally may have encountered radioactivity is directed to the dirty radwaste drainage system.

9.5.1.1.10 Fire Area Separation

The Auxiliary Building (radwaste, control, and diesel areas), Reactor Building, and Turbine Building, are separated from each other by 3-hour fire walls. Three-hour-rated walls, which separate buildings or barriers, are provided in the buildings to separate and isolate areas containing safety-related systems and components, as well as areas with a significant amount of combustible materials. Floors and ceilings are qualified for fire ratings consistent with the fire hazard analyses. All penetrations, not containing heating and ventilation duct work with fire dampers, through fire barriers/walls, are sealed with a sealant consistent with the fire ratings of the barriers/walls. Heating and ventilation duct penetrations with fire dampers are installed in accordance with the fire dampers manufacturer's instructions to provide a fire rating consistent with the fire rating of the barrier/walls. Exceptions to the above are identified in Appendix 9A for safety-related areas and in Section 9.5.1.6.3 for non-safety related areas.

Class A fire doors in the 3-hour fire walls or barriers that separate fire areas are maintained consistent with the approach outlined in Section III.N of Appendix 9A.

9.5.1.1.11 Use of Compressed Gases

Use of compressed gases for cutting and welding is controlled in accordance with an NBU administrative procedure describing/controlling the Station Fire Protection Program. Except for the two CO_2 storage tanks located in the Turbine Building, bulk storage of N_2, H_2, and CO_2 for plant operation is located outside in the yard area. Nitrogen bulk storage, consisting of 8800 gallons of liquid nitrogen, is located approximately 5 yards from the northwest side of the Auxiliary Building radwaste area. The hydrogen bulk storage consists of 88,000 scf in permanently mounted storage bottles and 260,000 scf stored in hydrogen tube trailers. Both hydrogen storage areas are located on the south side of the Turbine Building with the permanent storage bottles approximately 65 feet from the building and the hydrogen tube trailers approximately 250 feet from the building.

Both hydrogen and oxygen storage facilities are located in accordance with the EPRI guidelines requirements (EPRI NP-5283-SR-A 1987). A 17-ton liquid CO_2 storage tank is located approximately 10 feet from the south side of the Reactor Building. A 4-ton and a 6-ton liquid CO_2 storage tank are located in the Turbine Building at floor elevations 102 and 120 feet, respectively. A complete listing of compressed gases in use or stored is shown in Table 9.5-3.

While not falling under the definition of a bulk storage facility per NFPA 50A, the Hydrogen Oxygen Analyzer System's hydrogen and oxygen bottles are stored next to the Condensate Storage Tank dyke wall. The hydrogen bottles are located on the South dyke wall over 50 feet from the reactor building. The 95 SCF of hydrogen and 98 SCF of oxygen are located in accordance with NFPA guidelines for compressed gas storage.

9.5.1.1.12 Use of Plastic Materials

Use of plastic materials has been minimized wherever practicable.

Use of plastic materials for interior architectural features is limited to vinyl composition tile flooring and suspended ceiling lighting fixture lenses. The tile flooring is located in office spaces, radwaste control room, shops, locker areas, and janitor rooms at floor Elevations 102, 124, and 137 feet of the radwaste area, in the janitor room, control room complex and storage room at floor Elevation 137 feet of the control area, in elevators and lobbies, the guardhouse and the administration facility.

9.5.1.1.13 Storage of Combustible and Flammable Liquids

Flammable liquid storage will be kept to a minimum. All flammable and combustible liquid storage complies with NFPA 30. Table 9.5-3 and Appendix 9A identify type, quantity and location of all combustible and flammable liquids.

The fuel oil storage tank rooms and the diesel generator rooms at floor Elevation 54 and 102 feet of the Auxiliary Building diesel area are provided with automatic early warning flame and smoke detection and automatic carbon dioxide total flooding systems actuated by thermal detectors. The fuel oil storage tank rooms are also provided with manually actuated deluge sprinkler systems as backup to the automatic carbon dioxide systems.

Use of combustible and flammable liquids is controlled via the administrative procedure in the operations manual.

9.5.1.1.14 Electric Cable Construction, Cable Trays, and Cable Penetrations

Cable trays are fabricated from aluminum throughout the plant and steel in the drywell area. Automatic preaction sprinklers are provided for safety-related areas containing high concentration of cable trays. The cable spreading room and control equipment room mezzanine are addressed in Section 9.5.1.2.20.

Fire areas in safety related areas with 6 or more cable trays within 10 feet of each other were evaluated for their effects on safe shutdown. See Appendix 9A for further discussion on safe shutdown. All these areas were also evaluated for accessibility and capability to manually suppress a fire. When it was warranted, automatic preaction sprinkler systems over high cable concentrations are provided. The areas which are provided with automatic preaction system for high cable concentration areas are:

1. Auxiliary Building Radwaste and Service Area

    a. Electrical access area 3204 at Elevation 77 feet

    b. Electrical access area 3425 at Elevation 124 feet

2. Auxiliary Building Control and Diesel Generator Area

    a. Corridor 5207 at Elevation 77 feet

    b. Corridor 5237 at Elevation 77 feet

    c. Electrical access 5339 at Elevation 102 feet

    d. Electrical access 5401 at Elevation 124 feet

e. Cable chases 5531, 5532, 5533, and 5534 at Elevation 150 feet, including all vertical portions of chases.

f. H&V chase 5535 at Elevation 150 feet.

3. Reactor Building

a. Motor control center area 4201 at Elevation 77 feet

b. Corridor 4301 at Elevation 102 feet

In addition, water hose stations and portable fire extinguishers are provided for manual firefighting throughout the plant in accordance with Section 9.5.1.2.9 and 9.5.1.2.13, including those provided with automatic preaction sprinkler systems. The tray configurations comply with the separation criteria of Regulatory Guide 1.75, with exceptions stated in Section 1.8.

Cable and cable tray penetrations through fire barriers, both vertical and horizontal, are sealed to provide protection equivalent to the fire barriers with clarifications as noted in Section 9.5.1.6.3. Fire barrier penetration seal materials are tested in accordance with the guidelines in BTP CMEB 9.5-1, Revision 2, Section 5.a.3, ASTM E-119 and ASTM E-814, as appropriate. In addition we have evaluated the effect of a fire on cable tray penetration seal integrity with regard to the mechanical forces on the seal. It is concluded that under the worst case scenarios, the barrier seal at the electrical cable tray penetration will maintain its fire integrity.

Medium and low voltage power and control cables, and all other cables installed in cable trays in the plant have passed the IEEE 383 vertical flame test or equivalent. Cables installed in conduits for normal and emergency lighting, limited communication/data wiring routed in small quantities (one to two cables), short segments of flexible conduit to local junction boxes for the normal and

emergency lighting systems, some cables and wirings used in the administration facility and nonsafety-related yard structures, and cables and wirings in some components mounted in non-Class 1E cabinets are not subjected to IEEE 383 flame test requirements. Any new or replacement cables added that are not qualified to IEEE 383 vertical flame test requirements or equivalent will be evaluated as part of the Fire Protection Program to ensure that the change does not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

No piping for flammable or combustible liquids or gases is routed in cable trays, or in electrical raceways and conduits used only for electrical cables.

The design considerations for cabling involve an optimized balance of electrical, physical, and environmental characteristics. The environmental prerequisites of the jacketing materials include high flame retardance, radiation resistance, and capability to endure a postulated accident condition. These jacketing materials, when involved in a fire, give off small amounts of hydrogen chlorides, which turn into corrosive acids in the presence of a substantial amount of moisture or water. Alternative materials that satisfy the primary design bases without releasing potentially corrosive gases were not available at the time.

Cables entering the main control room also terminate there, and are essential to its operation.

Areas containing cable concentrations are provided with ventilation systems capable of being manually controlled to vent smoke, except as identified in Section 9.5.1.6.12. Automatic smoke detectors are provided in cable concentration areas for prompt fire brigade response in the event of a fire.

9.5.1.1.15 Building Ventilation

9.5.1.1.15.1 Room Isolation and Smoke Removal

1. Room isolation - Fire dampers in the supply and exhaust/return ductwork penetrating fire barriers close automatically and isolate the fire area. The fire damper

is closed by melting of the fusible link, or energizing the electrothermal link (ETL) for rooms provided with a carbon dioxide total flooding system or for which duct mounted fire detectors actuate the ETL.

Fire dampers are selected to close against normal ventilation air flows. As a result of a 10CFRPart 21 finding by Ruskin on November 6, 1984 indicating that fire dampers may not close against published air flow rates, all fire dampers were reviewed with respect to their location within the ventilation systems. The results of that review resulted in the following damper/system modifications or concluded that:

Some dampers as delivered would close against system air flows based on test results furnished by Ruskin.

Some dampers were modified to include a larger spring closure mechanism. Based on test results furnished by Ruskin or by in place testing, these dampers would close against system air flows.

Some multisection dampers were modified to include electro thermal links that would be released based on a high duct temperature sensors. This modification ensures that all damper sections close simultaneously.

Dampers that would not close against system design air flow after modification require shutdown of the ventilation system. Some systems have been modified to automatically shut down the system based on smoke detectors installed in the ductwork or room thermal detector. These systems are listed below with a reference to the FSAR Section that describes the system modification.

SYSTEM	FSAR SECTION
Radwaste Supply (RWS)	9.4.3
Service Area Exhaust (SAE)	9.4.3
Service Area Supply (SAS)	9.4.3
Solid Radwaste Exhaust (SRWE)	9.4.3
Solid Radwaste Supply (SRWS)	9.4.3
Wing Area Exhaust (WAE)	9.4.1
Wing Area Supply (WAS)	9.4.1
Administration Facility	N/A
Guard house	N/A

In addition to the systems that automatically shut down three systems are manually shut down based on area smoke detectors. These systems are:

Control Room Return (CRR)
Control Room Supply (CRS)
Control Area Exhaust (CAE)

Three systems in the Turbine and Radwaste fire areas have Ruskin fire dampers which have been modified with the maximum listed springs installed yet have not passed a qualifying test. These dampers are as follows:

Chem Lab Exhaust (CLE)	OGLD375D10
	OGLD375D7
	OGLD375D9
	OGLD375D8
Turbine Building Supply (TBS)	IGED097D2
	1GED097D4
	1GED097D6
	1GED105D5
	1GED125D10
Turbine Building Oily Exhaust (TBOE)	1GED042D3
	1GED043D3

Since these dampers do not separate safe shutdown equipment and the fire barriers are not otherwise required by BTP CMEB 9.5-1 (C.7.h, C.7.n, etc.) no further fixes are postulated.

Two systems in the diesel area penetrate into the unoccupied (formally Unit 2) area and a deviation was requested in Appendix 9A.6.5.1.h., to accept these five Ruskin dampers as is. An additional deviation was requested in Appendix 9A.6.5.1.g, for one damper in the Diesel Area Supply system.

Some Ruskin fire dampers were installed in non-fire rated slabs. No further actions to fix these dampers are postulated. These dampers are as follows:

Diesel Area Supply (DAS)	1GMD283D7
	1GMD284D3
	1GMD285D1
	1GMD286D1

Diesel Area Exhaust (DAE)	1GMD274D1
	1GMD275D1
	1GMD276D1

Some fire areas of the same shutdown division were combined to eliminate the requirement for a fire barrier between them. Ruskin fire dampers in those newly created interior fire walls, which are not part of a fire area boundary, are left as is. No further actions to fix these dampers are postulated. These dampers are as follows:

Switchgear Room Cooling (SRC)	1GMD264A,B,C&D
	1GMD269A,B,C&D
Diesel Area Supply (DAS)	1GMD267D2
	1GMD960
Diesel Area Exhaust (DAE)	1GMD266D1
	1GMD267D1
Control Area Battery Exhaust (CABE)	1GKD418
Control Equipment Room Supply (CERS)	1GKD419
	1GKD420

Some HVAC duct was externally wrapped with a qualified fire barrier to extend the fire area past the Ruskin fire damper to the first qualified fire barrier. The dampers involved are as follows:

Diesel Area Panel Supply (DAPS)	1GMD174
	1GMD177
	1GMD497
	1GMD993

2. Smoke Removal - The normal building ventilation systems or separate smoke removal systems are provided to remove products of combustion. For areas where smoke can not be removed via the permanent plant ventilation systems as described below, portable blowers for use as smoke ejectors will be provided by the fire brigade. Refer to Section 9.4 for a complete description of the air conditioning, heating, cooling and ventilation systems.

   a. Control Area - A separate smoke removal system is provided for the control area to remove the products of combustion for the control area heating and ventilation equipment room (5602), diesel area heating and ventilation equipment room (5603), control equipment room mezzanine (5403) inverter rooms (5447 & 5448), electrical access at floor Elevation 137 feet (5501), cable spreading room (5202), control equipment room (5302), and electrical equipment rooms (5102 & 5103). For any specific area, smoke is removed by manually opening a normally closed shutoff damper and associated fire damper located in the perimeter of the affected room and then manually starting the control area smoke exhaust fan. There is no automatic discharge of smoke or corrosive gases in case of fire. The control area smoke exhaust fan is used only for smoke removal.

      Redundant control area exhaust fans for the control room complex are located in the heating and ventilation equipment room. This normal exhaust system can be used to remove smoke produced by a fire in the main control room. Provisions are provided to completely isolate the emergency filter unit during the smoke removal operation to avoid fouling the carbon absorbers.

Controls for the control area smoke exhaust fan and the control area exhaust fans are located on a remote control panel local to the equipment.

b. Turbine Building - There is no separate mechanical smoke removal system. The normal turbine building supply and exhaust systems have a manual purge switch for 100 percent outside air ventilation and discharge to the south plant vent. The Turbine Building compartment exhaust and oil storage exhaust also discharge directly to the south plant vent. The Turbine Building battery room exhaust fan discharges directly outside. These systems have smoke removal capability.

c. Reactor Building - The normal ventilation system is a once through system that provides HEPA filtering before air is discharged to the south plant vent. The system also has smoke removal capability.

d. Service area - There is no separate mechanical smoke removal system. Air from the uncontrolled areas is returned to service area supply (SAS) units; air from the controlled areas is exhausted by the service area exhaust (SAE) fans and discharged to the south plant vent; and air from the Chemistry Laboratory and adjacent areas to the laboratory and fume hoods is exhausted by the Chemical Laboratory Exhaust (CLE) System. The CLE system air is filtered by HEPA filters before being discharged to the north plant vent. The SAE and CLE systems have smoke removal capability. The remote shutdown panel room has a separate heating, ventilating, and air conditioning system. There is no direct exhaust from the remote shutdown panel room. Supply air is a mixture of outside and return air.

e. Radwaste Building - There is no separate mechanical smoke removal system. The radwaste exhaust system and solid radwaste exhaust system removes air from areas of the radwaste building, and filters the air by HEPA filters before discharging it to one of two monitored plant vents. The systems have smoke removal capacity.

f. Diesel area - There is no separate mechanical system for smoke removal. The diesel area exhaust system normally operates to exhaust air directly outside from the following areas: Tank rooms (5107, 5108, 5109, and 5110); diesel generator room recirculation fan rooms (5208, 5209, 5210 and 5211); diesel generator rooms (5304, 5305, 5306 and 5307); and corridors (5537, 5604 and 5702). In addition, various battery exhaust fan exhaust air directly outside from four battery rooms at elevation 146'-0" (5539, 5541, 5543, and 5545) and four battery rooms at elevation 163'-0" (5609, 5614, 5626 and 5627). These systems all have smoke removal capability.

g. Wing area - There is no separate mechanical system for smoke removal. The wing area exhaust system normally operates to exhaust air directly outside from electrical access areas (5339 and 5401) and from corridor 5237. This system has smoke removal capability.

9.5.1.1.15.2 Power Supply and Controls

Power supply and control cables for the control area mechanical smoke removal system are routed outside the fire area served by the system.

9.5.1.1.15.3 Stairwells

A mechanical ventilation system supplies clean air to stairwells serving as escape/access routes for firefighting activities, thus maintaining a positive pressure in the stairwells to prevent smoke infiltration during a fire.

Doors provided for stairwells are self-closing, thus minimizing smoke infiltration during a fire. Stairwells are provided in accordance with Building Officials and Code Administrators International Inc. (BOCA) Basic Building Code life safety requirement, and they provide access and egress during fire emergencies. The walls of the stair towers have a fire rating of 2 hours, the doors are 1-1/2-hour, B-labeled, consistent with NFPA 80, for use in openings in 2-hour enclosures of vertical communication within the building. Elevators are not used during fire emergency except by fire brigade personnel as required. The doors to the stairwells are clearly marked with exit signs.

9.5.1.1.16 Breathing Air

Self-contained breathing apparatus is provided for the fire brigade, and main control room personnel. Extra air bottles and an onsite reserve air supply are available.

9.5.1.1.17 HVAC Charcoal Filters

All heating, ventilating, and air conditioning (HVAC) charcoal filters in the Reactor Building are provided with hydraulically designed preaction water spray systems, and all HVAC charcoal filters outside the Reactor Building, except the solid radwaste extruder/evaporator vent hood filter, are provided with hydraulically designed water spray systems. Drainage of fire protection water is provided from these filter units to the dirty radwaste system. See Sections 9.5.1.2.5 and 9.5.1.2.7 for specifics on the fire suppression systems.

9.5.1.1.18 Outside Air Intakes

Outside air intakes for supply units are located remotely from exhaust openings and smoke vents of other fire areas to minimize the potential for introducing any product of combustion to the intake air.

9.5.1.1.19 Quality Assurance Program

The overall responsibility for the fire protection quality assurance (QA) program for HCGS lies with PSE&G. Refer to Section 17.2 for a description of the Quality Assurance Program during the operations phase. PSE&G had delegated the management of the fire protection QA program during the design and construction phase to Bechtel to ensure QA Program implementation during the design, procurement, construction, installation, and testing of fire protection systems, emergency lighting and communications.

The remaining paragraphs in Section 9.5.1.1.19 are maintained for historical purposes to reflect the commitments and status of the Quality Assurance Program during the design and construction phase of the plant.

Bechtel implements its corporate 10CFR50, Appendix B, QA program (Bechtel Nuclear Quality Assurance Manual, as amended for the Hope Creek Project) for those items within the scope of the fire protection program to the extent of the 10 quality assurance criteria of Appendix A to Branch Technical Position (BTP) APCSB 9.5-1, and to an extent consistent with their importance to safety. The QA program for fire protection program includes such items as, fire detection and suppression, for safety related areas, emergency lighting, communication, and emergency breathing apparatus.

Implementation of the fire protection QA program by Bechtel will be ensured through review, surveillance, and audit conducted by the PSE&G QA Department, as described in Section 16 of the PSAR.

The fire protection QA program controls applicable to the startup and operational phases are provided, respectively, in Section 14 and Section 17.2.

The QA program for Bechtel's responsibilities is responsive to the QA program guidelines in the following manner:

The fire protection quality assurance program ('F' program) was formally implemented effective July 1, 1978. An 'F' designation is used to identify the applicable fire protection systems/components covered under the quality assurance program. The fuel oil tank, the fire pumps and associated controls, and the fire protection water spray systems, the carbon dioxide systems and the early warning smoke and detection systems in safety related areas are covered under the 'F' program. Since the 'F' program is not retroactive, certain fire protection system components purchased and installed prior to July 1, 1978 such as the fire water storage tanks, the tank heaters and associated controls and the valve pit unit heaters are excluded from the 'F' program, during the construction phase. They will be maintained under the "F" program after fuel is delivered to the site.

1. Design control and procurement document control - Bechtel design criteria, calculations, drawings, specifications, material requisitions, and contracts and changes, and/or deviations thereto, shall be checked and approved in accordance with engineering department procedures to assure that design related guidelines have been incorporated. Suppliers and contractors will meet the requirements of state and local authorities, OSHA, standards of the NFPA, and the recommendations of the insurers, as delineated in the specifications.

2. Instructions/procedures and drawings - Activities on FPSs, such as inspections, services, construction, and installation, will be accomplished according to standard Bechtel procedures. Drawings will be prepared in accordance with engineering department procedures.

Construction department procedures will apply to work performed by Bechtel. Instructions, procedures, and drawings applicable to FPSs are subject to review and approval by PSE&G.

3. Control of purchased material, equipment, and services - Bechtel will procure appropriate materials, equipment, or services from suppliers and subcontractors that have demonstrated their ability to satisfactorily perform or that have been established as satisfactory by survey. Bid evaluations will be performed in accordance with engineering department procedures and the Bechtel procurement supplier quality department will perform surveillance inspections of supplier's work in accordance with specifications, requirements, inspection, plans, and other instructions when directed by engineering. Jobsite receiving inspection will be accomplished in accordance with construction quality control procedures. The supplier provided engineering documentation required by Bechtel specifications will be reviewed by Bechtel project engineering for compliance with specified requirements.

4. Inspection

   a. Bechtel will require contractors/subcontractors to inspect their installations to assure compliance with contract requirements and will conduct surveillance inspection of the contractor's activity.

   b. Jobsite receiving inspection for Bechtel-purchased items will be accomplished in accordance with construction quality control procedures by Bechtel field engineering.

   c. Installation inspection of Bechtel construction activities will be performed by Bechtel construction

quality control personnel. Bechtel field engineering inspection records, for fire protection dampers and internal conduit penetration seals included in the 'F' program, may be accepted in lieu of quality control inspection records for items installed prior to initiation of this program or for specific cases, such as where disassembly would be required to perform the inspection. Each exception will require approval from Bechtel quality assurance. Results of inspections will be documented.

5. Test and test control - Tests required to qualify, demonstrate, or assure quality of procured items or completed construction are defined in engineering drawings, specifications, or test procedures. As a condition of acceptance, Bechtel will require, through specifications, that tests be satisfactorily performed and documented by suppliers and contractors/ subcontractors to demonstrate conformance with design requirements as appropriate. Tests performed by Bechtel will be documented.

6. Inspection, test, and operating status - Bechtel will require, through construction procedures and inspection instruction, that systems, equipment, and components satisfactorily pass required tests and inspections. This is documented on appropriate check sheets at startup when systems are turned over to PSE&G. Discrepant material or equipment will be appropriately tagged. Tags, labels, or similar temporary markings will also be used, as appropriate, to indicate completion of required inspection and tests as well as the operating status of systems, equipment, and components.

7. Nonconforming items - The Bechtel construction receiving group will identify and segregate nonconforming items in accordance with construction quality control

procedures. Nonconformances occurring after receiving inspection will be identified and controlled in accordance with construction department procedures. Bechtel will require contractors/subcontractors, as appropriate through procurement documents, to have a nonconformance control program.

8. Corrective action - Bechtel will identify the need for corrective action through the review of nonconformance reports, supplier surveillance activities, surveillance and monitoring programs, and audits. Corrective action is controlled and documented by means of corrective action reports and an associated procedure.

9. Records - Bechtel will provide records verifying that Criteria 1 through 10 have been met as directed by engineering, procurement, and construction procedures. Bechtel will also require, through procurement documents, that suppliers/contractors and subcontractors provide required records of their activities. Bechtel will turn the records over to PSE&G at the appropriate time.

10. Audits - Audits will be performed in accordance with written procedures as appropriate on Bechtel activities in engineering, procurement, construction, installation, and testing. Audits will be conducted by Bechtel QA and PSE&G QA departments.

9.5.1.2 System Description

9.5.1.2.1 General

Plant Drawings M-5001 through M-5013 and M-5101 through M-5111 show the plant layout, facility arrangement, fire wall/barrier ratings, and fire detection and suppression with respect to FPS equipment and components.

The FPS is also shown schematically on Plant Drawing M-22-0.

Hazardous materials are listed in Table 9.5-3.

9.5.1.2.2 Codes and Standards

In general, the FPS is designed and constructed in accordance with the following codes and standards:

1. Nuclear Mutual Limited (NML) Property Loss Prevention Standards for Nuclear Generating Plants

2. New Jersey Uniform Construction Code, Chapter 23, Title 5

3. American National Standards Institute (ANSI)

4. National Fire Protection Association (NFPA), as listed in Table 9.5-1

5. Underwriters Laboratory (UL), Inc, Building Materials List, Fire Resistance Directory, and Fire Protection Equipment Directory

6. Factory Mutual (FM) Approval Guide

7. National Electrical Manufacturer's Association (NEMA)

8. Code of Federal Regulations, 10CFR50, Appendix A, GDC 3

9. Occupational Safety Health Act (OSHA)

10. HCGS General Plant Electrical Design Criteria, D4.0

11. Nuclear Regulatory Commission's Appendix A to BTP APCSB 9.5-1 and 10CFR50, including Appendix R.

12. Nuclear Regulatory Commission's BTP CMEB 9.5-1.

9.5.1.2.3 Fire Protection Water Supply Systems

9.5.1.2.3.1 Water Source

Fire protection water supply is from two, 350,000 gallon nominal capacity, fire water storage tanks located north of the plant. Each tank feeds the FPS and the demineralized water and boiler makeup systems. Of the 350,000 gallons of storage capacity for each tank, 328,000 gallons is dedicated to the Fire Protection Water System, and the remaining amount is available for the demineralized water system. The demineralized and boiler makeup water systems are fed through an external tap physically located above the fire water level of 328,000 gallons. Water is pumped by two deep well water pumps, and the discharge piping for the pumps is cross connected so that either pump can fill both tanks. Each pump is capable of filling the fire water portion of either fire water storage tank within 8 hours.

The adjacent Salem Generating Station fire protection water supply is physically connected to the Hope Creek yard loop by a 10-inch connection controlled by a normally closed post-indicator valve (PIV).

The dedicated fire water storage capacity of 328,000 gallons in each tank will provide water to meet the demand of 2180 gpm of the largest sprinkler system (non safety-related system) plus 500 gpm for manual hose streams for 2 hours. The largest safety related sprinkler demand is 1455 gpm plus 500 gpm for hose streams.

The fire pump suction piping and valve arrangement allows either fire pump to take water from either or both fire water storage tanks. With the present arrangement and normal valve line-up, a leak in the pump suction piping could cause the loss of water from both tanks. However, low water inventory in the storage tanks is annunciated in the control room. Isolation valves have been

provided in the storage tank supply headers and in the fire pump suction headers to prevent loss of reserved fire water from both tanks. This combination of water level instrumentation and isolation valve arrangement provides adequate protection against losing the fire water inventory from one tank and/or both tanks.

9.5.1.2.3.2 Pumps

Two 100 percent capacity, UL-listed, horizontal, centrifugal fire pumps are provided in accordance with NFPA 20, each with a rated flow and pressure of 2500 gpm and 125 psig, respectively. One fire pump is electric motor driven and the other is diesel engine driven. A jockey pump rated at 55 gpm and 125 psig is also provided to maintain the system pressure between 115 and 125 psig and to provide makeup for system leakage. The two fire pumps and the jockey pump are arranged so that each pump can take suction from either tank and pump water into the yard loop system.

Each fire pump is capable of providing, over the most hydraulically remote route of the water supply system, the design demand of 2180 gpm for the largest sprinkler system at the design pressure of 56 psig and 500 gpm for manual hose streams. In addition, each pump is capable of providing a minimum of 65 psig at the highest standpipe outlet with 100 gpm flowing from the outlet in accordance with NFPA 14. See Sections 9.5.1.6.19 and 9.5.1.6.21 and Table 9.5-18.

The electric motor driven fire pump starts automatically at 110 psig. If it fails to start or cannot meet the water flow demand, the diesel engine driven fire pump starts automatically when the system pressure drops to 100 psig. The fire pumps continue to operate until manually stopped at the local pump control panel. Both fire pumps can be started remotely from the fire status panel in the main control room or locally at the fire pumphouse.

Each fire pump is provided with a UL-listed automatic controller. Power supply for the electric motor driven fire pump is from a non-Class 1E bus. Offsite power is needed to run the electric motor driven fire pump. The diesel engine driven pump controller is provided with power from batteries. Offsite ac power is provided to the battery charger. Loss of ac power does not prevent startup or operation of the diesel driven fire pump. The diesel fire pump starts automatically on loss of ac power.

The diesel fuel supply tank has a capacity of 280 gallons of fuel oil. This is sufficient to supply the necessary fuel needed for diesel engine driven fire pump operation in excess of 8 hours at full pump capacity.

The electric motor driven fire pump and controls are located in a room along with the jockey pump and controls. The diesel driven fire pump and controls are located in a separate enclosure with 3-hour fire-rated barriers. The diesel fuel oil day tank is located outdoors. Each fire pump room is provided with an automatic water sprinkler system.

9.5.1.2.3.3 Yard Piping

The connections to the yard fire main loop from each of the two fire pumps are spaced approximately 75 feet apart, separated by a divisional valve with additional valves arranged to isolate either connection to maintain a 100 percent water supply to the main loop. The top of the piping is below the site frost line of 3 feet 6 inches below ground level. For underground piping within the power block area, bedding is of lean concrete or granular material compacted to 90 percent, according to ASTM D 1577 (Method D); and for piping outside the power block area, bedding is of granular material compacted to 90 percent (ASTM D 1577, Method D) or of lean concrete or sandcrete. Backfill is of granular material compacted to 85 percent (ASTM D 1577, Method D).

The outdoor, underground yard loop was designed in accordance with NFPA 24. The yard loop consists of 12-inch diameter cement mortar lined ductile iron pipe that extends around the power block. Post-indicator valves (PIV's) are provided for sectional control. Hydrants with two 2-1/2 inch outlets, controlled by individual curb box valves, are installed on the yard loop at intervals sufficient to provide an effective hose stream to any yard location.

Per BTP CMEB 9.5-1, Section C.6.b(7), the HCGS yard fire hydrant design was based on approximate spacing of 250 feet along the underground piping loop. With the four exceptions identified below, all hydrants within the protected area are included in a 200 to 300 foot hydrant to hydrant spacing envelope. The exceptions to this are:

1. Hydrants 52 to 17, 327 feet

2. Hydrants 15 to 4, 383 feet

Yard hydrant coverage at HCGS is adequate to effectively protect all areas based on the following features.

1. Per NFPA 24, Section 4-2.1, maximum hose lengths are limited to 500 linear feet. The worst case HCGS hydrant-to-hydrant spacing of 383 feet, which equates to a maximum required hose run of less than 200 linear feet to reach a point between hydrants is well within the NFPA 24 criteria.

2. A mobile response vehicle will be used to transport sufficient hose and associated equipment to provide effective hose streams at any yard location.

3. Yard supply pressure in excess of 90 psig with 2500 gpm flowing is available at all yard hydrants within the protected area. This is ample water supply to allow effective hose streams to be deployed in all yard areas.

4. The four exception hydrants identified above all cover areas of the yard with no safety-related equipment and which present no exposure fire hazard to safety-related structures.

The HCGS hydrant configuration provides acceptable yard fire suppression in compliance with NFPA 24. The deviations from the BTP spacing criteria do not adversely affect yard fire protection.

9.5.1.2.3.4 Water Supply for Automatic and Manual Sprinkler/Spray Systems

Automatic and manual sprinkler/spray systems headers are connected to the inplant loops that are fed from the main underground fire protection water piping or yard loop by two separate supplies. The inplant loops are 8-inch (Auxiliary and Reactor Building) and 10-inch (Turbine Building) lines. Automatic and manual sprinkler/spray systems and hose standpipe systems serving a single safety-related area have takeoffs from an inplant loop, separated by sectional control valves. Except as identified in Section 9.5.1.6.1, the header arrangement is such that, by manual positioning of the sectional valves, no single piping failure can impair both the primary and backup fire protection provided for a single area.

An outside screw and yoke (OS&Y) gate valve for each sprinkler and deluge system is located adjacent to the system control or alarm valve. The branch connection into the building is provided with a post-indicator valve at the connection to the yard loop. Each sprinkler and deluge system is provided with local water flow alarms and remote annunciation in the main control room.

Control and sectionalizing valves in the fire protection water system are either electrically supervised or administratively controlled in accordance with NFPA26. The valves that are electrically supervised are those valves that control the water suppression systems and the valves in the fire pump suction and discharge lines located in the fire pump house. These valves are shown on Plant Drawing M-22-0 sheets 1 through 4 and 6. The electrical supervision signal is indicated on the local control panels and registers as a system trouble on the fire protection status panel in the main control room.

The valves that will be administratively controlled are the post indicator valves in the yard area that provide sectional control of the fire main loop and fire water supply lines branching into various buildings, the sectional valves in the inplant loop and supply piping, and the valves that control the water supply to standpipe and hose systems and some sprinkler systems. These valves are padlocked in the appropriate position so that they cannot be inadvertently operated. The control valves for the standpipe and hose system in the reactor building and intake structure are normally closed to maintain these systems in a dry condition.

Valves are either electrically supervised, or locked and inspected monthly. Documentation recording this inspection will be maintained.

Automatic and manually actuated sprinkler system design was based on area coverage of hazards. To affect this result ordinary hazard listed sidewall sprinkler heads and sprinklers with orifices below one half inch in diameter were utilized to provide full coverage and to control water density, respectively. In all cases, the system design was specific to the room and hazards involved.

9.5.1.2.4 Wet Pipe Sprinkler Systems

Wet pipe sprinkler systems are provided for the plant areas listed in Table 9.5-2. The density coverage and installation for the sprinkler systems are in accordance with NFPA 13. Each sprinkler system is provided with an alarm check valve or flow switch that annunciates in the main control room. OS&Y gate valves serving as shutoff valves to automatic sprinkler systems are supervised with any problems annunciated in the main control room.

The flow of water through an alarm check valve or flow switch energizes a local audible alarm and registers an alarm condition on the fire monitor panel in the main control room. Once initiated, the wet sprinkler system operation is terminated manually by shutting either a gate valve external to the hazard or a post-indicator valve outdoors.

9.5.1.2.5 Water Spray Systems

Water spray systems are provided for the plant areas or equipment listed in Table 9.5-2.

The water spray systems have directional solid cone spray nozzles or perforated pipe for certain HVAC charcoal filters or closed sprinkler heads for certain areas. The water flow is controlled by UL-listed deluge valves. A system actuation alarm and an alarm, which annunciates supervised circuit trouble as well as out of position supervised OS&Y isolation valves, for each spray system are provided in the main control room. Spray densities and installation complies with NFPA 13 and 15.

Operation of the automatic spray systems is initiated by a temperature sensor (thermal spot type or continuous line-type detectors). This sensor detects a rapid rise in ambient temperature and/or attainment of a fixed high temperature and releases a tripping device to open the deluge valve, thus

supplying water under pressure to the open spray nozzles. Actuation of a sensor also initiates a local alarm, and registers the alarm condition on the fire protection status panel in the main control room, independently of water flow in the system. Water flow in the system initiates a local alarm and registers the system-actuated condition on the fire protection status panel in the main control room independent of the detection alarm.

Manual release of the deluge valve tripping device also initiates local and remote water flow alarms. System operation is terminated by manually closing a gate valve external to the hazard area.

Upon reception of a high-high temperature alarm, operation of the manual water spray systems is initiated by a pushbutton on the local panel and opening a normally closed OS&Y gate valve. Water flow in the system initiates a local alarm and registers the system actuated condition in the main control room independent of the detection alarm. System operation is terminated by manually closing the OS&Y gate valve external to the hazard area.

9.5.1.2.6 Deluge Systems

Deluge systems are provided for the diesel fuel tank rooms and control equipment room mezzanine as listed in Table 9.5-2.

The deluge systems for the diesel fuel tank rooms have open sprinkler heads. Water flow is controlled by a UL-listed deluge valve actuated by a manual release valve on the deluge valve trim, a pushbutton on the local control panel, or by a manual pull station located at the entrance to the hazard area. Then the system isolation valve, which is normally closed, must be opened. A system alarm and a valve position alarm on supervised OS&Y gate valves for each deluge system is provided in the main control room. The density coverage and installation for the systems are in accordance with NFPA 13. Water flow in the system initiates a local alarm and registers the system actuated

condition on the fire protection status panel in the main control room. System operation is terminated by manually closing a gate valve external to the hazard area.

The manual deluge system for the control equipment room mezzanine is divided into four zones with open sprinkler heads and the water flow for each zone is controlled by a normally closed OS&Y gate valve. The gate valves are supervised and a common trouble alarm is provided in the main control room if the valves are not 100 percent closed. The system is designed in accordance with NFPA 13. Operation of the system is initiated by manually opening any of the gate valves for each zone, allowing water to discharge through the open sprinkler heads. Water flow alarm for the system is annunciated locally and in the main control room. When the fire is controlled, water discharge is terminated by manually closing the gate valve. After the water is drained, the system is ready for use again.

9.5.1.2.7 Manual Preaction Water Spray Systems

Manual preaction water spray systems protect charcoal filter beds in nine HVAC units located in the Reactor Building. The specific HVAC units covered are listed in Table 9.5-2.

The individual charcoal filter systems are supplied by a common header which is normally dry. The header is charged with supervisory air between the common deluge valve at the supply end of the header and the individual motor operated valves (normally closed) which isolate each of the nine subsystems. The deluge valve isolation valve is normally kept in the closed position. A motor operated isolation valve, located on the header inside the building, is maintained normally open.

Linear thermistor circuits are installed in each charcoal filter unit which alarm on local annunciator panels installed at each filter unit and on the common control panel (located adjacent to the deluge valve) when the "high" and "high-high" temperature

setpoints are reached. A common alarm is received in the Control Room when the "high" setpoint is reached on any linear thermistor circuit and a subsystem specific alarm is received when the "high-high" setpoint is reached.

When the "high-high" setpoint is reached for any subsystem, the header isolation valve is opened, and then the deluge valve is tripped and the subsystem MOV is opened using pushbuttons on the local control panel. When the fire is extinguished the system can be reset as follows:

1. The subsystem MOV and header isolation valves are closed and the header drained.

2. The local control panel is reset and the deluge valve is manually reset.

3. The header is recharged with supervisory air.

9.5.1.2.8 Preaction Sprinkler Systems

Preaction sprinkler systems are provided for plant areas or equipment as listed in Table 9.5-2.

Preaction sprinkler system operation is initiated by thermal or smoke detectors located in the hazard area, which actuates the UL-listed valve and charges the system with water up to the closed, fusible link sprinkler heads. No water is discharged to the hazard area at this time. System specific fire alarms are annunciated in the main control room. High temperature due to fire condition melts one or more of the fusible link sprinkler heads and water discharges onto the hazard.

When the fire is controlled, water discharge is terminated by manually closing the fire main gate valve, and the system is drained. Fused sprinkler heads are replaced, the deluge valve is manually reset, and the header is pressurized with supervisory air.

The preaction sprinkler system for the cable spreading room at Elevation 77 feet of the Auxiliary Building control area is divided into four zones, each of which has a deluge valve. All zones are actuated when smoke detectors from the early warning detection system detect a fire. This is the only water system which is initiated by smoke detection. Details of the early warning detection system are provided in Section 9.5.1.2.15.1.

9.5.1.2.9 Wet Standpipes and Hose Stations

Wet standpipes for fire hoses are designed to provide 65 psig at the topmost outlet of the hose standpipe system with 100 gpm flowing from the outlet in accordance with NFPA 14. Standpipes are installed adjacent to stairwells, exits, and other points in all normally accessible areas in plant buildings. Four-inch standpipes are provided for three or more hose connections, and 3-inch standpipes are provided for one or two hose connections except in one instance where three hoses are connected to a 3-inch branch. These three hose stations are not on the same floor and cannot be used to fight the same fire. The standpipe hose connections are equipped with 1-1/2-inch hose valves and preconnected with 75 or 100 feet of 1-1/2-inch woven jacket lined hose and spray nozzles.

In safety-related areas, some standpipe hose connections (fire hose stations), are provided with an additional 50 feet of hose which is not connected and is stored near the fire hose station. In the unlikely event of a fire, the additional hose will be used to reach certain areas that a 100-foot hose will not reach. For a list of the fire hose stations that have the additional 50 feet of hose and the areas that they will be used to reach, see Section 9.5.1.6.21.

The existing 75/100-foot fire hoses may not reach some areas of the nonsafety-related Turbine Building and Auxiliary Building -

radwaste/service area. The fire brigade is equipped with additional lengths of hose which will be used if necessary. Installed hose length will not exceed 150 feet.

For hose stations that have 150 feet of hose, there is enough pressure above the 65 psi required by NFPA 14 at the hose station inlet, to make up for the additional pressure drop through the extra 50 feet of hose length.

The fire water supply can provide water at the required flow and pressure to supply any hydraulically designed sprinkler or deluge system and all the hose streams which can be brought to bear on the same fire. See Sections 9.5.1.6.19 and 9.5.1.6.21.

Standpipes are maintained in a dry condition in the Reactor Building and the intake structure.

Adjustable spray nozzles with shutoff capabilities, UL-listed for Class C fires, are provided.

9.5.1.2.10 Halon Extinguishing Systems

An automatic Halon 1301 total flooding system is provided underneath the raised floor of room number 1 in the guardhouse. The system is actuated by a fire detection system using cross-zoned ionization detectors. The Halon extinguishing system is designed in accordance with NFPA 12A.

The system is designed to achieve a Halon 1301 concentration by a volume of 7 percent within a nominal 10 seconds; with a maintained concentration of Halon 1301 of not less than 5 percent for a period of 10 minutes. A 100 percent backup supply of manifolded Halon storage containers is provided to enable a manual electric discharge into the protected area.

A manually actuated Halon system is provided for the main control room console and associated pit. For further discussion on this system, see Section 9.5.1.2.19.

9.5.1.2.11 Carbon Dioxide Systems

Low-pressure carbon dioxide systems, designed in accordance with NFPA 12, are provided for room total flooding, local application, and turbine generator purge. Local hand hoses are also provided, but are not expected to be available for firefighting applications. The carbon dioxide is stored in low-pressure storage units consisting of a pressure vessel that maintains the carbon dioxide at approximately 300-psig pressure and 0^{O}F temperature, using an integral refrigeration unit. Two fire protection storage units are provided for the plant: one serving the Turbine Building and one serving the remainder of the plant. A third carbon dioxide storage unit located in the Turbine Building is used for generator purge and is not considered part of the fire protection system.

Each fire protection carbon dioxide storage tank serves two or more zones with a solenoid pilot-operated master control valve. Additionally, each total flooding hazard area is provided with a pilot-operated selector control valve in series with the master valve. A supervised annunciated alarm is provided to indicate closure of the manual defeat valve in the selector valve pilot line. Thermal detectors initiate automatic operation. Provisions are made for local and remote alarm, and manual operation. The ETLs provided to close fire dampers for room isolation from the ventilation system are actuated by a signal from total flooding the carbon dioxide system control panel.

9.5.1.2.11.1 Carbon Dioxide Total Flooding Systems

Carbon dioxide total flooding systems are provided for plant areas or equipment, as listed in Table 9.5-2.

Low pressure carbon dioxide system operation is initiated by attainment of a fixed high temperature. A temperature sensor initiates the following automatic operation sequence for total flooding:

1. A local predischarge alarm is sounded to allow personnel to evacuate the area. The alarm condition is registered on the fire protection status panel in the main control room.

2. After completion of a delayed action timer circuit sequence, the master and selector valves open, releasing carbon dioxide to the hazard area. Electrothermal devices actuated by the circuit shut all fire dampers. Upon completion of the discharge cycle, the timer closes the master and selector valves. The alarm condition is maintained until the system is reset manually.

Control pilot valves located outside the hazard area may also be operated manually to activate the system. A supervised 1/4-inch ball valve, with a valve position alarm in the main control room serves as a defeat valve in the pilot line and can be used to deactivate the system when personnel occupy the room. The carbon dioxide storage capacity is maintained sufficiently for a single discharge within the largest single protected area.

The local manual defeat valve for the CO_2 systems will not be routinely locked due to personnel safety considerations. However, actuation of the manual defeat mechanism alarms in the Main Control Room on the fire protection status panel. Operations or fire brigade personnel will investigate and rectify any unanticipated CO_2 system defeat.

Inadvertent manual operation or automatic operation due to release failure is detected by registry of a "system actuated" signal, without a fire alarm. Failure of one detector to sense fire results in no adverse effects, as another detector in the area

senses the fire and releases the system. If the master or zone valve fails to open, no carbon dioxide discharge occurs, but a fire alarm is registered.

Room overpressurization has been evaluated for each total flooding carbon dioxide system to assure that room pressure will remain below 1 psid and below the penetration seal limitations.

9.5.1.2.11.2 Carbon Dioxide Hose Reel Systems

Carbon Dioxide Hose Reel Systems are no longer in use and are removed from the plant.

9.5.1.2.11.3 Carbon Dioxide Local Application System

A carbon dioxide local application system is provided for the oil piping inside the generator exciter located in the Turbine Building at elevation 137 feet.

The initial system discharge is initiated automatically by thermal detectors located in the exciter housing. Additional discharges can be initiated manually, as required, via a pushbutton station located near the local control panel. The sequence of operation for the automatic actuation of the system is similar to the total flooding systems described in Section 9.5.1.2.11.1, except only a master valve is provided for the system. The master valve opens after the predischarge alarm period has ended.

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9.5.1.2.12 Mechanical Foam System

Means are provided for injecting foam into the 1,000,000 gallon fuel oil storage tank located in the yard. A hose connection is provided to pipe foam solution from a fire truck to a foam maker mounted on the tank. Rate-compensated thermal detectors inside the fuel tank locally and remotely alarm on the fire status panel in the main control room upon fire conditions.

The source of foam solution will e the various fire protection vehicles available to the on-site fire department. The water and foam mixture is pumped by the fire trucks to the foam maker on the fuel storage tank which discharges foam into the storage tank.

9.5.1.2.13 Portable Fire Extinguishers

Portable fire extinguishers are provided in plant areas that contain, or could present a fire exposure to, safety-related equipment. In general, dry chemical type fire extinguishers and CO2 type fire extinguishers with B:C ratings are provided. Dry chemical type fire extinguishers were selected with consideration given to the possible adverse effects the extinguishing agent could have on safety-related equipment in the area. Class A fire fighting is provided by the standpipe and hose station system described in Section 9.5.1.2.9. Also pressurized water fire extinguishers are provided in the reactor building and service water intake structure to supplement the normally dry standpipe and hose station system in these areas. Portable fire extinguishers with the agent Halon 1211 are provided within the main control room and in the vicinity of the remote shutdown panel room.

9.5.1.2.14 Wheeled Type Dry Chemical Fire Extinguishers

Wheeled type dry chemical fire extinguishers of a nominal 300 pound capacity are available for use on large flammable liquid fires as may occur in areas with pumps that contain a substantial quantity of lubricating oil. These units supplement the standpipe and hose station system. Normally, these units are stationed in the turbine building for easy access to safety-related plant areas within the RCA and the diesel generator area.

9.5.1.2.15.1 Early Warning Fire and Smoke Detection Systems

Early warning fire and smoke detection systems are installed in all required areas in accordance with NFPA 72, 72D and 72E. Except for the cable spreading room at Elevation 77 feet of the Auxiliary Building control area, the early warning fire and smoke detection systems are independent of the detection systems used to actuate the suppression systems. For discussion of the detection systems used to actuate the suppression systems, see Sections 9.5.1.2.5 through 9.5.1.2.8 and 9.5.1.2.10 through 9.5.1.2.12.

The selection, placement, and spacing of fire and smoke detection devices is based on the design, configuration, and use of the area, together with draft conditions due to natural or mechanical ventilation.

The smoke stratification criterion of NFPA 72E, Appendix A has been evaluated as it relates to the specific conditions within HCGS. In most cases, HVAC exhausts are located at or near the ceiling level, eliminating stratification as a concern due to the tendency to draw air toward the ceiling. In the limited areas where HVAC exhaust is not at the ceiling, smoke stratification has been considered in the design of the detectors and is not a problem at HCGS due to air changes and ventilation patterns. Both fire and supervisory alarm signals register locally and in the main control room.

The early warning fire and smoke detection devices are activated by the several stages of fire. Ionization detectors or Incipient Fire Detectors (IFD) sound an alarm at the presence of invisible combustion products during the incipient stage of fire. Flame detectors respond directly to the infrared radiation emanating from a flame sustained for at least 3 seconds in areas where fire develops rapidly with a minimum or absent incipient stage. Photoelectric smoke detectors respond directly to visible smoke concentrations of not less than 0.5 percent per foot of light obscuration caused by smoke for at least 5 seconds, and are used in

areas where fire potential might exist and areas that are exposed to a radiation dose rate greater than that recommended for ionization detectors. Rate compensating thermal detection responds to area high temperature conditions. All fire and smoke detection devices are supervised for reliability per NFPA 72D with exceptions as noted in Section 9.5.1.6.14.

Areas with combustible loading greater than 8000 Btu/ft^2 are provided with fire and smoke detection systems. See Appendix 9A, Table 9A-1 for specific safety-related areas where detectors are provided. Safety-related areas without detectors are also identified in Table 9.5-19. These areas have been evaluated for combustible loading and alternate means of determining whether an abnormal condition exists during a postulated fire. The evaluation has also considered radiation zoning (ALARA considerations), safe shutdown equipment and likely ignition sources. The evaluation has indicated that early warning detection is not justified. This is based on the fact that all of the identified areas consist of or contain two or more of the following mitigating factors:

1. Low or negligible fire loading
2. Lack of safe shutdown equipment and cable
3. Lack of safety-related equipment and cable
4. Vestibules, corridors, janitor's closet, or small vertical chases
5. High radiation area
6. Cutoff by barriers with detection in adjacent areas
7. Alternative means of fire detection, e.g., pump overload signals
8. Existing suppression or hazard in containment (charcoal in filter)

FSAR fire hazards analysis tables in Appendix 9A include specific combustible loading and area (sf) for each room.

9.5.1.2.15.2 Fire Protection Status Panel

All fire protection alarms that are sent to the main control room are processed by the fire protection status panel. All alarms are recorded on a dedicated printer and displayed at the fire alarm work station. One common annunciator is also provided on the C800 vertical board in the main control room, which will alarm when any fire protection alarm is received by the fire protection status panel.

The Fire Protection Status Panel is a Proprietary Supervision Station as defined in NFPA 72. The Fire Protection Status Panel is a Foxboro Intelligent Automation (I/A) Series Distributive Controls System (DCS). The I/A Series System is comprised of a series of modules which are microprocessor based each performing specific functions such as control, computations, and operator interface. The center of the I/A Series System node architecture is the Nodebus, a redundant serial bus that interfaces with the process modules. These modules attach directly to the Nodebus and have full communications capability. The main components of the I/A system are the control processors, communications processor, intelligent automation application processor, workstation processor, the workstations and the interface modules (field bus modules).

The Fire Protection Status Panel (Central Panel) receives signals from the Fieldbus Modules, which are enclosed in the Field Enclosures and provide the interface between the local Fire Panels and the Central Panel. The Signaling Line Circuits between the Field Enclosures and the Central Panel are called Fieldbusses which connect the Fieldbus modules to the Control Processors in the central panel. There are three Fieldbusses, each with a series of Field Enclosures connected to it. The arrangement of Control Processors, Fieldbusses and Fieldbus Modules is classified per NFPA 72 as a Style 4 signaling circuit based on the ability to diagnose opens, shorts, shorts to ground and combinations there of.

The Central Panel processes the information such as fire alarms and trouble signals from the local panels and provides an audible-visual alarm on the Control Room Vertical Board C800 along with a printout (permanent record) and displays the information at the workstations (CRT's dedicated to the fire alarm system).

9.5.1.2.16 Emergency Lighting

See Section 9.5.3 for a discussion of emergency lighting.

9.5.1.2.17 Communication System

See Section 9.5.2 for a discussion of the HCGS communication system.

9.5.1.2.18 Primary Containment and Reactor Building Enclosure Fire Protection

There are no provisions for permanently installed manual firefighting facilities within the primary containment. The primary containment is inerted during plant operation. Permanent dry standpipe hose stations and portable extinguishers are provided at strategic locations throughout the reactor building and near the drywell entrances for fire protection of the drywell during plant shutdown. During refueling and maintenance operations in the primary containment, portable fire extinguishers, in addition to the hose stations, are adjacent to the work area and readily available for use by plant personnel. Self-contained breathing apparatus is provided near the containment entrances for firefighting personnel.

9.5.1.2.19 Main Control Room Fire Protection

The walls, floors, and ceiling of the control room complex, which consists of a main control room, shift supervisor room, ready room, store room, instructional viewing area, training room, conference room, computer service room, computer room, toilet, and storage room, are qualified as 3-hour fire-rated barriers.

The walls and doors separating the main control room within the control room complex and from the corridors, instructional viewing area, and ready room are qualified as 1-hour fire-rated

barriers. The control room complex present design is in compliance with BTP CMEB 9.5-1, which requires that the control room complex be separated from other plant areas by 3-hour barriers.

The main control room and rooms adjacent to the control room, ready room, shift supervisor room, and computer room have a very low fire loading mainly due to transient combustibles. The control room is not exposed to a disabling exposure fire hazard in the adjacent supporting facilities rooms, such as the storage rooms, instructional viewing area, corridors, toilets, janitor room, and training/conference room.

Manual firefighting facilities for the main control room consist of portable Halon 1211 extinguishers within the main control room, one water hose station at the radwaste service area that provides coverage for the east portion of the control rooms, and one water hose station in the south corridor of the control area that provides coverage in the west portion of the control room. These water hose stations are outside of the control room and equipped with Class C fog nozzles.

Fires that could develop in the control room should be rapidly extinguished with a portable Halon 1211 extinguisher. In the unlikely event that the fire develops beyond the control capability of the portable extinguishers, water hose stations can be brought into the control room from the adjacent and nearby corridors to extinguish the fire. In the event of a fire requiring manual attack by hose streams, it is

anticipated that the control room personnel would be evacuated, and safe shutdown operation would be performed from the remote shutdown panel room.

A manual Halon 1301 total flooding system is provided for the main control room console and the associated pit. The Halon storage containers or bottles are not permanently connected to the system discharge piping but stored in a room near the main control room. In the event there is a fire in the console pit which cannot be extinguished by portable fire extinguishers, the Halon storage containers are connected to the system discharge piping by quick-connect hoses between cylinder piping and console piping, and then manually actuated. Enough Halon storage containers are stored near the main control room to provide two separate discharges into the hazard area. The manual Halon system is designed in accordance with NFPA 12A, except that discharge time exceeds ten seconds, (discharge time 13.9 seconds). This short time delay will not have a significant effect on the promptness with which the system extinguishes the fire, since a time delay is already anticipated for the fire brigade response to the alarm, and for completing of the necessary flexible hose connections.

Ionization detectors are provided in individual cabinets and consoles in the main control room that contain both redundant shutdown trains. They are provided in addition to the area fire and smoke detection. Alarm and annunciation are provided in the main control room.

The cable or other penetration openings in the control room floor, walls and ceilings are sealed with silicone foam tested to ASTM E 119 criteria, to provide an equivalent fire resistance rating as that of the fire barrier.

9.5.1.2.20 Cable Spreading Room Fire Protection

A preaction sprinkler system is provided for the CSR at Elevation 77

feet of the Auxiliary Building-control area. An automatic CO_2 total flooding system and a manual deluge system as backup are provided for the CSR (Control Equipment Room Mezzanine) at Elevation 117 feet-6 inches of the Auxiliary Building control area. A fire and smoke detection system is provided for early warning of the fire condition. Also, a manual hose standpipe system and portable extinguishers are provided as backup.

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Three-hour floors, walls with Class A fire doors, and ceiling are provided for each CSR. Penetrations are sealed to equivalent barrier rating. Two remotely separated entrances are also provided for access to each CSR.

Redundant safety-related cabling in each CSR meets the requirements of Regulatory Guide 1.75, with exceptions stated in Section 1.8. Auxiliary shutdown capability is provided by redundant systems with cabling independent of both CSR in accordance with the requirements of Appendix R to 10CFR50.

Fire dampers are provided in the supply and return air ducts.

9.5.1.2.21 Computer Room Fire Protection

The computer room walls, ceilings, and floors are 3-hour rated.

The computer room is provided with an automatic smoke detection system that alarms locally and annunciates in the main control room.

The computer room is adjacent to the control room complex and shares the manual hose facilities provided for the control room complex, in addition to the portable extinguishers installed within the computer room.

The Radiation Monitoring System (RMS) computer is located in control equipment room 5605. It is segregated by a gypsum board partition for HVAC and dust control considerations. Early warning smoke detection is provided. Room 5605 is surrounded with rated 3-hour fire barriers.

9.5.1.2.22 Class 1E Switchgear Room Fire Protection

Early warning smoke detectors are provided in all switchgear rooms and MCC and load center areas. Manual hose station and portable extinguishers are readily available.

9.5.1.2.23 Remote Shutdown Panel Fire Protection

The remote shutdown panel is located in the remote shutdown panel room at the floor Elevation 137 feet. Automatic fire detectors alarm locally, and alarm and annunciate in the main control room. Also, portable fire extinguishers and a manual hose station are provided in the adjacent area.

9.5.1.2.24 Station Battery Room Fire Protection

The Class 1E battery room walls, doors, floor, and ceiling are fire-rated as 3-hour barriers. Each battery room for Class 1E batteries has a 100 percent capacity Seismic Category I fan to provide continuous exhaust to the outdoors at a rate that precludes attainment of explosive hydrogen concentrations in the battery rooms. Manual hose stations and portable extinguishers are provided in the vicinity of battery rooms. The "low air flow" remote alarm in the control room registers fan failure conditions. Automatic fire detectors alarm locally, and alarm and annunciate in the main control room.

The exhaust ducts for the ventilation system for certain battery rooms are located at a distance from the ceiling. The NRC expressed concern that a dead-air space existed above the ducts and that hydrogen gas in explosive concentrations might accumulate there. By letter dated December 16, 1985, PSE&G reaffirmed a commitment to maintain the hydrogen gas concentrations in these rooms to not more than 2 percent. This gas concentration has been confirmed by helium testing. On the basis that these tests have confirmed that prevailing room ventilation patterns maintain a hydrogen gas concentration below 2 percent, the NRC considers the location of the exhaust ducts acceptable.

9.5.1.2.25 Turbine Lubrication and Control Oil Storage and Use Areas Fire Protection

The turbine lubrication and control oil storage and use areas are

remote from areas containing safety-related systems, and are separated by 3-hour fire barriers with Class A fire doors.

The condenser area, secondary condensate pump area, RFPT lube oil reservoir and purifier rooms, and RFPT rooms are protected with wet pipe sprinkler systems. The lube oil storage room and the main turbine lube oil reservoir and purifier room are protected by a water spray system.

9.5.1.2.26 Diesel Generator Area Fire Protection

The diesel generators are separated from each other and other areas of the plant by 3-hour fire barriers with Class A fire doors.

One 550-gallon capacity diesel generator fuel oil day tank is located in each diesel generator room. An automatic fixed carbon dioxide total flooding system, actuated by thermal detector, is provided in each diesel generator room. Manual water hose stations are provided as a backup fire suppression system. Early warning ionization and infrared detectors that alarm locally and annunciate in the main control room are provided in each diesel generator room.

Each fuel oil day tank is provided with a dike which surrounds the floor area under the tank. The dike area is also below the equipment access grating that surrounds the diesel generator. Three sides of the dike are made of a 6 inch channel that is bolted to the floor with a neoprene oil resistant gasket. The fourth side is the east wall of the diesel generator room. The floor area within the dike is sloped to a sump area located in the middle of the dike area. No drain is provided to drain the dike area or the sump. However, the dike has sufficient capacity to hold 110 percent of the contents of the fuel oil day tank.

Each diesel generator room drains via normally closed isolation valves to a common drainage sump pump basin that has a sump pump capable of discharging 100 gpm.

The normal ventilation system can be used for manual smoke venting. Each supply and return duct is provided with ETL operated fire dampers which are used to isolate the room when the carbon dioxide total flooding system is actuated.

9.5.1.2.27 Diesel Fuel Oil Storage Area Fire Protection

Two 26,500-gallon diesel fuel oil storage tanks are located in each storage tank room at floor Elevation 54 feet of the diesel building. There are four storage tank rooms, containing a total of 212,000 gallons of storage in the Auxiliary Building diesel area. Each room is enclosed by 3-hour rated fire walls and can hold the contents of both tanks. The diesel area is separated from the control area by 3-hour rated fire walls. The diesel generators are located above the diesel fuel oil storage tanks at floor Elevation 102 feet of the Diesel Building.

Separating floors have a fire resistance rating of 3 hours. Drains are provided to remove possible oil spills and water discharge to a safe location during manual firefighting operation.

An automatic carbon dioxide total flooding system actuated by thermal detectors and a manually actuated deluge sprinkler system are provided in each diesel fuel oil storage tank room. Manual water hose stations are provided as a backup fire suppression system. Early warning flame and smoke detection is provided.

Even though the CO_2 system is not safety-related, the CO_2 systems serving the diesel generator fuel oil storage vaults have seismically qualified components, such as the control panel, master and selector valves, thermal detectors, electro-manual pilot cabinets, and pushbutton stations, to avoid inadvertent discharge of CO_2 during a seismic event. (Reference Section 9.5.1.1.4 and Plant Drawing M-22-0 sheet 5)

To prevent inadvertent discharge of water from the manual deluge systems during a seismic event, the outside screw and yoke gate

valve for each system is kept closed. Since the gate valve is closed, the system can not discharge water unless the operator manually opens the gate valve and the deluge valve. The fire protection in each of the diesel generator fuel oil storage tank rooms consists of an early warning smoke and fire detection system, an automatic CO_2 total flooding system and a manual deluge system, which serves as a backup to the CO_2 system. Firewater hose stations and portable extinguishers are located in adjacent Room 5112.

The early warning smoke and fire detection system consists of two (2) ultraviolet flame detectors and two (2) photo electric smoke detectors mounted on the ceiling. If a fire occurs, the early warning detection system will detect the fire, by either the smoke or flame detectors, and will register an alarm at the local detection control panel and in the main control room.

Thermal detectors are utilized to actuate the automatic CO_2 total flooding system. There are seven (7) thermal detectors per room which actuate at 160°F. A warning alarm will be initiated in the diesel fuel oil storage tank room and on the local CO_2 system control panel, and in the control room prior to the release of CO_2. The alarm will allow personnel in the area sufficient time to evacuate the room prior to the release of the CO_2. The CO_2 system in the rooms can also be manually actuated from a pushbutton station located outside the respective diesel fuel oil storage tank room adjacent to its associated door.

There are two (2) water hose stations located in the corridor outside of the diesel fuel oil storage tank rooms. Each station is equipped with a hose capable of reaching into the diesel fuel oil storage tank room with at least one hose stream to combat fires.

The final permanently installed system to combat fires in the diesel fuel oil storage tank rooms is the deluge system. This system is actuated by manually opening a gate valve and actuating a pushbutton on the local control panel or a pushbutton station located next to the entrance door.

The fire alarms for the early warning fire and smoke detection system and the thermal detection for the CO_2 flooding systems are registered locally and in the control room on the fire protection status panel (10C671).

The location of the detector registering an alarm is printed out at the fire protection status panel in the order that the alarms are received. The receipt of an alarm, indicating fire, without first the receipt of an early warning alarm would indicate a possible spurious actuation of the CO_2 system. This information would be passed to the fire brigade dispatched to investigate the cause of the alarm.

Fire brigade personnel dispatched to investigate fire alarms will be briefed in the methods to be utilized to determine if an alarm is spurious or if there is an actual fire condition.

Design features of the fire protection system and personnel training programs, in response to fire alarms, will prevent the inadvertent actuation of the deluge system, in the diesel fuel oil storage tank rooms, if the CO_2 system is inadvertently actuated and/or a spurious alarm is received. In addition, if the system has been actuated, the other three tank vaults and equipment are available for use by the diesel generators.

Fire Brigade Personnel training will include initial actions upon arrival at the fire scene. For the diesel fuel oil storage tanks this will include:

1. Door exterior elevated temperature or discoloration

2. Failure of the cardox discharge system to discharge following an initiation signal.

9.5.1.2.28 Safety-Related Pump Fire Protection

Fire hazard analyses considering combustible loadings and fire exposures do not indicate a requirement for additional automatic fire suppression in any safety-related pump area to minimize potential damage to safety-related equipment required for safe plant shutdown. Early warning fire detection is provided in all safety-related pump rooms having combustible loading greater than 8000 Btu/ft^2, with alarm and annunciation both locally and in the main control room. Local hose stations and portable extinguishers are provided in the vicinity of all safety-related pump rooms. For separation of redundant safety-related pumps required for safe shutdown, see Appendix 9A.

9.1.2.29 New Fuel Area Fire Protection

Portable extinguishers and hose stations are provided in the vicinity of the new fuel area. Automatic smoke detection is also provided by photoelectric beam type smoke detectors installed on the reactor building wall just above the polar crane for alarm and annunciation both locally and in the main control room.

A 4-inch curb is provided all around the top edge of the new fuel vault. The new fuel vault is provided with a steel plate cover. Thus, water inadvertently spilled on the refueling floor, which is at floor elevation 201 feet, will not drain into the vault. Furthermore, a 6-inch floor drain is located at the bottom of the vault at floor Elevation 181 feet 4 inches to preclude accumulation of water.

9.5.1.2.30 Spent Fuel Pool Area Fire Protection

A hose station and portable extinguishers are provided in the vicinity of the spent fuel pool. Automatic smoke detection is provided by photoelectric beam type smoke detectors installed on the reactor building wall just above the polar crane for alarm and annunciation both locally and in the main control room.

9.5.1.2.31 Auxiliary Building Radwaste/Service Area Fire Protection

Except as noted in Appendix 9A, the radwaste/service area is separated from the control area, Reactor Building, and Turbine Building by 3-hour fire barriers with Class A fire doors.

The Radwaste Area Ventilation System can be isolated.

All drainage in the radwaste area is directed to the liquid radwaste sumps.

Wet pipe sprinklers are provided for the solid radwaste area. A preaction sprinkler system is provided for the radwaste truck loading area and solid radwaste filled drum storage area.

Hose stations, portable extinguishers, and smoke detectors are provided in the solid radwaste area. Smoke detectors annunciate and alarm in the main control room, and also alarm locally.

Automatic sprinkler protection is provided for the radwaste service area facilities such as the locker area, machine shops, clean store rooms, and chemistry laboratory storage room. Water flow in the sprinkler system, due to opening of a sprinkler head or heads, annunciates and alarms locally and in the main control room.

The radwaste service area is provided with early warning smoke detection, a manual hose station, and portable extinguishers. Smoke detectors annunciate and alarm in the main control room, and also alarm locally.

9.5.1.2.32 Decontamination Area Fire Protection

Hose racks and portable extinguishers are provided in the vicinity of the decontamination room at floor Elevation 102 feet in the auxiliary building radwaste area. The access control area in the radwaste service area at floor Elevation 137 feet has automatic

sprinklers based on ordinary hazard occupancy schedule, in addition to hose stations and portable extinguishers. Automatic early warning smoke detection is also provided for these areas.

The use and storage of flammable liquids utilized for decontamination purposes is controlled by an NBU administrative procedure(s) describing/controlling the Station Fire Protection Program.

9.5.1.2.33 Safety-Related Water Storage Tanks

There are no onsite Seismic Category I water tanks located outdoors to supply water for safe shutdown. Both the Safety Auxiliary Cooling System (SACS) expansion tank at floor Elevation 201 feet and standby liquid control (SLC) tank at floor Elevation 162 feet are located in the Reactor Building. The SACS supply side and return side accumulators are located at floor elevation 54 feet of the Auxiliary Building diesel area. There is no significant combustible material nearby that affects these storage tanks and accumulators. Local hose stations and portable extinguishers are provided in the vicinity of these storage tanks.

9.5.1.2.34 Miscellaneous Areas Fire Protection

The cooling tower is located such that a fire will not adversely affect any safety-related systems or equipment. The cooling tower basin is not used for the ultimate heat sink or fire water supply.

Warehouse, machine shop, asphalt storage, record storage, and auxiliary boilers are remote from safety-related systems and equipment. The fuel oil storage and day tanks for the auxiliary boilers are located outdoors and provided with dikes to contain 110 percent of tank capacity.

The permanent storage of welding/cutting acetylene oxygen fuel gas is not permitted in areas housing safe shutdown equipment or cabling.

Storage areas for dry ion exchange materials, such as dry unused resins, are remote from essential safety-related systems. Hazardous chemicals are also stored remote from safety-related areas.

The handling of solid radwaste materials is discussed in Section 11.4. The solid radwaste area located at the north end of the Auxiliary Building radwaste service area at Elevations 102, 124 and 137 feet is provided with automatic wet pipe and preaction sprinkler systems, early warning detection, local hose stations and portable fire extinguishers as shown in Plant Drawings M-5003, M-5004 and M-5005. Also the solid radwaste area is separated from other areas of the Auxiliary Building by fire barriers with a minimum rating of 2-hours fire barrier.

Except for the intake structure, all yard buildings contain no safety-related equipment, and there are negligible combustible material located near safety-related buildings, i.e. Reactor Building, Auxiliary Building control and diesel area, and the intake structure.

9.5.1.3 Safety Evaluation

The safety evaluation for the FPS is included in Appendix 9A, Fire Protection Evaluation.

9.5.1.4 Inspection and Testing Requirements

9.5.1.4.1 Preoperational Testing

Fire protection systems and equipment are acceptance tested in accordance with the manufacturer's recommendations, and the applicable NFPA design and installation standards. The preoperational testing program is described in Section 14.2.

9.5.1.4.1.1 Pumps

Each fire pump is subjected to a factory hydrostatic test at not less than 250 psig, is performance certified, and is accepted after installation and field testing to 150 percent of rated capacity.

9.5.1.4.1.2 Piping

All systems, including yard piping are hydrostatically tested at not less than 200 psi for two hours. Alarm valves, deluge valves, strainers, trim piping and all components are tested for operative condition.

9.5.1.4.1.3 Halon Extinguishing System

Upon completion of installation, the Halon extinguishing systems are tested for correct operation and function. All system piping is pneumatically tested to a pressure of 450 psig. During this test, the joints are inspected using soap and water solution and are proven leaktight. Also, all check and block valves are checked to see if they hold pressure. Tests also include actual operation of mechanical and electrical equipment.

9.5.1.4.1.4 Carbon Dioxide System

Upon completion of installation, the carbon dioxide systems are tested for correct operation and function. All integral piping and fittings which are normally under continuous pressure are bubble tested with carbon dioxide at 300 psig and are proven leaktight. All other pipe is pneumatically tested to 300 psig. Tests also include actual operation of mechanical and electrical equipment.

9.5.1.4.1.5 Mechanical Foam System

Upon completion of installation, the mechanical foam system is tested for correct operation and function. All system piping and

fittings are hydrostatically tested to a pressure not less than 200 psig and are proven leaktight. All operating parts, including automatic detection equipment, are fully tested for operative condition.

9.5.1.4.1.6 Smoke and Fire Detection System

The smoke and fire detection system is tested for correct operation and function in accordance with NFPA 72E.

9.5.1.4.2 Operational Testing and Inspection

Administrative controls are provided through existing NBU, Fire Protection and Hope Creek Station Administrative Procedures, Station Operating Procedures and the Operational Quality Assurance Program to ensure that the Fire Protection Program and equipment is properly maintained. This includes Nuclear Oversight audits and performance based assessments of the program implementation, conduct of periodic test inspections, and remedial actions for systems and barriers out of service. This program emphasizes those elements of fire protection that are associated with safe shutdown as described in Appendix 9A and their significance when evaluating program and equipment deficiencies.

All fire protection equipment and systems are subject to a complete inspection and acceptance test in accordance with the National Fire Codes after installation is completed. After the plant is in operation, periodic inspections and tests will be conducted as defined by the Fire Protection Program utilizing the National Fire Codes as guidance based on the performance history of the equipment and equipment accessibility. The following fire protection features will be subjected to periodic tests and inspections:

A. Fire alarm and detection systems
B. Wet pipe automatic sprinkler systems
C. Water spray systems
D. Preaction water spray systems
E. Preaction sprinkler systems
F. Carbon dioxide total flooding systems

G. Halon systems
H. Foam systems
I. Fire pumps
J. Fire barriers (walls, fire doors, penetration seals, fire dampers)
K. Manual suppression (fire hoses, extinguishers, hydrants)

Installation of internal conduit seals is in accordance with approved details and falls within the scope of the fire protection quality assurance program ('F' Program). The modification of internal conduit seals is controlled by Administrative Procedures. Based on this configuration management, limited access to internal conduit seals, the seals material qualification for the station's service life and small contribution to risk of fire propagation, regularly scheduled inspections of internal conduit seals are not performed.

Equipment out of service, including fire suppression, detection, and barriers, will be controlled through the administrative program and appropriate remedial actions taken. The program requires all impairments to fire protection systems to be identified. Based on the condition, engineering analysis may be required to determine the extent of the fire hazard to safe plant operations. As conditions warrant, remedial actions would include compensatory measures to ensure an equivalent level of fire protection in addition to timely efforts to effect repairs and restore equipment to service.

Routine surveillance testing of the fire protection system in nonsafety-related areas of the plant will be performed in accordance with the applicable NFPA design and installation standards as modified by the performance history of the equipment and equipment accessibility.

9.5.1.5 Organization Personnel Qualification and Training

9.5.1.5.1 Organization for Fire Protection

The President & Chief Nuclear Officer is the upper level on-site management position who has management responsibility for the formulation, implementation, and assessment of the effectiveness of the Fire Protection Program.

The Director, Engineering Services is the management position who is responsible for formulating and implementing a program or programs to control and maintain the design aspects (i.e. evaluate design changes and plant modifications for impact of the fire hazards analysis) of the Fire Protection program.

The Director, Corporate Operations is the management position who is responsible for formulating and implementing a program or

programs to control and maintain fire prevention aspects of the Fire Protection Program and the readiness to detect and suppress fires and safely shut down the plant.

The Director, Corporate Operations is responsible for establishing a method of tracking and correcting Fire Protection Program deficiencies; establishing program requirements for implementing the aspects of the Fire Protection Program relative to fire prevention and housekeeping, readiness to detect and suppress fires, and a trained fire brigade; and ensuring any required maintenance of fire protection systems is completed promptly and effectively.

The Plant Manager is responsible for maintaining procedures for safely shutting down the plant in the event of a fire and providing trained operators in support of safe shutdown and fire brigade activities.

The fire brigade responds to the Shift Manager during plant emergencies.

The Plant Manager is responsible for ensuring that personnel designated to operate the plant are trained such that they can safely shut down the plant and maintain it in a safe shutdown condition in the event of a fire.

The Director – Nuclear Oversight (NOS) is the management position responsible for defining a QA program for fire protection and for conducting independent verification and review for compliance with Fire Protection Program requirements.

9.5.1.5.2 Fire Brigade Organization, Training, and Equipment

The Hope Creek Fire Brigade is comprised of dedicated personnel from a five person trained fire fighting team capable of responding to a fire in either Hope Creek or Salem nuclear plants. At least three of the five-person team will be sufficiently knowledgeable in Hope Creek safety systems to understand the effects of fire and fire suppressants on safe shutdown capability. The fire brigade members will be required to satisfactorily complete a physical examination for performing strenuous activity and the fire brigade training program which includes testing of fire protection equipment and systems.

The fire brigade will be provided with personal protective clothing, emergency communication equipment, portable lights and portable ventilation equipment.

Portable extinguishers will be available throughout the plant. At least ten self-contained breathing units with a minimum of 30 minute rating will be available for fire brigade personnel. Additional self-contained breathing units will be available for control room personnel. At least two extra air bottles per unit will be located on site. In addition, a six hour supply of reserve air will be provided by means of a breathing air compressor and stored air available to Salem or Hope Creek stations.

Fire protection training will be conducted in accordance with the guidelines of the SRP (NUREG 0800) Section 13.2.2.II.6, 10CFR50 Appendix R and Branch Technical Position CMEB9.5.1, Section C.3.d. This training will include classroom instruction, hands-on fire extinguishing and plant drills. The training covers, but is not limited to the following:

1. Indoctrination of the plant fire fighting plan.
2. Identification of fire hazards.
3. The properties of the product of combustion.
4. Identification and use of all fire fighting equipment.
5. The proper use of communication, lighting, ventilation, and emergency breathing equipment.
6. Familiarization with the layout of the plant, including access and egress routes to each area.
7. Correct method of fighting fires, including fires in energized electrical equipment, fires in cable and cable trays, hydrogen fires, fires involving flammable and combustible liquids or hazardous process chemicals, fires resulting from construction or modifications (welding) and record file fires.
8. The direction and coordination of the fire fighting activities (site fire brigade leaders only).
9. Detailed review of fire fighting strategies and procedures.
10. Review of the latest plant modifications and corresponding changes in fire fighting plans.

The classroom instruction includes the following course material:

1. Fire Fighting Plan
    a. Response to alarms
    b. Responsibility of members
    c. Reason for fire brigade

2. Identification of Fire Hazards

   a. Concept of fire

   b. Properties of flammable and combustible liquids

   c. Hazardous chemical properties

   d. Boiling liquid, expanding vapor explosion

3. Products of Combustion

   a. Products of burning plastics

   b. Products of smoke

   c. Properties of carbon monoxide

   d. Properties of contaminated smoke

   e. Effects of heat

   f. Ventilation

4. Fire Fighting Equipment

   a. Fire detection

   b. Fire suppression

5. Types of Fires

6. Auxiliary Equipment

7. Plant Modifications

Actual hands on fire extinguishing is conducted to provide brigade members with actual fire extinguishing and the use of emergency breathing apparatus under strenuous conditions. These practice sessions are held at least once per year for each site fire brigade member.

Plant drills are held at specified intervals, not to exceed three months, for each shift to allow site fire brigade members the opportunity to practice as a team and to ensure adequate procedures and readiness. Each site fire brigade member must participate in at least two drills per year.

Each drill is preplanned to establish training objectives and is critiqued to determine how well the training objectives have been met. Performance deficiencies noted are remedied by additional training. Records regarding drill attendance, deficiencies and follow-up training requirements are maintained by the Nuclear Training Center.

Fire drills, as a minimum, assess the fire alarm's effectiveness, time to assemble the site fire brigade, use of the fire fighting equipment, fire fighting strategies and the effectiveness of the Brigade Leader.

Each drill includes the simulated use of fire fighting equipment required to cope with the situation and type of fire selected for the drill. The area and type of fire chosen for the drill differ from those used in the previous drill so that brigade members are trained in fighting fires in various plant areas. The situation selected simulates the size and arrangement of a fire that could reasonably occur in the area selected, allowing for fire development due to the time required to respond, to obtain equipment, and organize for the fire, assuming the loss of automatic suppression capability.

At least one drill per year is performed on a back shift for each shift on the site fire brigade.

At least one drill for each shift of the site fire brigade per year is unannounced to determine the fire fighting readiness of the site fire brigade, brigade leader, and fire protection systems and equipment. Personnel planning and authorizing an unannounced drill ensure that the responding site fire brigade members are not aware that a drill is being planned until it is begun. Unannounced drills are not scheduled closer than four weeks.

Unannounced drills are planned and critiqued by members of the management staff responsible for plant safety and fire protection. Performance deficiencies of a shift of the site fire brigade or individual site fire brigade members are remedied by scheduling additional training for the brigade or members. Unsatisfactory drill performance is followed by a repeat drill within thirty days.

At three year intervals, a randomly selected unannounced drill is critiqued by qualified individuals independent of the licensee's staff. A copy of the written report from such individuals is available for NRC review.

Regularly planned meetings are held every three months for site fire brigade members to review changes to the program.

Periodic refresher training repeats classroom instruction over a two year period. These sessions may be concurrent with planned meetings.

Training of the site fire brigade is coordinated with the local fire department so that responsibilities and duties are delineated in advance. This coordination is part of the training course and is included in the training of the local fire department staff.

Local fire departments are provided training in operational precautions when fighting fires on nuclear power plant sites and are made aware of the need for radiological protection of personnel and the special hazards associated with a nuclear power plant site.

Instruction is provided by qualified individuals who are knowledgeable, experienced and suitably trained in fighting types of fires that could occur in the plant and using types of equipment available in nuclear power plants.

Instruction is provided to employees on fire protection topics within General Employee Training. Instruction is given on 1) the fire alarm system, 2) the evacuation routes, and 3) the procedure for reporting a fire.

Instruction is provided for security personnel that addresses 1) entry procedures for outside fire departments, 2) crowd control for people exiting the station, and 3) procedures for reporting potential fire hazards observed when touring the facility.

Instruction is provided to Nuclear Fire Protection Supervisors that addresses safety systems.

Instruction is provided to temporary employees so that they are familiar with 1) evacuation signals, 2) evacuation routes, and 3) the procedure for reporting fires.

9.5.1.5.3 Administrative Controls

Administrative controls are implemented at Hope Creek for the purpose of controlling combustible and hazardous materials, controlling ignition sources, controlling fire protection system impairments and testing fire protection equipment and systems.

Procedures are established for governing actions to be taken in the event of a fire for general employees, control room personnel, fire brigade members and other required support groups. Prefire plans are written for all safety-related areas.

Administrative Procedures are available for review. Procedures are implemented for all areas where new fuel is to be stored prior to receiving fuel on site. The fire protection program was implemented in its entirety prior to fuel load.

9.5.1.6 <u>SRP Rule Review</u>

All differences and clarifications discussed below are differences and clarifications to BTP CMEB 9.5-1, Revision 2, dated July 1981.

HCGS has implemented the requirements of BTP CMEB 9.5-1 Revision 2, dated July 1981 per NUREG 0800 (SRP 9.5.1, Revision 3) in the development of the fire protection program and in the design and installation of the fire protection systems. HCGS is in compliance with the BTP requirements, with deviations as identified in Section 9.5.1 and Appendix 9A.

9.5.1.6.1 Paragraph C.1.c.(2)

Paragraph C.1.c.(2) requires that a single active failure or crack in a moderate-energy line in the fire suppression system should not impair both the primary and backup fire suppression capability.

At HCGS, automatic and manual sprinkler/spray systems headers are connected to inplant loops that are fed from the main underground fire protection water piping or yard loop by two separate lines. Since the inplant loops are fed by two separate supplies, they are considered an extension of the main underground yard loop. Except for the radwaste/service area, elevator shaft, and machine room for elevator 11-02 in the Turbine Building, the administration facility, Unit 2 control area office space at Elevation 137 ft and elevator shaft and machine room for elevator 51-01 in the control area, the automatic and manual sprinkler/spray systems and hose stations serving a single area, including safety-related areas, have takeoffs from the inplant loop, separated by sectional control valves normally locked open. The header arrangement is such that, by manual positioning of the sectional valves, no single piping failure can impair both the primary and backup fire water protection provided for a single area. Onsite hose, yard hydrants, adjacent area hose station, and available pumping capability provide added assurance that all power block areas can be reached with an effective hose stream after any single piping failure.

In addition, the automatic water sprinkler/spray systems, manual foam system, and fire water hose stations or hydrants serving the circulating water pump structure and the nonsafety-related 1,000,000-gallon fuel oil storage tank located in the yard are each fed from the main underground yard loop by one feed line. A single break in the feed line can impair both the primary and backup fire water protection.

A single failure of the fire water piping serving the above areas and buildings will not affect safe shutdown of the plant. HCGS is

designed for separation of redundant safe shutdown trains to meet the requirements of Appendix R to 10CFR50 to the extent noted in Appendix 9A.

9.5.1.6.1.1 Paragraph C.4

Paragraph C.4 requires that the quality assurance program of the contractors should ensure that the guidelines for design, procurement, installation and testing of the fire protection systems for safety related areas are satisfied.

For HCGS, the fuel oil tank, the fire pumps and associated controls, and the fire protection water spray systems, the carbon dioxide systems and the early warning smoke and fire detection systems in safety related areas are covered under the fire protection quality assurance program ('F' program). The 'F' program was formally implemented, effective July 1, 1978. In view of that, certain fire protection system components purchased and installed prior to July, 1, 1978, such as the fire water storage tanks, the tank heaters and associated controls and the valve pit unit heaters are excluded from the 'F' program during the construction phase. They will be maintained under the "F" program after fuel is delivered to the site.

9.5.1.6.2 Paragraph C.5.a.(1)

Paragraph C.5.a.(1) requires separation of redundant divisions or trains of safety-related systems from each other and from any potential fires in nonsafety related areas.

HCGS complies with the requirements of Appendix R to 10CFR50 with regards to redundant division separation with deviations as noted in Appendix 9A, Section 9A.6.0. Branch Technical Position fire barriers are shown on UFSAR Figure 9.5-46 and Plant Drawings M-5102 through M-5111. All plant fire barriers, including those required by our insurance carrier, are shown on Plant Drawings M-0001 through M-5013 and M-5101.

9.5.1.6.3 Paragraph C.5.a.(3)

Paragraph C.5.a.(3) requires that openings inside conduit larger than 4 inches in diameter be sealed at the fire barrier penetration. Openings inside conduit 4 inches or less in diameter should be sealed at the fire barrier unless the conduit extends at least 5 feet on each side of the fire barrier and is sealed either at both ends or at the fire barrier with material to prevent the passage of smoke and hot gases.

At HCGS, specific internal conduit sealing requirements to control flame spread and the propagation of combustible products (smoke and hot gases) have been established. The sealing requirements are similar to SRP guidelines and the requirements contained in the Technical Evaluation Report dated May 12, 1989 which supports the Safety Evaluation Report issued to Wisconsin Electric Power Company on October 23, 1989. In addition, PSE&G has supplemented the Technical Evaluation Report by evaluating specific conduit configurations for sealing requirements based on plant specific fire severities, locations of safe shutdown equipment and the availability of fire detection and suppression systems. These supplemental requirements are documented in various engineering evaluations. Conduits terminating in equipment are not sealed.

Where bus ducts penetrate fire barriers, the penetrations are sealed with fire-rated material between the wall opening and the outside of the bus duct. The NRC staff expressed concern that if the inside of the bus duct was not sealed, smoke and hot gases might pass through the opening and damage shutdown-related systems on both sides of the barrier. However, where bus ducts penetrate the fire barriers surrounding the four emergency diesel generator rooms, PSE&G has committed to seal the internals of the bus ducts with a silicone elastomer. The detailed description of this seal and a supporting fire test and analysis were submitted by letter dated November 21, 1985.

Silicone-based fire barrier penetration seals are used over combustible filler in seismic joints, where the configuration is a fire seal. The silicone foam is not considered in the analysis of combustible loads.

Appendix 9A states that unprotected bus ducts penetrate the common fire barrier between rooms 5301 and 5339 in the auxiliary building fire area AB1. However, room 5339 is protected by an automatic sprinkler system, with four nozzles located to spray water directly at the duct penetrations. The NRC staff, therefore, has reasonable assurance that a fire, if one should occur, would be limited to the room of origin and would not damage redundant shutdown systems in both locations.

The remaining unprotected bus duct penetrations in the turbine and auxiliary buildings are located in fire barriers that neither separate redundant shutdown systems nor segregate significant unmitigated fire hazards. Therefore, these conditions represent an acceptable deviation from Section C.5.a of the NRC staff's fire protection guidelines.

By letter dated August 27, 1985, PSE&G provided the results of a structural analysis on cable tray supports in plant locations that are not protected by an automatic fire suppression system. This analysis was based on an assumption of a worse case fire scenario. On the basis of this analysis, it was demonstrated that the stresses resulting from deadweight of the tray will not cause failure of the tray or the penetration seals. Because of the conservative assumptions made in conjunction with this analysis, and because any fire in these locations is expected to be detected and suppressed at an early stage by the plant fire brigade, the NRC staff concludes that the penetration seals will remain in place and the integrity of the fire barrier will not be affected. In those locations protected by an automatic fire suppression system, the NRC staff expects any potential fire to be detected and controlled before significant fire propagation or room temperature rise occurred. The cable trays that are routed through the penetration seals will not experience the elevated temperatures required to cause their failure. The NRC staff, therefore, concludes that, in areas protected by an automatic fire suppression system, the penetration seals will remain in place. On the basis of this evaluation, the NRC staff concludes that the installation of seals at cable tray penetrations of fire barriers is acceptable.

9.5.1.6.3.1 Paragraph C.5.a.(3)

Paragraph C.5.a.(3) requires that openings in fire barriers for pipe, conduit and cable trays which separate fire areas should be sealed or closed to provide a fire resistance rating at least equal to that required of the barrier itself.

At HCGS, the non-segregated phase bus ducts from the station service transformers penetrate through various 2 and 3 hour fire barriers in the Turbine and Auxiliary Buildings. The penetrations are sealed with fire barrier material between the wall openings and the outside of the bus duct, but the ducts are not sealed internally at each fire barrier penetration with fire sealant material. For fire barriers which do not separate safe shutdown equipment, safe shutdown of the plant will not be affected, even if a fire did spread to both sides of the barriers. See Appendix 9A for discussion of the duct penetration in fire barriers that separate safe shutdown areas.

Also, at Elevation 137 feet of the Turbine Building there are six 12-foot by 10-foot, six 7-foot by 7-foot, and two 11-foot by 11-foot openings in the 3-hour fire-rated floor between the moisture separator areas and the condenser area below. The openings are provided for the turbine combined intermediate valves (CIVs) and associated piping, moisture separator piping, and access to platforms below and are also used for ventilation. Since the moisture separator areas and condenser area do not contain any safe shutdown equipment, a fire in these areas will not affect safe shutdown of the plant.

9.5.1.6.3.2 Paragraph C.5.a.(4)

Paragraph C.5.a.(4) states that penetration openings for ventilation systems should be protected by fire dampers having a rating equivalent to that required of the barrier.

At HCGS, fire barriers that separate safe shutdown areas are provided with fire dampers of equivalent fire rating in penetration openings for ventilation systems, except as noted in Appendix 9A.

Miscellaneous fire barriers in the Turbine Building, Auxiliary Building radwaste service area, and yard buildings that do not separate safe shutdown areas are provided with fire dampers of equivalent fire rating in penetration openings for ventilation systems, except as noted below.

1. Turbine Building

   a. Two openings through 3 hour rated floor of steam seal evaporator room 1508 at Elevation 137 feet.

   b. Five openings in the Turbine Building Supply (TBS) have Ruskin fire dampers with maximum listed springs which have not been qualified to fully close against the design air flowrates.

   c. Two openings in the Turbine Building Oily Exhaust (TBOE) have Ruskin fire dampers with maximum listed springs which have not been qualified to fully close against the design air flowrates.

2. Auxiliary Building radwaste service area

   a. Two openings through 2 hour rated floor of elevator machine room 3701 at elevation 174 feet.

   b. One opening through 2 hour wall between janitor's room 3304 and men's toilet room 3303 at elevation 102 feet.

   c. Four openings in the Chem Lab Exhaust (CLE) have Ruskin fire dampers with maximum listed springs which

have not been qualified to fully close against the design flowrates.

Since the openings listed above are not in fire barriers that separate safe shutdown areas, fire involving areas located on either side of the fire barriers will not affect safe shutdown of the plant.

9.5.1.6.5 Paragraph C.5.a.(5)

Paragraph C.5.a.(5) require door openings in fire barriers be protected with equivalently rated doors, frame, and hardware that have been tested and approved by a nationally recognized laboratory.

At HCGS, Underwriter's Laboratories (UL) or Factory Mutual (FM) labeled doors are used at door opening in fire barriers and have a fire rating consistent with the fire rating of the fire barrier. However, several of the doors which are used in 3-hour fire barriers exceed the maximum size for which UL or FM labeled doors are available. The door supplier has provided a UL or FM Certificate of Inspection which states that except for being oversized, the doors comply with all other requirements for design, materials and construction. This certificate has been accepted by the insuring authority as compliance with the requirement to provide a 3-hour fire rated door.

9.5.1.6.5 Paragraph C.5.a.(8)

Paragraph C.5.a.(8) requires each CSR to contain only one redundant safety division.

At HCGS, the CSR and the control equipment room mezzanine contain cables from both safety divisions. In the unlikely event of a fire in one of the two rooms, the cables affected by the fire can be electrically isolated at the remote shutdown station, and safe shutdown can be performed from the remote shutdown panel. The remote shutdown capability provided is independent of either of

the two rooms. The HCGS design complies with the requirements of Appendix R of 10CFR50 to the extent noted in Appendix 9A.

9.5.1.6.6 Paragraph C.5.a.(13)

Paragraph C.5.a.(13) requires that outdoor oil filled transformers be located at least 50 feet distant from the building, or by ensuring that such building walls within 50 feet of oil filled transformers be without openings and have a fire resistance rating of at least 3 hours.

At HCGS, the oil filled transformers, such as the main transformers and the station service transformers, are located less than 50 feet from the Turbine Building and circulating water pump structure walls. All building walls facing the transformers have a fire resistance rating of 2 hours, and are not entirely free of openings. No safe shutdown equipment is located in these two buildings.

Since each transformer is protected by an automatic water spray system, the location of the transformers in the yard with respect to adjacent buildings is considered satisfactory from a fire protection point of view. The location of the transformers, the rating of the building walls, and the automatic water spray system meet the insuring authority's recommendations.

9.5.1.6.7 Paragraph C.5.b

Paragraph C.5.b requires one safe shutdown train be free of fire damage by separation of redundant shutdown trains by a 3-hour fire barrier or other alternates.

HCGS complies with Appendix R to 10CFR50 requirements for separation of redundant safe shutdown trains, except as noted in Appendix 9A, Section 9A.6.0.

9.5.1.6.8 Paragraph C.5.c

Paragraph C.5.c requires alternative or dedicated shutdown capability if guidelines of paragraph C.5.b(1) and C.5.b(2) are not met.

HCGS has the capability to remotely shut down the reactor from outside the control room in the event of a fire in the control room. In a submittal dated April 8, 1986 (C. McNeill, PSE&G, to E. Adensam, NRC), PSE&G provided the results of the analysis concerning the possibility of spurious signals at high/low pressure interfaces in the event of a fire in the control room (in conformance with the guidelines in SRP Section 9.5.1). The submittal identified three high/low pressure interfaces. One interface is the suction line of the residual heat removal (RHR) systems and the two normally closed containment isolation valves (BC-HV-F008 and -F009). The power is disconnected from at least one of these valves during normal plant operation (operational modes 1 and 2).

The second high/low pressure interface is the RHR return line to the reactor vessel for normal shutdown cooling and the core spray system return line. These lines contain an outboard motor-operated valve and an inboard check valve with a 1-inch bypass line around the check valves. These bypass lines also contain a solenoid-operated valve. To prevent a spurious signal from opening the two valves in series and thereby creating a loss-of-coolant accident (LOCA), PSE&G had committed to have power removed from the solenoid-operated valves in the bypass line during normal plant operation. However, a subsequent evaluation of this event demonstrated that the results of this spurious actuation were acceptable. Power was reconnected to the RHR and core spray system solenoid valves. The results of the evaluation are discussed in Appendix 9A.

In the event of a fire in the control room, the spurious opening of one relief (or automatic depressurization system) valve will not result in core uncovery through this high/low pressure interface.

Based on this, HCGS complies with the above alternative shutdown requirements. For meeting additional requirements in Appendix R to 10CFR50 regarding alternate shutdown capability, see Appendix 9A.

9.5.1.6.9 Paragraph C.5.e.(2)

Paragraph C.5.e.(2) requires redundant safety-related cable systems outside the cable spreading room to be separated from each other and from potential fire exposure hazards by a 3-hour fire rated barrier or protect them with automatic water systems.

In general, HCGS complies with the requirement for separation. For HCGS's differences and justifications from this requirement, see Appendix 9A.

9.5.1.6.10 Paragraph C.5.e.(2)

Paragraph C.5.e.(2) requires that redundant safety-related cable trays outside the cable spreading room be provided with continuous line type heat detectors.

At HCGS, except for the torus area, continuous line type heat detectors are not provided. Instead, photoelectric and ionization detectors are installed in most areas where safety-related cable trays are located to detect fires. See Appendix 9A, Table 9A-1 for specific safety-related areas where detectors are provided. These detectors are adequate for use with cables that meet the IEEE 383 flame test requirements. The ionization detectors will alarm at detection of invisible particulate matter during the incipient fire stage and the photoelectric detection will alarm at presence of visible smoke from any exposure fire. The detection system fire alarms annunciate locally and in the main control room.

The same paragraph also requires that safety-related cable trays outside the cable spreading room be protected from the effects of a potential exposure fire by providing automatic water suppression in the area where such a fire could occur.

At HCGS, most safety-related cable trays of a single division located outside the cable spreading room are separated from redundant divisions by a 3-hour rated fire barrier, but only the

safety-related areas listed in Section 9.5.1.1.14 that have high concentration of cable trays are provided with an automatic water suppression system. The HCGS design meets the separation requirements of Appendix R of 10CFR50, to the extent noted in FSAR Appendix 9A. With the inclusion of the remote shutdown station, a fire in any one fire area will not prevent safe shutdown of the plant.

Certain types of electrical cable used in the plant are not IEEE 383 qualified. The NRC staff was concerned that if large quantities of such cable were installed, this would significantly increase the risk from fire. In response to the NRC staff's concern, PSE&G, by letter dated December 16, 1985, provided clarification as to the nature and extent of unqualified cable at Hope Creek. In all locations where such cable is found, the nonqualified cable is in conduit, is installed in a non-safety-related area, is located in an area protected by an automatic fire suppression system, and/or is routed in small quantities such as one or two cables to individual computer terminals. On this basis the NRC staff concludes that the installation of unqualified cable at Hope Creek is an acceptable deviation from Section C.5.e of BTP CMEB 9.5.1.

9.5.1.6.11 Paragraph C.5.g.(1)

Paragraph C.5.g.(1) requires fixed self-contained lighting consisting of fluorescent or sealed beam units with individual 8-hour minimum battery power supplies be provided for access and egress routes to and from all fire areas.

At HCGS, emergency light units with at least 8-hour battery power supply are provided in all areas needed for operation of safe shutdown equipment in the event of fire and in access and egress routes thereto per 10CFR50, Appendix R, Section III. J. See Section 9.5.3 for specific areas where emergency lights are provided.

9.5.1.6.12 Paragraph C.5.f.(1)

Paragraph C.5.f.(1) requires smoke and corrosive gases generally be discharged directly outside and separate smoke and heat vents be provided for cable spreading rooms, diesel fuel oil storage areas, switchgear rooms, and other areas where potential exists for heavy smoke conditions.

As stated in Section 9.5.1.1.15.1, smoke and corrosive gases are generally discharged to the outside using the normal ventilation system and a separate smoke removal system provided for the control area. Since the switchgear rooms and diesel generator control rooms, at floor Elevation 130 feet, and the heating and ventilation equipment rooms, control equipment room and inverter rooms, at floor Elevation 163 feet 6 inches of the diesel area, are not provided with direct exhaust to the outside, portable blowers will be provided for the fire brigade to use as smoke ejectors. Smoke will not be ejected through areas housing smoke sensitive electronic equipment of the redundant division.

All battery rooms are provided with air exhaust systems that can discharge smoke and gases directly outside.

9.5.1.6.13 Paragraph C.5.g.(3)

Paragraph C.5.g.(3) states that a fixed emergency communication system independent of the normal plant communication system should be installed at preselected stations.

HCGS has no fixed emergency communication system that is solely provided for emergency situations. The plant has an intraplant, five channel, page-party, public address (PA) intercom system. The inplant communication system is provided with reliable uninterruptible power supply (UPS) for uninterrupted communications between all areas of the plant. At least one channel of the PA system will be assigned for emergency use. In addition, portable radio communication units, sound powered phones and telephones will

also be available during an emergency situation. No single fire can prevent at least one of the plant communication systems from operating.

9.5.1.6.14 Paragraph C.6.a.(2)

Paragraph C.6.a.(2) requires that the fire detection systems comply with the requirements of Class A systems, as defined in NFPA 72D.

At HCGS, the Reactor Building except the refueling deck elevation, the remote shutdown panel room and the safety-related equipment areas used for initial hot shutdown are provided with a Class A early warning fire and smoke detection system in accordance with NFPA 72D. The areas outside the reactor building are the 250 V dc RCIC and HPCI battery and inverter rooms at Elevation 54', the cable spreading room at Elevation 77', the control equipment room at Elevation 102', the switchgear room B at Elevation 130' of the Auxiliary Building SDG area, and the remote shutdown panel room at Elevation 137'. Except for the continuous line detection system in the torus area of the reactor building, the Class A system will not prevent the detection system from initiating a fire alarm due to an occurrence of a single break or single ground fault of the detection circuit between the local control panel and the associated detectors. For the continuous line detection system, a single break in the detection circuit between the local panel and continuous line detector will not prevent a fire alarm. Since the continuous line detection system normally operates in the ground fault condition, no ground fault detection is provided, and a ground fault will not prevent the continuous line detector from initiating a fire alarm. The balance of the plant, however, is provided with a Class B detection system, which also complies with NFPA 72D. This includes two areas; the control equipment mezzanine and the main control room for initial hot shut down. The control equipment mezzanine detection system is backed up by a separate fire detection and alarm system for the automatic CO_2 system and the control room is continuously staffed. The safety-related equipment areas with

Class B system are accessible during normal plant operation. The Class B early warning fire and smoke system is electrically supervised to detect circuit breaks, ground faults, removal of a detection device from a detector circuits, and power failure. If any of the above problems occur, a fire detection system trouble is annunciated locally and in the main control room. This would alert the operators to begin repairing the system immediately to bring the early warning fire and smoke detection system back to working order without jeopardizing plant safety. Plant operators will periodically test the system for proper functioning, similar to inservice testing of other plant systems.

The Fire Protection Status panel (10C671) in the control room is a Proprietary Supervision Station installed in accordance with NFPA 72 which was the applicable NFPA code at the time of upgrade. The three major deviations from NFPA 72 are: 1) the number of initiating device exceed the limits specified, 2) the system is not listed by a listing agency and 3) the fire alarm in the control room is not distinctive for other control room alarms. Justification for these deviations is provided below:

The Signaling Line Circuits from the interface panels (Field Enclosures) to the Fire Protection Status panel are Style 4 signaling circuits as defined in NFPA 72. BTP CMEB 9.5.1 required that fire alarm systems meet the requirement of NFPA 72D for a Class A systems. The Signaling Line Circuits are not Class A as required by BTP CMEB 9.5.1. NFPA 72 states "The loading of signaling line circuits designated only as class A or Class B (without a style designation) shall not exceed the capacities for the style with the lowest capacities in the their class (Style 0.5 or 1 Class B and Style 2 for Class A circuits)". This would limit the signal line capacity to a maximum of 250 initiating devices to met the BTP CMEB 9.5.1 requirement. NFPA 72 Appendix A section A-3-6-1 (g) states: "The overall system reliability is considered to be equal from style to style when the capacities are at the maximum allowed". Therefore, a style 4 system with 500 initiating devices per circuits is just as reliable as a Style 2 (minimum Class A) circuit with 250 initiating devices per circuit. The number of devices on the Signaling Line Circuits are over the limit specified in NFPA 72. This condition has been evaluated and based on the design of the system compared to commercial installations (basis the for limits in NFPA 72), it has been determined that the Signaling Line Circuits provide a level of reliability as of NFPA 72. Based on the above, the design of the system meets the intent of BTP CMEB 9.5.1.

The Foxboro I/A system is not listed by a testing and listing agency as required by NFPA 72. However, the functional requirements of the system were reviewed against U.L. 864 "Standard for Control Units For Fire-Protective

Signaling Systems" and it was determined that the system meets the intent of the standard, and therefore the intent of NFPA 72.

There is an audible alarm provided on the control room C800 Vertical Board which is the same as other vertical board alarms. This is considered justifiable since the control room C800 Vertical Board provides an audible indication of the alarm condition to the control room operator, as well as a visual indication via an illuminated window indicating that the system is in an alarm condition (i.e., fire). Since there is one common alarm annunciator in the control room for every plant alarm condition and the control room operator responds to every audible alarm/illuminated window at the C800 Vertical Board to determine which system is in alarm a separate, distinctive and redundant fire alarm audible device is not needed.

At HCGS, the fire and smoke detection system meets the intent of NFPA 72 and 72D except that the operation and supervision of the system is not the sole function of the plant operator. The plant operator's duties cover operation of the generating station and monitoring and supervising the Fire Protection Systems.

9.5.1.6.15 Paragraph C.6.a.(3)

Paragraph C.6.a.(3) requires that the fire detectors be installed in accordance with NFPA 72E.

The design of the early warning IFD, ionization and photoelectric smoke detectors was performed to provide general area detection in the areas covered. The spacing was determined by the detection system vendor, under the direction of a qualified fire protection engineer. NFPA 72E also allows detector locations to be determined based on engineering judgement considering ceiling shape, ceiling surfaces, ceiling height, configuration of contents, detector maximum spacing combustible characteristics, air changes and ventilation patterns.

An independent third party NFPA walkdown was performed as added assurance that the HCGS detection system provides acceptable coverage, based on as-built plant configuration. Individual "beam pockets" were identified that require individual smoke detectors

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to be placed inside in order to achieve strict compliance with NFPA 72E spacing rules for beamed ceilings. Public Service has evaluated these recommendations. The coverage provided by adjacent detectors has been assessed with respect to allowable smooth ceiling spacing with appropriate reductions for beam(s) traversed in reaching the effected beam pockets. Consideration has also been given to room air changes and ventilation patterns. New smoke detectors will be added in specific beam pockets where coverage from existing detectors is inadequate.

9.5.1.6.15a Paragraph C.6.a.(4)

Paragraph C.6.a.(4) requires local audible alarms should sound in the fire area.

At HCGS, a dedicated audible fire alarm system is not provided. Fire alarm signals go to the Control Room and register on an annunciator panel, both visually and audibly, indicating the fire location. The control room operator then contacts the fire brigade and dispatches it to the area of the alarm. Notification is accomplished through the use of either telephone or portable radio communication, as described in Paragraphs 9.5.1.6.13 and 9.5.2, which is the intent of the above stated requirement.

9.5.1.6.16 Paragraph C.6.a.(6)

Paragraph C.6.a.(6) requires primary and secondary power supplies be provided for the fire detection system and electrically operated control valves conforming to NFPA 72 and 72D.

At HCGS, the fire detection system is supplied with uninterruptible 120 volt ac power fed from an inverter type system which has three power supplies. The normal or primary power supply is from an offsite source and the alternate or secondary power supply is from a 4-hour station battery supply. A third power supply serves as backup to the primary and secondary power supplies. In addition, both the primary and backup power supplies are connected to buses which are backed by standby diesel generators (SDG). The buses are disconnected from the SDGs during a LOCA event; however, the buses can be reconnected to the SDGs under administrative control. Plant Drawing E-0012-1, Sheet 3, is the single line diagram of the power supplies to the fire detection system equipment. Therefore, the fire detection system is furnished with power supplies which meet the intent of NFPA 72 and 72D requirements.

At HCGS, motor operated control valves are used to control fire water for the preaction water spray systems provided for the FRVS recirculation charcoal filters, FRVS vent unit charcoal filters and the drywell prepurge cleanup charcoal filter. See Section 9.5.1.2.7 for description of system operation.

The primary source of power for these motor operated valves is from the normal offsite power. The secondary source is from the stand by diesel generators via a non safety-related motor control center. Power is available for operation of these valves during a loss of offsite power, except during a LOCA. All nonsafety-related equipment are automatically dropped off the emergency power bus during a LOCA. However, the valves can then be manually reconnected back on the bus after the diesel generators have started. The design meets the intent of NFPA 72D.

9.5.1.6.17 Paragraph C.6.b.(6)

Paragraph C.6.b.(6) requires that the fire pump installation conform to NFPA 20.

At HCGS, the installation of the fire pumps conforms to NFPA 20, except for the location of the fuel oil day tank for the diesel-driven fire pump, the installation of the pump test flow meter, and the arrangement of the diesel fire pump waste water line.

The fuel oil day tank is located just outside the fire pump house. NFPA requires that the fuel oil day tank be located inside the building, in regions where freezing may be encountered. However, the manufacturer of the diesel engine has stated that by using a suitable diesel fuel oil no problems for diesel engine starting and/or operation would occur due to the outdoor installation of a fuel oil tank which could be subjected to temperatures as low as -4°F. The diesel manufacturer has stated that fuel oil number 2 or 1 or a mixture can be used without affecting normal starting or operation of the diesel fire pump. The fuel oil selected is suitable for use at temperatures less than the worst ambient temperatures expected at the HCGS site. Also, the portion of the fuel supply line from the outdoor tank to the diesel engine is provided with electric heat tracing. The fuel oil day tank installation has been approved by the insuring authority.

NFPA 20 requires that the waste water line from the diesel fire pump heat exchanger discharge into a visible open waste cone. At HCGS, the diesel fire pump waste water line does not discharge to a waste cone, but it does discharge to an equipment drain in such a way that the water flow into the drain is visible.

The pump test flow meter and test manifold are installed in series in the same test line. Though NFPA 20 does not contemplate installation of the test flow meter and test manifold in the same line, the installation will provide a way to accurately measure the pump discharge water flow by either device. The installation of both measuring devices in series in the same line has been approved by the insuring authority.

9.5.1.6.17.1 Paragraph C.6.b.(7)

Paragraph C.6.b.(7) states that hydrants should be installed approximately every 250 feet on the yard main system.

At HCGS, hydrants are provided on the yard main system, but in some areas, the distance between hydrants is greater than 250 feet. The hydrants are located to provide coverage of the outside walls of the power block, major yard buildings, and various yard areas where combustible materials may be located. An effective hose stream can be provided to any yard location. See Section 9.5.1.2.3.3 for further discussion.

9.5.1.6.18 Paragraph C.6.b.(9)

Paragraph C.6.b.(9) requires that failure in one fire water storage tank or its piping should not cause both tanks to drain.

At HCGS, the fire pump suction piping and valve arrangement allows either fire pump to take water from either or both water storage tanks. With the present arrangement, and normal valve line up, a leak in any one tank or in the fire pump suction piping could cause the loss of water from both tanks. However, low water inventory in

the storage tanks is annunciated in the main control room. Isolation valves have been provided in the storage tank supply headers and in the fire pump suction headers to prevent loss of reserved fire water from both tanks. This combination of water level instrumentation and isolation valve arrangement provides adequate protection against losing the fire water inventory from one tank and/or both tanks.

9.5.1.6.19 Paragraph C.6.b.(11)

Paragraph C.6.b.(11) requires that the fire water supply should be calculated on the basis of the largest expected flow rate, and the flow rate should be based on 500 gpm for manual hose streams plus the largest design demand of any sprinkler or deluge system as determined in accordance with NFPA 13 or NFPA 15.

At HCGS, the water supply system can supply the flow rate of the largest sprinkler or deluge system plus 500 gpm for hoses inside the building that can be used to fight the same fire. The largest sprinkler system is located in the Turbine Building and does not cover safety-related areas.

The water supply system can supply the flow rate of the largest sprinkler or deluge system covering a safety-related area plus 750 gpm for hoses inside the building.

Table 9.5-18 lists the minimum and actual hose stream flows for each hydraulically designed sprinkler or deluge system. Minimum hose stream flows can be achieved by connecting a sufficient number of fire hoses to the standpipe riser. For some systems, a hose stream flow of 750 gpm is a system design parameter which exceeds the 500 gpm required in BTP CMEB 9.5-1, paragraph C.6.b.(11). Actual hose stream flows are based on the number of installed fire hoses that can reach the fire area as shown in Table 9.5-18. All flows are based on a minimum of 65 psig in the standpipe at the hose connection. See Plant Drawings M-5001 through M-5007

for areas covered by the sprinkler and deluge systems listed in Table 9.5-18.

9.5.1.6.20 Paragraph C.6.c.(1)

Paragraph C.6.c.(1) requires that each sprinkler and standpipe system be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve and waterflow alarm.

At HCGS, each sprinkler and deluge system is provided with an OS&Y gate valve adjacent to the system automatic control or alarm valve. The branch connection into the building is provided with a post indicator valve at the connection to the fire main loop. Each sprinkler and deluge system is provided with local water flow alarms (using pressure or flow switch) and remote annunciation in the main control room.

An OS&Y gate valve is provided at each branch (off the in-plant fire main loop) supplying the sprinkler, deluge or standpipe system.

The standpipe systems are not provided with water flow alarms. Waterflow in the standpipe systems is indicated by pump running annunciation in the main control room without automatic system actuation annunciation.

9.5.1.6.20B Paragraph C.6.c.(2)

Paragraph C.6.c.(2) requires that control and sectionalizing valves in the fire water system should be electrically supervised or administratively controlled, and all valves should be periodically checked to verify position.

At HCGS, control and sectionalizing valves in the fire protection water system are either electrically supervised or administratively controlled (locked in the open or closed position) in accordance with NFPA 26. See Section 9.5.1.2.3.4 for

description of the electrical supervision and administrative controls provided for the fire protection water system valves.

The valves that are administratively controlled are inspected monthly with documentation recording the inspection. The electrically supervised valves are not inspected periodically because the electrical supervision provides continuous monitoring of the valve position.

9.5.1.6.20C Paragraph C.6.c.(3)

Paragraph C.6.c.(3) requires that fixed water extinguishing system comply with the appropriate NFPA standards, such as NFPA 13 and NFPA 15.

At HCGS, the referenced NFPA standards were used as the baseline guidance for water extinguishing system design and installation. Each system was individually designed and reviewed for the specific room, hazards and other plant parameters which could have an impact on effective fire suppression. The final configuration for each suppression system considered multiple aspects of plant safety and plant fire safety. As the NFPA standards were not written specifically for nuclear power generation facilities, they were used as the guidelines to determine the most appropriate protection scheme. In order to assure that deviations from the NFPA standards were identified and considered appropriately in the design, an independent, third party walkdown has been performed, with significant deviations identified in the FSAR. The results and disposition of all known NFPA deviations has been documented and is available in the files. Sprinkler obstructions which have been identified have been corrected.

The significant deviation from NFPA 13 and 15 are as follows.

1. Sprinkler systems OWS1, OWS5, OWS6, OWS8, OWS14, OWS16, OWS17, 1WS4-8, 1WS13, OPS2, OPS3, 1PS1, 1PS2, 1PS6, 1PS9, 1PS14-16, 1D8, and 1D9 do not cover the entire area

within their respective fire zones. This is acceptable as these systems were designed to protect specific hazards such as oil piping, structural steel above high cable concentrations, and oily waste sumps. In addition certain systems did not extend to areas above water sensitive electrical equipment.

2. Sprinkler risers and or local panels for systems 1PS1, 1PS2, 1PS3, OPS3, OWS10, OWS11, and OWS14 are located within the fire hazard areas. This is acceptable as each system is either in a non safety-related area, a remote facility (fire pump house, circulating water pump structure, or service water intake structure) or a limited coverage system in a larger fire zone. In addition, remote shutoff valves are provided.

3. The electric motor operated valves comply with NFPA Standards 13 and 15 with the exception that the motor operators are not UL-listed and/or FM-approved. The motor operators for these valves are the same type, manufacturer and model number as those used on safety-related valves. The particular model of motor operator used at HCGS has been seismically and environmentally qualified for use on safety-related valves by Aero Nav Laboratories, Inc. In view of the above qualification, the valves with operators are equivalent to a UL-listed design.

9.5.1.6.21 Paragraph C.6.c.(4)

Paragraph C.6.c.(4) requires individual standpipes be at least 4 inches in diameter for multiple hose connections and 2 1/2 inches in diameter for single hose connections.

At HCGS, all standpipe connections to the inplant loop are 4 inch diameter for standpipes feeding multiple hose connections. See Plant Drawing M-22-0. But branches off the standpipes, that feed two or less hose connections, are 3 inches in diameter

except in one instance where three hoses are connected to a 3 inch branch. These three hose stations are not all on the same floor and could not all be used to fight the same fire. This 3 inch branch has been evaluated and found acceptable to meet NFPA 14 pressure and flow requirements. As stated in Section 9.5.1.6.19, the fire water supply can provide water at the required flow and pressure to supply any sprinkler or deluge system and all the hoses which can be used to fight the same fire.

Paragraph C.6.c.(4) requires that the interior manual fire water hose installation should be able to reach any location that contains or could present a fire exposure hazard to safety-related equipment with at least one effective hose stream. To accomplish this, hose connections should be equipped with a maximum of 100 feet of fire hose.

At HCGS, certain fire hose stations are provided with an additional 50 feet of hose which is not connected and is stored near the fire hose station. In the unlikely event of a fire, the additional hose will be used to reach certain areas where a 100-foot hose will not reach. The hose stations which are provided with the additional hose are 1EHR400 and 1HHR400 at Elevations 54 feet and 77 feet of the Auxiliary Building control area, respectively; 1RHR200 at Elevation 132 feet, 1VHR200 and 1UHR200 at Elevation 162 feet, and 1AHR202 at Elevation 178 feet-6 inches of the Reactor Building, and YHC-300 at elevation 124 of the Auxiliary Building radwaste and service area and 1AHR500 and 1BHR500 at Elevation 100 feet of the intake structure. The additional hose would be used to reach the back part of RPS motor generator set room and reach unoccupied spaces 5124 and 5234 where nonsafety-related cable trays are located at elevations 54 and 77 feet of the Auxiliary Building control area. Also, the additional hose would be used to reach the area behind the FRVS recirculating units at Elevations 132 feet, 162 feet, and 178 feet-6 inches of the reactor building; to reach the back part of the containment pre-purge cleanup room at Elevation 162 feet of the Reactor Building to reach the batch of equipment removal area 3442 and to reach the traveling screen motor area at elevation 114 feet of the intake structure. See Plant Drawings M-5001, M-5002, M-5004, M-5006, M-5007 and M-5011 for hose station locations.

Even with the additional lengths of hose, there is adequate pressure to provide a water flow equal to or greater than what is required in NFPA 14 and stated in Table 9.5-18.

9.5.1.6.22 Paragraph C.6.c.(4)

Paragraph C.6.c.(4) requires that provisions be made to supply water at least to standpipes and hose connections for manual firefighting in areas containing equipment required for safe plant shutdown in the event of a safe shutdown earthquake (SSE). The firewater piping serving such hose stations should be analyzed for SSE loading, and should be provided with supports to ensure system pressure integrity.

AT HCGS, the hose station standpipes and the firewater piping feeding the standpipes inside the plant buildings meet the requirements of ANSI0B31.1, but the piping is not analyzed for SSE loadings, and therefore, is not Seismic Category I. No cross connection is provided to a normal Seismic Category I water system, such as the Station Service Water System (SSWS).

HCGS is designed to meet the requirements of Appendix R to 10CFR50, to the extent noted in Appendix 9A, with regards to safe shutdown of the plant. Separation of safe shutdown equipment and cables meets these requirements, and a fire following an SSE that affects one shutdown division will not prevent safe shutdown using the other division.

Since HCGS is not located in an area of high seismic activity, the fire protection piping system, as presently designed and installed, is considered adequate.

9.5.1.6.22a Paragraph C.6.d

Paragraph C.6.d requires that in addition to the guidelines of NFPA 12A and 12B, preventive maintenance and testing of Halon systems, including check-weighing of cylinders, be done quarterly.

At HCGS the Halon systems are tested and maintained in accordance with the guidelines of NFPA 12A, which requires that the Halon quantity and pressure in the cylinders be checked on a semi-annual basis. This frequency is considered adequate for the systems at HCGS.

9.5.1.6.22b Paragraph C.6.f

Paragraph C.6.f requires that portable fire extinguishers be provided in accordance with the guidelines of NFPA 10. Based on a hazard classification of ordinary hazard involving both Class A and B hazards, NFPA 10 requires portable fire extinguishers for both Class A and B protection. At HCGS, portable fire extinguishers with a Class B:C rating only are provided in many areas. Class A protection is provided by the standpipe and fire hose station system. Class B:C fire extinguishers are acceptable during the early stages of Class A fire development involving the type of hazards expected in plant areas. Beyond this

stage, fire development is expected to exceed the capability of the fire extinguisher, necessitating the use of a fire hose station. Therefore, the lack of portable fire extinguishers with a Class A rating for the type of hazards in the plant is considered to be acceptable.

NFPA 10 also establishes maximum travel distances to portable fire extinguishers. These requirements are based on the assumption that the building occupants would be responsible for fire suppression activities.

Building occupants at HCGS are not required nor expected to extinguish fires. Fire suppression is provided by the fire brigade responding from outside the area. As such, the travel distance between a hazard and the installed fire extinguishers is not considered to be a factor for fire suppression activities as performed by the fire brigade. Therefore, as applied to HCGS, the travel distances contained in NFPA 10 are only used for guidance.

9.5.1.6.23 Paragraph C.7.a.(1).(C)

Paragraph C.7.a.(1).(C) requires that fire detection systems with backup general area fire detection capability be provided for each fire hazard in primary containment.

At HCGS, no FPS is provided in the containment drywell since it is inerted with nitrogen gas.

9.5.1.6.24 Paragraph C.7.b

Paragraph C.7.b requires that ventilation system openings between the control and peripheral rooms be provided with automatic smoke dampers that close upon operation of the fire detection or suppression system.

HCGS uses fire dampers in lieu of automatic smoke dampers in the return air ducts of the peripheral rooms. In the event of fire in one of these rooms, the fire dampers would close when the temperature reaches 165°F. Prior to this occurrence, however, the smoke detectors in the peripheral rooms will notify operations personnel in the main control room portable fire extinguishers are in the area for control and extinguishment of the fire. Should the amount of smoke become excessive to threaten habitability, the control room would have to be evacuated and safe shutdown performed from the remote shutdown panel.

Paragraph C.7.b also states that the peripheral rooms in the control room complex should have automatic water suppression.

At HCGS, the peripheral rooms in the main control room complex do not have automatic water suppression. The rooms are provided with fire water hose stations, automatic smoke detection, and portable fire extinguishers.

The peripheral rooms are separated from the main control room and the shift supervisor’s room by a 1-hour rated fire barrier. The

control room complex is separated from other areas of the plant by a 3-hour rated fire barrier.

The fire loading in the peripheral rooms is equivalent to a fire severity of approximately 30.4 minutes. A fire in one of the peripheral rooms will be promptly sensed by the smoke detectors and plant personnel will be able to quickly control and extinguish the fire. Because of the low fire loading of the peripheral rooms and their surrounding fire barrier, a fire in these rooms will not be capable of involving the main control room. Should the habitability of the control room become threatened, safe shutdown of the plant can still be accomplished from the remote shutdown panel.

Paragraph C.7.b also states that smoke detectors be provided in the control room cabinets and consoles. Also, additional fire protection measures should be provided if redundant safe shutdown equipment is located in the same control room cabinet or console.

At HCGS, automatic smoke detectors are only provided in those main control room cabinets and consoles that contain redundant safe shutdown equipment.

The main control room is provided with automatic smoke detectors, fire water hose stations, and portable fire extinguishers. The fire loading in this room is equivalent to a fire severity of 5.5 minutes.

A fire in a cabinet or console that contains equipment for only one safety division will be detected by the main control room smoke detector, or since the control room is continuously staffed, by the control room personnel. The fire can then be controlled by prompt manual response. No combustible path exists between cabinets and consoles that contain only one safe shutdown division. A single fire event in one cabinet or console, therefore, will not affect the safe shutdown capability of the plant.

Cabinets and consoles containing redundant safe shutdown equipment are provided with smoke detectors for prompt detection of a fire. Additional fire protection available includes fire water hose stations and portable extinguishers.

In the event a fire does occur in the main control room, safe shutdown capability independent of the main control room is provided via the remote shutdown panel room.

9.5.1.6.25a Paragraph C.7.c

Paragraph C.7.c requires that there be no carpeting in the control room.

At HCGS, carpeting is provided in Rooms 5509 (shift supervisor's office), 5510 (main control room), and 5511 (ready room). These rooms form fire area CD46. The carpeting is essentially complete in Rooms 5509 and 5511. In the main control room the carpeting covers the area at the main consoles, estimated to be approximately 40 percent of the total main control room floor area. The carpeting is applied using a water-based adhesive and is secured directly to the tile on the concrete floor. Fire characteristics are as follows:

Radiant Panel: (ASTME-648)>0.45, Class1

The carpet provides less than a 4-minute fire loading in any of the three separate areas and adds less than a 2 1/2-minute average fire load to the established in-situ and estimated transient fire loading in fire area CD46.

Safe shutdown is analyzed in Table 9A-61, Sheet 3 of 4, and is not affected by the installation of the carpeting.

9.5.1.6.25b Paragraph C.7.c

Paragraph C.7.c requires that the primary fire suppression in the cable spreading room be an automatic water system.

At HCGS, the primary fire suppression in the cable spreading room, at floor Elevation 77 feet of the control area, is an automatic preaction sprinkler system. The primary fire suppression in the control equipment room mezzanine (cable spreading room), at floor Elevation 117 feet - 6 inches of the control area, is an automatic carbon dioxide total flooding system. A manual deluge system is provided for the control equipment room mezzanine, serving as a back-up system for the carbon dioxide system.

The carbon dioxide system with manual deluge system as backup meets the requirements of Appendix A to BTP A PCSB 9.5-1 and provides a reasonable assurance that a fire in the room will be controlled and extinguished. This area meets the requirements of Appendix R to 10CFR50, to the extent noted in Appendix 9A. Any fire in the room will be extinguished and will not prevent the plant from achieving a safe shutdown.

9.5.1.6.26 Paragraph C.7.c.(2)

Paragraph C.7.c.(2) requires aisle separation between tray stacks in the cable spreading room be at least 3 feet wide and 8 feet high.

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At HCGS, the main aisles for the cable spreading room at Elevation 77 feet of the control area are at least 3 feet wide and approximately 8 feet high. The height of the aisles provides ample space for accessibility for the fire brigade personnel. In addition, the room is provided with an automatic preaction sprinkler system and an early warning fire and smoke detection system.

The main aisles for the control equipment mezzanine at floor Elevation 117 feet - 6 inches are less than 3 feet wide and 8 feet high in some areas. The room is provided with an automatic carbon dioxide system. The carbon dioxide system provides reasonable assurance that a fire in the room will be controlled and extinguished. This area meets the requirements of Appendix R to 10CFR50 to the extent noted in Appendix 9A. In addition, the room is provided with an early warning fire and smoke detection system.

9.5.1.6.27 Paragraph C.7.c.(5)

Paragraph C.7.c.(5) requires continuous line-type heat detectors for the cable trays inside the cable spreading room.

At HCGS, the cable spreading rooms are not provided with continuous line type heat detectors for the cable trays. The rooms are provided with fire and smoke detectors (ionization and photoelectric type) at ceiling level. This type of fire and smoke detection provides a means to detect an incipient cable tray fire, whereas thermally actuated line type detectors will not initiate an alarm until the fire has passed beyond the incipient stage. In addition, the cable spreading rooms are provided with automatic fire suppression systems. HCGS's design for fire detection and fire suppression capability in the cable spreading rooms ensure that a fire involving cable trays will not prevent safe shutdown of the plant from being achieved.

9.5.1.6.28 Paragraph C.7.c

Paragraph C.7.c requires each cable spreading room be separated from the others and from other areas of the plant by barriers with a minimum fire rating of 3-hours.

At HCGS, the cable spreading room at floor Elevation 77 feet of the control area is separated from the other cable spreading room and from other areas of the plant by 3-hour fire rated barriers.

The control equipment mezzanine (cable spreading room), at floor Elevation 117 feet - 6 inches, is surrounded by and separated from the other cable spreading room and other areas of the plant by 3-hour fire barriers when the west access corridor, at Elevation 124 feet, is included with it. See Plant Drawing M-5004.

9.5.1.6.29 Paragraph C.7.f

Paragraph C.7.f requires redundant safety-related panels, remote from the control room complex, be separated from each other by barriers having a minimum fire rating of 3 hours.

In general, HCGS complies with this requirement. For specific deviations from this requirement, see Appendix 9A, Section 9A.6.

9.5.1.6.30 Paragraph C.7.i

Paragraph C.7.i requires the automatic fire suppression system for the diesel generator areas be designed for operation when the diesel is running without affecting the diesel.

At HCGS, each diesel generator room is provided with an automatic carbon dioxide total flooding system.

The diesel generator rooms are separated from each other and other parts of the plant by 3-hour fire barriers. For the diesel area, HCGS meets the requirements of Appendix R to 10CFR50 to the extent noted in Appendix 9A. Any discharge of the carbon dioxide system due to a fire or an inadvertent operation, will not prevent safe shutdown of the plant because the other three diesel generators will be available.

9.5.1.6.31 Paragraph C.7.j

Paragraph C.7.j requires that diesel fuel oil tanks with capacity greater than 1,100 gallons should not be located inside buildings containing safety-related equipment.

At HCGS, two 26,500 gallon diesel fuel oil storage tanks are located in each of the four fuel oil storage tank rooms at floor elevation 54 feet of the diesel area. Each room is enclosed by 3-hour fire barriers and the diesel area is separated from the control area by a 3-hour fire wall. The diesel generators are located two floors above the diesel fuel oil storage tank rooms.

Separating floors and main structural members have a fire resistance rating of 3-hour. Drains are provided to remove possible oil spills and water discharged during deluge system operation. Each room is diked such that it can hold fuel oil

spilled from one entire tank plus thirty minutes of water flow from the manual deluge sprinkler system.

An automatic CO_2 total flooding system is provided in each diesel fuel oil storage tank room. Manual deluge system and water hose stations are provided as a backup fire suppression system. Fire and smoke detectors are also provided in each room.

Although the combustible loading in the diesel fuel oil storage tank rooms is 7,100,000 Btu/ft^2 of floor area, oxygen depletion can restrict the fully developed period of any fire event to approximately 5 minutes.

HCGS design for fire detection and fire suppression capability in the fuel oil storage tank rooms will ensure that a fire in one of the four will not prevent a safe shutdown of the plant from being achieved.

9.5.1.6.32 Paragraph C.7.k

Paragraph C.7.k requires that pump housing and rooms housing redundant safety-related pump trains be separated from each other and from other areas of the plant by a 3-hour fire barrier.

At HCGS, 3-hour fire barriers are provided to separate redundant safety-related pump trains to the extent noted in Appendix 9A. Separation of safety-related pumps from other areas of the plant was done only if the fire hazard analysis indicated that it was required to ensure safe shutdown of the plant. See Appendix 9A for details of the HCGS fire hazard analysis. HCGS's design of fire barriers and fire suppression provides a reasonable assurance that a fire in any one safety-related pump area will not prevent safe shutdown of the plant.

9.5.1.6.33 Paragraph C.7.n

Paragraph C.7.n requires that fire barriers, automatic fire suppression and detection be provided for the radwaste and decontamination areas.

In general, HCGS radwaste and decontamination areas are provided with fire barriers, as indicated by the fire hazard analysis, to separate them from other areas of the plant. See Plant Drawings M-5001 through M-5005 and M-5008. In addition, fire barriers are provided between floor elevations in the radwaste area and between the solid radwaste areas and other areas within the radwaste area.

Four Ruskin fire dampers in the Chem Lab Exhaust (CLE) have not been qualified to fully close against the design air flow rates. These fire barriers do not separate decontamination or radwaste processing areas.

Automatic fire water suppression and detection systems are provided for the clean storage room at floor Elevation 87 feet, the restricted and unrestricted machine shop areas at floor Elevation 102 feet, the solid radwaste areas at floor Elevations 102, 124 and 137 feet and the controlled and uncontrolled locker areas and decontamination areas at floor Elevation 137 feet of the radwaste area. An automatic water spray system has been provided for the two radwaste tank vent charcoal filters at Elevation 54 feet. Also fire detection has been provided for most areas in the radwaste area. See Plant Drawings M-5001 through M-5005 for specific areas. Although detection has been provided in the access corridors to the gaseous and liquid radwaste areas below floor Elevation 87 feet, no detection or automatic fire suppression has been provided for the individual tank, filtration, separator, pipeway and pump areas. Provisions for detection and automatic fire suppression systems throughout these areas would not sufficiently increase the level of fire safety to be justified due to the restricted access and lack of fixed and transient combustibles, as indicated in the fire hazard analysis. See Appendix 9A for HCGS's fire hazard analysis.

9.5.1.6.34 Paragraph B.4 (Definition)

Paragraph B.4 contains the definition of a noncombustible material. Part b of this definition identifies the parameters for noncombustible coating materials, which includes a flame spread rating of 50 or less, when tested in accordance with ASTM E-84. HCGS uses noncombustible coating materials as determined by a flame spread rating of 50 or less when tested in accordance with either ASTM E-84 or equivalent fire test CAN/ULC-S102.2-M88 entitled "Standard Method of Test for Surface Burning Characteristics of Flooring, Floor covering, and Miscellaneous Materials and Assemblies."

9.5.2 Communications Systems

9.5.2.1 Design Bases

The communication systems have no safety-related functions. Various communication systems are provided in the plant to ensure reliable communication. These systems and their design bases are:

1. An intraplant, five channel, page party, public address intercom system to provide onsite communication between various plant locations

2. An automatic telephone system from the plant to the telephone company switching facilities to permit plant to offsite communication on a continuous basis

3. A two way radio communication system to provide communications between onsite and offsite locations

4. A two way radio communication system for inplant personnel with the capability for communication during a fire.

5. An electro sound communication system to provide communications between the Remote Shutdown Panel Room and various plant locations.

The communications systems provided on HCGS are of proven design as used in previously approved plants. In addition, the communication system will be tested as described in Section 9.5.2.4. As part of Table 9.5-17, the maximum noise levels are estimated for the areas where personnel will be communicating with the control room or remote shutdown panel room. Generally, PA handsets and telephones are not located in areas with high noise levels. The maximum noise levels are estimated based on the type of operating equipment in the area with the sound defined by industry standards, such as NEMA Publication MG I and IEEE standards. If several types of equipment are in the same area, then the noise level associated with the noisiest equipment is shown on this table.

9.5.2.2 System Description

9.5.2.2.1 Public Address System

The intraplant public address (PA) system is a five channel, independent, page party communication system, consisting of telephone handsets, amplifiers, and loudspeakers located at selected areas throughout the plant. Drawing numbers E-1468-0 and E-1469-1 (these drawings submitted in Section 1.7) illustrate the locations of the components in a riser diagrammatic form.

The loudspeakers are powered from individual amplifiers or amplifiers contained in each handset station. The system provides two-way communication facilities for speech at all handset stations. Each station is capable of originating and receiving the information by switching to either a page channel or to one of five non-interfering party line channels. A page party desk station is located at the unit operator's monitor console in the main control room. This station is modified to include a goose neck microphone and foot operated switch for hands off operation of the paging system. An additional wall mounted page party station is located at rear of the console for refueling operations.

During refueling operations the PA subsystem located at the refueling area can be isolated from the main PA system to limit conversations to that area. This PA subsystem also includes headset/microphone assemblies for hands off operation while communicating from refueling platforms. After refueling this PA subsystem is merged with the main PA system.

The communication cabinet, 10C685, contains major components of the PA system which are, but not limited to:

1. Termination points for all loop wiring of communication circuits and input ac power supply wiring.

2. Interface equipment for evacuation alarm, fire alarm and telephone systems connections.

3. Multitone generator for injecting four different tones into the paging channel

4. Merge-isolate, test and distribution cabinet for testing of individual communication loops and for control and testing of the merge-isolate circuit for the refueling area PA subsystem.

5. Multiparty handset station with provision for use of headset/microphone.

"Merge-Isolate" capability for the plant and refueling platform PA systems is provided at the communication cabinet located in the main control room.

The telephone system of Section 9.5.2.2.2 can be patched into the PA system page channel to enable communications to be conducted between telephone and PA handset locations.

The radiation alert signal and the fire alarm signal are transmitted over the paging channel of the PA system, overriding its normal use.

The PA system is fed from an uninterruptible power source, as shown on Plant Drawing E-0012-1, Sheet 2, as power supply 10D496.

The locations of public address loudspeakers and handset/speaker amplifier are selected to provide effective communications and to accommodate areas with high noise levels during normal plant operation and accident condition, including fire. The design of these public address components includes provisions for volume control of the loudspeakers, adjustment in loudspeaker mounting to provide maximum coverage, and special noise-cancelling handset which are effective in high ambient noise areas without use of acoustic

booths. As indicated in Section 14.2.12.1.38, the public address system will be tested with area equipment running. Any relocation and adjustment of the public address components will be provided as necessary as a result of the testing. Estimates of maximum sound levels are provided as indicated on Table 9.5-17. These estimates are based on equipment being energized or running and based on no sound level attenuation which would result from accounting for room constant and distance and location of the noise source(s).

The page party communication system is available at or nearby the above working stations. In addition, a two-way radio communication system is available as a backup system. Table 9.5-17 also shows for each of the safety-related rooms the types of communication system components available with the associated maximum sound levels within the room. All of the communication components have the capability to function in the sound environments that are listed in the Table 9.5-17. Table 9.5-17 defines the maximum sound level capability for each communication component.

9.5.2.2.2 Telephone System

The telephone system at Hope Creek Generating Station is a Private Automatic Branch Exchange (PABX) supplied and installed by the telephone company. The system is equipped with the latest software package and dual processing for backup reliability.

The Hope Creek Generating Station telephone communication system is designed to provide reliable intraplant and interplant (plant to offsite) communications under both normal plant operation and accident conditions.

The telephone equipment allows communication throughout the plant by dialing the appropriate four digit extension number. Communications onsite, offsite or with the Emergency Operations Facility (EOF) is accomplished by dialing the appropriate tie line code(s). The communications network connects both public and private facilities to the site. It is tied directly to the site

switching network with multiple Telephone Company systems, central office tie lines, private PSE&G tie lines and microwave channels.

The telephone system provides sufficient equipment for various types and in various locations so that the plant has adequate telephone communications to start up, continue safe operation, and safely shut down.

Hope Creek primary communication paths entering the PSE&G Network, including the EOF (Emergency Operations Facility), will be through PSE&G's private Microwave System. The lines to the corporate headquarters in Newark and the Salem EOF will be routed "first-choice" through the PSE&G Microwave System. PSE&G's microwave is equipped with its own battery chargers and emergency 8-hour batteries, and backed up with UPS (Uninterruptible Power Supply) and diesel generator.

Communication channels may also enter or exit Hope Creek Generating Station via two additional paths, provided by the telephone company. These paths will enter the Salem C.O. (Central Office telephone company) through either a hardwire link or the telephone company's microwave system. The Salem Generating Station switch (PABX) is equipped with a UPS system and diesel generator. The Hope Creek switch (PABX) will also be equipped with a UPS system and diesel generator.

Upon failure of telephone equipment or in emergency situations, necessary telephone communications for pertinent personnel will be maintained. These communication channels will be available in the form of Newark Centrex extensions via Microwave which will be placed at strategic locations.

9.5.2.2.3 Microwave System

The Public Service Electric & Gas Co. microwave system provides Hope Creek Generating Station with a reliable telecommunications medium. The microwave system links Hope Creek Generating Station

into the various facilities within the Public Service Electric & Gas Co. service area including the Load Dispatcher Command Center in the Newark, N.J. Corporate Headquarters. The microwave links are a combination of general use communication channels and dedicated voice channels for operational communications and emergency communications.

The microwave system uses frequency modulated low power radio signals that operate in the 6,000 MHZ band, which is the industrial microwave frequency band established for industrial users by the Federal Communications Commission. The system is equipped with its own battery chargers and emergency 8-hour batteries, and backed up with UPS (Uninterruptible Power Supply) and diesel generator.

The microwave electronic equipment has built in redundant equipment in the hot standby mode in case of failure, and two transceivers in parallel for redundant transmitting and receiving capabilities. The microwave tower also contains a dish antenna in addition to the Public Service Electric & Gas Co. antenna for the Telephone Company microwave system, which is used for additional site communications and redundancy. The load dispatcher's office contains alarms that give indication of microwave trouble. This is also alarmed locally.

The microwave equipment is contained in a separate building separated from the telephone equipment building; these structures are located on the Salem Generating Station site. These equipment buildings and the microwave tower are located a considerable distance from the Salem Generating Station power block, Hope Creek Generating Station power block and the Hope Creek Generating Station telephone equipment building.

9.5.2.2.4 Two-Way Radio Communications System

Three radio communication systems are provided. One system is for security personnel use and it is described in Section 13.7. The second system is for station personnel use as described herein.

This radio communication system serves as an alternate communication system to the public address and the telephone systems. This system consists of three remote control consoles, a primary and a backup base repeater stations with remote manual switchover provision, handheld transceivers (radios) and antenna divider network with antennas and transmission lines distributed throughout the power block. Plant Drawing number E-1475-1 (drawing referenced in Section 1.7) illustrates the location of the fixed components in a riser diagrammatic form. The third system (EMRAD) is for Emergency Plan use and is described in Emergency Plan Section 7.

The radio system is used by the fire brigade, described in Section 9.5.1.5.2, and by other station personnel. The radio system also has interface capability for connection with the Salem radio system.

One of the remote control consoles is located in the main control room for operators use and another is located in the site firehouse. The third remote control console is available at the simulator. The repeater stations are located within the auxiliary building. Antenna networks are located throughout the power block in order to achieve maximum coverage.

The Hope Creek two-way radio communication system has an interface capability for connection with the Salem system. The system interconnection is designed as follows:

There are four designated channels, with each having a different UHF carrier frequency.

Salem 1	-	Channel 1
Salem 2	-	Channel 2
Hope Creek	-	Channel 3
Security	-	Channel 4

A dedicated radio remote control console is provided in each of the Hope Creek and Salem units' control rooms. The radio system is used

for two-way communications by station operating and maintenance personnel and is controlled by the consoles in each unit. The system is designed so that the radio systems provide segregated communications for each nuclear unit.

The only instance where interplant or inter-unit radio systems are inter-tied is when a conversation or instruction is necessary to be transmitted to the fire fighting emergency personnel.

The power source is an uninterruptible source. This repeater supply is the instrumentation ac power supply 1BJ484, and the control room controller supply is instrumentation ac power supply 1CJ484 as shown on sheet 5 of Plant Drawing E-0012-1.

9.5.2.2.5 Remote Shutdown Panel

The remote shutdown panel room has both a telephone and a PA handset station for communication link with other plant locations.

In addition, a dedicated communication system is provided for plant operators' use when performing remote shutdown duties from the Remote Shutdown Panel (RSP) as discussed in Section 7.4.1.4. This system serves as a backup to the telephone and PA systems and is an electro sound system. It consists of a control cabinet located in the RSP room and various jack stations located remote from this room. The jack stations are wired to the control cabinet independent of the other communication systems' wiring. Headsets are provided to permit hands free operations while communicating. Drawing E-1466-0 (drawing submitted under Section 1.7) depicts this design in a riser diagrammatic form.

9.5.2.3 System Evaluation

System design considerations include diversity and operational reliability. The inplant communication systems are provided with reliable, uninterruptible power supply for uninterrupted communications between all areas of the plant.

The PA system is the primary means of intraplant communication for plant operations. The telephone system is used as a backup in the event of a failure of the public address system. The telephone system is also used for special communication requirements and normal offsite communications. A two-way radio communication system provides backup to intraplant communication in the event of total loss of both systems. The EMRAD system provides backup for offsite communication during an emergency, as stated in Emergency Plan Section 7.3. The electro sound communication system provides alternative means for communicating at the RSP room in the event of failure of other communication systems.

The communication systems have adequate flexibility to keep the plant personnel informed of plant operational status at all times.

The integrated design of the system provides effective communication between plant personnel in all vital areas during startup, normal plant operation, and during the full spectrum of accident or incident conditions (including fire), under maximum potential noise levels. Effective plant to offsite communication has also been provided.

Additional protective measures provided to assure a functionally operable onsite and offsite communication system include:

1. Locating central components of the communication system in different areas of the plant so that a fire cannot damage more than one system.

2. Providing separate and dedicated raceways for each of the communication system's wiring so that each communication system circuit is physically separated from the other.

3. Immediate detection of component failures for the onsite communication systems of page party public address, telephone and two-way radio systems because of their regular use in the day-to-day plant operation. This item is further addressed in Section 9.5.2.4.

4. Additionally where non-1E MCC's are used as the power source for the onsite communication system, this equipment was purchased under the same specification, purchase order as used for the Class 1E equipment. Therefore, the non-1E equipment is the same model number, design and construction as its 1E counterpart.

Although the onsite and offsite communication systems are independent of each other, there are cases where individual components of each system are located in the same room, e.g., control room, because of operational consideration. In the event of loss of communication lines as a result of an accident or fire, the two-way radio system serves as the backup communication system to the hard-wired communication systems for that room.

A fire in a single room can not cause a total loss of the public address system and the telephone system because their major components including power supplies are not located in the same room. The separation of the conduits used for routing of each communication system mitigate the potential for loss of all communication system due to a single failure in the conduit system.

A partial loss of the hard-wired communication systems may result from a fire in a single room if there are conduits of both systems located therein but because the communication circuits are designed and routed in branches, a common loss of one branch of both systems only affects that fire area.

The onsite-handheld radios (transceivers) have provision for transmitting and receiving independent of the base station such that communications can be maintained in the event that the base station or remote control consoles are lost due to a fire or to loss of power.

As indicated previously, the Hope Creek onsite radio system provides an overall backup to the other onsite hardwired communication systems.

The communication systems have been evaluated to ensure that adequate communications are maintained following a seismic event such that safe shutdown capability is not affected. This assurance is provided by the design and locations of major components of the intraplant communication systems as discussed below:

1. Power Sources

   Although the communication systems are classified non-Class 1E, Class 1E sources are provided for the PA system and Class 1E and non-Class 1E sources are provided for the radio, electro sound and telephone systems. The Class 1E sources are designed to withstand seismic events and are located within a Seismic Category I structure to prevent a loss of power occurrence. The Class 1E sources are physically separated and independent of each other so that a single failure can only affect one communication system. The non-Class 1E communication loads are isolated from the Class 1E power supplies by use of solid state inverters and shunt trip of the backup source circuit breakers upon receipt of a LOCA signal to prevent degradation of the Class 1E power sources. A loss of the non-Class 1E power source to the telephone system affects only that system.

   The power sources referred to in this subsection are those which supply input power to the static inverters from which the PA, electro sound and radio systems receive ac power. Plant Drawing E-0012-1 depicts the design of each uninterruptible power supply (UPS). The static inverter is one component of each UPS, others are voltage regulator, rectifiers, and transfer switch; all components collectively form an UPS system. The UPS system for the PA system has Class IE, Channel A, ac and dc input power sources; the UPS components are seismically qualified, and its distribution panel's construction, configuration and components are similar or nearly identical to those of the Class IE distribution

panels shown on Plant Drawing E-0012-1. The UPS system for the radio system has input ac power supplied from Class IE, Channel B, power sources through non-Class IE motor control centers (MCCs), and its dc input power is from a non-Class IE power source. The electro sound system is similarly powered as the radio system except that Channel A supplies the input ac power. However, both the non-Class IE MCC's and the non-Class IE dc equipment were purchased under the same specification and are the same model number, design and construction as their Class IE counterpart. Similarly, the radio system UPS components, distribution panel and input power MCCs are considered seismically qualified because the components are of Class IE design and construction. Therefore, power to the PA, electro-sound and radio systems will not be interrupted following a seismic event.

2. Equipment Locations

The locations of the communications equipment are widely dispersed throughout the power block. The majority of the telephone components are located in nonsafety-related areas, including the central equipment. In safety-related areas, the telephone components are comprised only of telephones and their dedicated conduits and are located away from safety-related equipment. The major components of the PA, electro sound and radio systems are located within a Seismic Category I structure; however, they are physically separated from each other and from safety-related equipment. The communications equipment are not classified as Class IE; however, because of their inherent design and construction features, such as solid state components, and the manner in which communication equipment is mounted on walls and floors, the communications equipment are expected to remain functional following a seismic event. Therefore, it is

unlikely that there will be a total loss of all communications equipment following a seismic event.

3. Raceways

Each of the communication system wiring is enclosed in its own dedicated conduits and/or with metallic sheathing and is physically separated from each other and from safety-related raceways. Because of the dispersed locations of the communications components, and of the communication circuits' design and routing as branches which are independent of each other, it is unlikely that there will be a total loss of all communications due to failure of the wiring following a seismic event.

4. Communications Following a Seismic Event

Safe shutdown of the plant from the control room or the Remote Shutdown Panel room can be achieved without the need for intraplant communication systems because all necessary shutdown controls and indications are located therein. The operator also can initiate evacuation instructions/alarm from the control room, if necessary, by use of any one of the three communication systems (PA, telephone and radio) since the total loss of all three systems is considered unlikely. It is also unlikely that the radio system will cause interferences with control instrumentation and equipment because this type of system has been widely used in previously approved plants and preoperational testing of all safety-related systems together with the radio system will demonstrate that interferences are not caused.

In the event that communications need to be established between the control room or Remote Shutdown Panel room and other plant areas to achieve safe shutdown, an evaluation of communication systems available at each

area revealed that at least one communication system component is located within or nearby each area. Table 9.5-17 lists the areas evaluated; the selected areas are based on the Fire Hazards Analysis presented in Appendix 9A which identifies areas containing safe shutdown equipment. Thus, assuming that there is a total loss of power to the communications system central equipment plus loss of the central equipment, communications can be maintained by use of hand-held radios (transceivers).

9.5.2.4 Inspection and Testing Requirements

The systems described above are conventional and have a history of successful operation at similar, existing plants. Most of these systems will be in routine use and maintenance, ensuring their availability. Infrequently used systems will be tested on a scheduled basis to ensure operability.

The radiation alert and fire alarm systems are periodically tested. These tests include adequacy of signal level, availability of power sources, and proper function of all circuits. See Section 14.2 for preoperational testing.

All employees are made familiar with the actual sound of the alarm signals. Notice is given to all plant personnel preceding any alarm test.

Records of the scheduled tests of infrequently used systems are maintained.

9.5.3 Lighting System

The Plant Lighting System is designed to provide adequate lighting during all plant operating and maintenance conditions. The system consists of the Normal Lighting System and the Emergency Lighting System. Both systems are discussed in detail in Section 9.5.3.2.

9.5.3.1 Design Bases

Design bases for the lighting systems are as follows:

1. Illumination intensities provided in various areas are either equal to or greater than those recommended by the Illuminating Engineering Society (IES).

2. Deleted

3. High pressure sodium or fluorescent fixtures are not used in the drywell, on the refueling platform or fuel pool areas where accidental breakage could contaminate the Reactor Coolant System (RCS) with the exception of high pressure sodium fixtures designed to: 1) preclude lamp breakage, 2) have minimal mercury content, and 3) maximize breakage retention and specifically designed for use in this environment. Mercury switches are not used in the lighting system.

4. Safety-related areas, which include the main control room, remote shutdown panel room, standby diesel generator (SDG) rooms, areas required for control and maintenance of safety-related equipment, and access routes to and between and egress routes from these areas requiring lighting during emergencies are served by both normal and emergency lighting systems.

5. The main control room lighting system consists of fluorescent lighting fixtures that are part of a seismically qualified acoustic ceiling system. It includes dimming control for selection of optimum illumination levels.

6. Areas needed for operation of safe shutdown equipment in the event of fire and access and egress routes thereto are

served by standby self-contained battery pack units with a minimum 8-hour battery power supply.

7. Outdoor area lighting is supplied from the normal lighting distribution system. Lighting fixtures consist of high pressure sodium fixtures mounted on 40-foot poles or building structures. This system provides the illumination required for safe movement of personnel and for security surveillance. The security lighting system is designed to provide a minimum illumination level of 0.2 foot candle within the security fence boundary and a 25-foot zone outside the fence.

8. All lighting system components are non-safety-related hence, they are non-Seismic Category I. When located in safety-related areas, these components comply selectively with Seismic Category II/I requirements as discussed in Section 3.2.

9.5.3.2 System Description

The Plant Lighting System consists of the normal lighting system and the Emergency Lighting System. These two systems are described in detail in the following paragraphs.

9.5.3.2.1 Normal lighting

The normal lighting system is powered from the non-Class 1E ac power distribution system. The fixtures are fed from 208/120 V or 480/277 V three phase, four wire, grounded neutral panels. These panels are supplied from 480 V non-Class 1E motor control centers (MCCs).

9.5.3.2.2 Emergency Lighting

The Emergency Lighting System consists of essential, standby, self-contained battery-backed safe-shutdown lighting units. The integrated design of the emergency lighting systems provides adequate emergency station lighting in all areas required for control and

maintenance of safety-related equipment and the access routes to and between and egress routes from these areas. These three systems are as follows:

1. Essential Lighting System - The essential lighting panels are supplied from diesel-generator-backed MCCs. Upon LOP, standby diesel generators supply power to these non-Class 1E MCCs through Class 1E unit substations. These MCCs are shed upon the occurrence of a loss-of-coolant accident (LOCA). Following a LOCA, the essential lighting panels are reconnected by manual administrative controls to the Class 1E source. In the interim, lighting is provided by one of the remaining two emergency lighting systems, standby or standby 8-hour battery pack units. The Essential Lighting System serves lighting fixtures in areas where illumination is required for control and maintenance of safety-related equipment.

2. Standby Lighting System - The standby lighting system is supplied from inverters connected to 125 V dc non-Class 1E buses. These buses are supplied by Battery chargers fed from non-Class 1E diesel generator backed MCCs and 125 V dc non-Class 1E batteries. In the event of both onsite and offsite power loss, the battery is capable of supplying the standby lighting system load for 1 hour.

   The Standby Lighting System serves "exit" signs, the drywell area, and stairway lighting fixtures.

3. Self-contained battery-backed safe-shutdown lighting units - The standby self-contained battery pack unit consists of a battery, charger, transfer switch, control and monitoring devices, and circuits. This system is independent of the standby lighting system described above. The battery in each unit is capable of supplying enough power to provide light for a minimum of 8 hours before changing is required.

The self-contained battery units are provided in the main control room, remote shutdown panel room, diesel generator rooms, areas containing safety-related equipment, and access routes to and between and egress routes from these areas.

The protective measures taken to ensure a functionally operable lighting system include:

1. Provision for emergency lighting as backup to the normal ac lighting system such that sufficient illumination is maintained during a loss of the normal lighting system due to component failure or loss of ac power.

2. Use of dedicated raceways and/or embedded conduits for branch circuits such that a severing of lighting cables as a result of an accident or fire affects only a portion of the lighting system. In the event the power supply cables in a particular area are severed instead of branch circuit cables, only a portion of the lighting system is affected because of the diversity provided in power sources, lighting subsystems and lighting components. Should branch circuits be severed as a result of a fire, self-contained battery-backed safe-shutdown lighting units will function to provide lighting.

3. The standby and essential lighting systems have a history of successful operation at similar, existing plants. Most of these systems will be in routine use and maintenance. For those areas of the plant that are not accessible during normal plant operation, maintenance and operations department personnel will determine if adequate lighting is available as part of plant walkdowns and job preparation.

   Testing of the Class 1E feed will be performed in conjunction with the standby diesel generator load testing.

The standby self-contained battery-backed safe-shutdown lighting units, as well as stored onsite portable dc lighting packs, will be tested on an 18 month interval in accordance with manufacturer's recommendations to insure that rated illumination is available. As a minimum this will include the following:

a. Check of battery voltmeter.

b. Functional test of the unit by an installed push button to verify lamp operation, power transfer, and battery operability.

Additionally, the capability of the self-contained battery-backed safe-shutdown lighting units to perform the design safety function shall be verified by testing a 5 percent sample, on an 18 month interval in accordance with the manufacturer's recommendations and as specified in the maintenance procedures. In the event of a failure additional 5 percent samples will be tested until there are no failures in a sample.

Table 9.5-17 lists the emergency lighting subsystems illuminance level provided for areas where operators and other station personnel may need to perform safe shutdown duties in the event of an accident. In the event of a prolonged loss of offsite power, each area will be illuminated by the self-contained battery-backed safe shutdown lighting units until the essential ac subsystem is manually reconnected to the standby diesel generator. Table 9.5-30 identifies areas associated with safe shutdown in the event of fire and access and egress routes thereto. For all other areas not listed on these tables, at least one of the emergency lighting subsystems is provided in each area required for personnel safety and for access/egress purpose during an evacuation or fire. The manual reconnection of the essential ac lighting loads to the diesel generator sources are performed in accordance with station operating procedures. Hand-held portable lighting units will also be available to station personnel to provide supplemental lighting when necessary during a prolonged loss of offsite power condition.

9.5.3.3 Safety Evaluation

The lighting systems are not safety-related and are classified as non-Class 1E. However, components of lighting systems located above or adjacent to safety-related equipment are supported by Seismic Category II/I supports to protect safety-related equipment from damage during a seismic event. In addition the control room lighting system is seismically qualified as part of the ceiling design.

The normal lighting system is designed such that offsite power supplies station lighting for normal plant operation, control and maintenance of equipment, and plant access routes.

The essential ac lighting system is designed to provide lighting from standby diesel generator sources through Class 1E unit substations and non-Class 1E MCCs. Although the non-Class 1E MCCs are shed upon the loss of normal station ac power, station operating procedures will require reconnection of the MCCs within 8 hours after the shedding. The non-Class 1E MCCs are designed and constructed the same as for Class 1E MCCs.

The integrated design of the emergency lighting systems uses onsite power and/or self-contained battery packs to provide adequate emergency station lighting in all areas required for control and maintenance of safety-related equipment, firefighting, and the access routes to and between and egress routes from these areas.

Although the power sources to the emergency lighting subsystem are non-Class 1E, except for the diesel generator source, it is unlikely that portions of the plant will be without sufficient lighting or without lighting for an extended period of time during a design basis event of seismic or LOCA. This assessment is justified as follows:

1. Control Room Lighting

The control room is served by three lighting systems normal ac, essential ac and self-contained battery-backed safe-shutdown systems. All the lighting components in this room are seismically analyzed and/or mounted to meet the Seismic Category II/I requirement (see Table 3.2-1). In the event that the essential ac system cannot be reconnected manually from the control room to the diesel generator source after the DBE, the self-contained safe-shutdown battery packs on selected lighting fixtures will automatically function to provide sufficient lighting. These self-contained power supplies have individual test feature and status indicating lights such that the operator can easily observe the operational status of each lighting fixture. Because periodic testing and maintenance are performed on these safe-shutdown battery packs, it is unlikely that there will be a complete failure of this emergency lighting subsystem.

2. Lighting for Other Areas

The lighting system for areas other than the control room is comprised of normal ac and one or more of the emergency lighting subsystems. The lighting components in safety related areas are mounted to meet the Seismic Category II/I requirement (see Table 3.2-1) and the self-contained battery-backed safe-shutdown lighting units have been seismically qualified. Areas required for safe shutdown have both essential ac and self-contained battery-backed safe-shutdown lighting subsystems and areas for evacuation of personnel have as a minimum, a self-contained battery pack subsystem for emergency lighting. Because the self-contained battery pack units are subject to periodic testing and maintenance, this lighting subsystem will function to provide sufficient illumination until normal or other emergency lighting subsystem(s) is restored. In addition, the lighting system components are diverse in location and are powered from different power sources such that the

possibility of insufficient lighting for an extended period of time is unlikely.

3. Lighting Following Seismic or LOCA Event

The non-Class 1E motor control centers (MCCs) which supply power to the essential ac lighting system are designed and constructed the same as for Class 1E MCCs. The non Class 1E MCC's were purchased on the same technical specifications as the Class 1E MCC's and are the same manufacturer model as the Class 1E MCC. These non Class 1E MCC's are mounted seismically as the Class 1E MCC's and are located in seismic Category 1 structures. Therefore, they are capable of withstanding a seismic event. After the LOCA event the manual reconnection of the essential ac lighting loads to the diesel generator sources will be performed in accordance with station operating procedures which will require the reconnection be made no later than 8 hours after the MCC disconnection. Because the lighting system can be supplied from onsite power sources and some lighting components are seismically analyzed or mounted (the self-contained battery-backed safe-shutdown lighting units have been successfully seismically tested), it is concluded that there will not be a total loss of lighting. However, in the event of loss of or insufficient lighting in some areas, station personnel will have access to hand-held portable lighting units.

Plant Drawing E-1421-0 is the single line drawing for the lighting distribution system.

Illumination levels provided in various areas either conform to or exceed those required in the IES handbook. Station personnel will have access to hand-held portable lighting units when necessary for supplemental lighting.

9.5.4 Standby Diesel Generator Fuel Oil Storage and Transfer

The standby diesel generator (SDG) fuel oil storage and transfer system provides onsite storage for at least 7 days of continuous operation for three of four SDGs operating at their full rated loads as described in Section 8.3.1.1.3. As demonstrated in Calculation E-9(Q), equipment required to shut down the plant with three of four SDGs following a Loss of Offsite Power (LOP) or a LOP concurrent with a Loss of Coolant Accident (LOCA) is allocated between the four SDGs such that safe shutdown is assured using any three of the four SDGs. The system also provides for both delivery of fuel oil from the fill connection to the storage tanks and transfer from one storage tank to another. The SDG fuel oil storage and transfer system is a safety-related system.

9.5.4.1 Design Bases

The SDG fuel oil storage and transfer system design bases are as follows:

1. The system provides adequate onsite storage of fuel oil to any three of the four SDGs to support 7 days of continuous operation under full operating loads, as described in SDG loading calculation E-9(Q), so that standby (onsite) electric power supply is available in case of loss of offsite power (LOP) and/or design basis accident (DBA).

2. The system provides for both delivery of fuel oil from the fill connection to the storage tank, and transfer of the oil from one storage tank to another.

3. A single failure of any active component in the system cannot affect the system's ability to store and deliver fuel oil to the SDG under the conditions in item 1. above.

4. The system is designed to remain functional during and after a safe shutdown earthquake (SSE).

5. The system is housed in a structure that is designed to withstand wind, tornadoes, floods, and missiles.

6. Main functional parameters of the system (flow, pressure, temperature, and equipment vibration) can be monitored while the SDG is tested or in operation.

7. The SDG fuel oil storage and transfer system complies with IEEE 387, Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations.

The SDG fuel oil storage and transfer system is designed to Seismic Category I requirements. The quality group classification and corresponding codes and standards that apply to the design of the system components are discussed in Section 3.2. Compliance with Regulatory Guides 1.9, 1.115, 1.117, and 1.137 is discussed in Section 1.8. Compliance with GDC 2, 4, 5, and 17 is discussed in Section 3.1. The SDG fuel oil storage and transfer system is in compliance with the recommendation of NUREG/CR-0660.

9.5.4.2 System Description

The SDG fuel oil storage and transfer system performs four functions:

1. Storing fuel oil for the SDGs

2. Filling the storage tanks and day tanks

3. Transferring oil from the fuel oil storage to the auxiliary boiler fuel oil storage tank

4. Transferring fuel oil between storage tanks.

This system is located in the Auxiliary Building at Elevations 54 feet and 102 feet. It consists of four identical, independent systems, one system for each SDG set. The system is shown schematically on Vendor Technical Document PM018Q-0049 and Plant Drawing M-30-1, and the major

component design parameters are listed in Table 9.5-4. The major components are:

1. Two fuel oil storage tanks

2. Two, 100 percent capacity, ac motor driven fuel oil transfer pumps

3. One fuel oil day tank

4. One engine driven fuel oil pump

5. One ac motor driven standby fuel oil pump

6. One duplex fuel oil pump suction strainer

7. One duplex fuel oil pump discharge filter

8. One conservation vent with flame arrestor

9. One emergency relief vent

10. One fill connection simplex fuel oil filter

11. One emergency fill station simplex fuel oil filter.

All equipment is mounted on the SDG skid, except for the storage tanks, the fuel oil transfer pumps, and the fuel oil day tank.

The standby diesel generators installed at HCGS use Colt-Pielstick PC 2.3V, 4 cycle, 12 cylinder engines which have a maximum fuel consumption rate of approximately 5.8 gpm using low sulfur (S500) No. 2 diesel fuel oil and 5.9 gpm using ultra low sulfur (S15) No. 2 diesel fuel oil at the diesel's rated full continuous load of 4430 kW.

9.5.4.2.1 Diesel Fuel Oil Storage Tanks

Each set of two storage tanks is located below its corresponding SDG unit in a separate concrete enclosure at Elevation 54 feet.

Each tank has connections for filling, venting, transfer pump suction, overflow return from the day tank, instrumentation, drain/sampling, and a manhole. The interior and exterior surfaces of the tank are corrosion protected. An elevated platform is provided over the tank for easy access to the instruments and the manhole.

There is an adequate onsite supply of diesel fuel oil to support 7 days of continuous operation of any three of the four SDGS under rated full operating loads as described in SDG loading calculation E-9(Q), to achieve safe shutdown following either a LOP or a LOP concurrent with a design basis LOCA.

The onsite fuel oil storage system is not sized in accordance with the requirements of SRP 9.5.4 and Regulatory Guide 1.137. In Technical Specification Amendment 59, the NRC granted HCGS permission to take exception to compliance with the 7-day per diesel requirement, allowing the station to follow acceptable alternative guidance that complies with the requirements of GDC 5 and 17 as well as meeting the intent of SRP 9.5.4. Instead, HCGS takes credit for the ability to transfer fuel oil from the storage tanks of the faulted SDG to the storage tanks of the three operating SDGs to meet the 7-day continuous operation at full rated capacity requirement. As shown in Plant Drawing M-30-1, Diesel Engine Auxiliary Systems Fuel Oil, and described in Sections 9.5.4.2, 9.5.4.2.3, 9.5.4.2.4, 9.5.4.2.5, 9.5.4.2.6, and 9.5.4.3 there is a simplex fuel oil filter in the barge and truck fill line, and a simplex fuel oil filter in the emergency fill connection line. The filter prevents solid particles or debris from entering the diesel fuel oil storage tanks.

In addition to the storage system filters, the SDG fuel oil skid piping has duplex fuel oil filter with a 5 micron particle retention mesh and duplex fuel oil strainer with a 40 micron particle retention mesh immediately upstream of the fuel oil inlet header supplying the cylinder injection pumps.

The diesel fuel oil storage tank design minimizes the possibility of sediment being drawn into the pumps by a six inch projection of the pump suction nozzle into the tank. The six inch projection of the nozzle into the tank allows for approximately 55 ft^3 of sediment before reaching the top of the inlet nozzle. Disturbances of the sediment will be minimal in the vicinity of the pump suction nozzle

since the diesel fuel oil storage tank fill nozzle is approximately thirty feet from the pump suction nozzle.

Filling of the diesel fuel oil tanks will be administratively controlled. For each diesel engine, one fuel oil storage tank will be designated as a fill tank and the other fuel oil storage tank will be designated as the diesel engine supply tank.

In order to provide adequate time for sediment to settle after the last fuel oil delivery, a minimum of 10 hours shall lapse before switching tank designations if a tank level is less than 19,000 gallons prior to filling. At a fuel oil level above 19,000 gallons, the tank is at least 71 percent full and any filling activity is not expected to disturb the sediment accumulated at the bottom of the tank.

The combined effect of the fuel oil filters, pump suction nozzle projection, and separation of fill and outlet nozzles, and administrative controls is such that turbulence of the sediment, during fill operation, will not cause sediment to be drawn into the fuel oil system, leading to degradation or failure of the diesel generator.

The diesel fuel oil storage tanks are provided with manholes for inspection, as described in Section 9.5.4.4. Biological growth in diesel fuel oil storage tanks may occur if water is allowed to accumulate inside the tank during long term storage. Water accumulation is prevented by:

1. Sampling fuel delivery trucks prior to loading new fuel oil in the storage tanks to prevent water intrusion.

2. Draining fuel oil storage tanks in accordance with the applicable recommendations provided in Regulatory Guide 1.137.

Diesel fuel will be sampled during every refueling outage to detect the presence of microbiological growth in the storage tanks. If microbiological growth is detected, an appropriate industry professional will be consulted to provide recommendations to eliminate the microbiological growth contamination.

In addition, surveillance testing to demonstrate diesel engine operability will include performance monitoring of the diesel engine fuel oil system. Fuel oil strainer and filter differential pressures will be monitored. Cleaning of the strainers and filters will be performed at the onset of an increase in differential pressure. Residue will be analyzed to determine the source of contamination and the need for storage tank cleaning.

9.5.4.2.2 Diesel Fuel Oil Transfer Pumps

One diesel fuel oil transfer pump is provided for each fuel oil storage tank. The diesel fuel oil transfer pumps receive their power from their respective Class 1E diesel generator channel. Each pump can transfer fuel oil to the day tank through its own discharge line. This pump, mounted outside the storage tank, requires a net positive suction head (NPSH) that is far below the available NPSH. It is located below the bottom of the storage tank so that the pump impeller remains continuously flooded. Operation of the transfer pumps is automatically controlled by a high-low level switch on the fuel oil day tank. Either transfer pump can refill the day tank, and operation is automatically alternated for even pump wear. Because the capacity of the transfer pump is greater than the fuel consumption of the diesel engine, it can supply fuel oil to the engine and simultaneously increase the inventory of the day tank.

The electrical schematic and control logic diagram for the diesel fuel oil transfer pump controls are shown on Vendor Technical Documents PM018Q-0141 and PM018Q-0366. The relays and devices listed below perform the following functions:

FTC = Day Tank Level Control
FLA = Day Tank Back Up Level Control

5EX = Diesel Generator Emergency Stop

CR4 = Pump No. 1 control relay

CR5 = Pump No. 2 control relay

CR6 = Pump No. 1 and 2 control relay

CS-34 = Pump No. 1 control switch

CS-35 = Pump No. 2 control switch

Automatic Operation

The fuel oil day tank level control provides start and stop interlocks, FTC, for the fuel oil transfer pump controls. When both pump control switches, CS-34 and CS-35, are in the auto position and both pumps are off, a low diesel fuel oil day tank level condition will start pump No. 1. This pump will stop automatically when the diesel fuel oil day tank is filled. During the period when pump No. 1 is running, CR6 relay will be sealed-in and will remain sealed-in after the pump has stopped. On the next tank refill cycle, pump No. 2 will start and also deenergize CR6 to repeat the tank filling cycle beginning with pump No. 1.

Manual Operation

The diesel fuel oil day tank may be filled manually at the remote engine control panel by use of one or both transfer pumps by operating control switches CS-34 and/or CS-35. The switches have three maintained positions-hand, off and auto. The "Hand" position will bypass the tank level control interlock used for automatic pump start. If the tank is filled to capacity under the manual filling operation, a high tank level alarm located at this panel will be initiated. The "Off" position will permit automatic filling of the day tank by the second pump under the tank control interlock while bypassing the pump cycling feature if one switch is in the "Off" position. If one or both switches are in the "Hand" or "Off" position, a fuel oil transfer system not in automatic alarm, also located on this panel, will be initiated.

9.5.4.2.3 Standby Diesel Generator Fuel Oil Day Tanks

Each day tank contains sufficient fuel oil for 55 minutes of continuous operation of the diesel engine at rated full load. Under normal conditions, fuel oil in the day tank is automatically replenished by either fuel oil transfer pump from either fuel oil storage tank. The day tank is located in the SDG room so that fuel oil flows by gravity to the fuel oil pumps to maintain a flooded pump suction. The day tank has connections for filling, overflow to the storage tanks, recirculation from the fuel injection system, venting, instrumentation, drain to the storage tanks, a drain for drawing off accumulated water, and an inspection, and sampling port.

9.5.4.2.4 Standby Diesel Generator Fuel Oil Pumps

Each SDG is provided with an engine driven fuel oil pump and an ac motor-driven fuel oil pump. The motor driven fuel oil pump motor receives its power from its respective Class 1E diesel generator channel. These pumps take suction from a common header. Since fuel oil flows through this header by gravity, both pumps stay continuously primed. A shutoff valve, locked open, is provided on the suction header to allow for maintenance or repair of the fuel oil pumps. Since the fuel oil pumps operate in parallel, a check valve is provided on the discharge line of the motor driven pump to prevent recirculation when this pump is not in operation. The motor driven fuel oil pump is automatically energized by low pressure in the fuel oil supply header and deenergized when pressure has returned to normal.

9.5.4.2.5 Filters

The system includes a 40-micron particle retention duplex strainer on the pump suction header, and a 5-micron particle retention duplex filter on the pump discharge header.

9.5.4.2.6 Associated Piping

The piping system shown on Vendor Technical Document PM018Q-0049 and Plant Drawing M-30-1 is made of carbon steel, designed for a primary rating of 150 psig and 500°F. The storage tanks are normally filled and replenished from the barge or the truck fill connection through a common underground line. A single fuel oil fill header is located in the SDG area of the Auxiliary Building with individual piping and valves to each of the eight tanks.

The diesel fuel oil transfer piping that is buried is primed and wrapped, in accordance with industry standards, AWWA-C-203 including Appendix A1.5 and/or A2.0. The buried portions of the diesel fuel oil transfer piping are cathodically protected by an impressed current cathodic protection system. The impressed current cathodic protection system is also considered as a nonsafety-related system.

The diesel engine fuel oil transfer piping cathodic protection system will be tested and inspected per Maintenance Department Preventive Maintenance Procedures. The frequency and type of preventive maintenance activities are shown below:

<u>2 Months</u>

Rectifier unit will be visually inspected for physical damage and excessive heat. Output voltage and amperage will be recorded. (Adjustments made as needed). The interior and exterior of the unit will also be cleaned at this time.

<u>12 Months</u>

1. The anode test leads will be cleaned and verified to be adequately protected.

2. Performance test of underground portion of system to determine if protection is adequate.

The buried portion of the diesel fuel oil transfer piping is not considered safety-related piping since an emergency fill connection is provided inside the diesel generator building, which can be isolated from the buried portion of the fill piping by an isolation valve which is located inside the building, as shown on Plant Drawing M-30-1. This emergency fill connection provides a protected fill path to the diesel fuel oil storage tanks, none of which is buried piping.

The diesel fuel oil transfer line from the diesel fuel oil storage tanks to the auxiliary boiler fuel oil storage tank is required for the following reasons:

a. regulatory requirements require the complete drainage of the diesel fuel oil storage tanks periodically,

b. provide capability of draining the diesel fuel oil storage tanks for maintenance and/or inspection,

c. provide capability to drain possibly contaminated diesel fuel oil.

The piping for transferring diesel fuel oil to the auxiliary boiler fuel oil storage tank has a minimum of 6 valves in the line from the transfer line of the diesel fuel oil storage tanks to the auxiliary boiler fuel oil storage tank.

Three of the valves are normally closed valves, two of the valves are check valves allowing flow from the diesel fuel oil storage tanks to the auxiliary boiler fuel storage tank, and one valve is a normally locked closed valve, reference Plant Drawing M-30-1 and Figure 9.5-31, sheet 1 of 2. The combination of normally closed valves, check valves and a locked closed valve will prevent inadvertent siphoning of the auxiliary boiler fuel oil back to the diesel fuel oil storage tanks if one of the manually operated valves is inadvertently opened. The combination of a normally locked closed valve and three normally closed valves minimizes the possibility of diesel fuel oil being inadvertently transferred away from the diesel fuel storage

oil tanks to the auxiliary boiler fuel oil tank if one of the valves is inadvertently left open.

The barge/truck fill connection has a simplex fuel filter, pressure drop instrumentation across the filter, fuel oil flow totalizer, and appropriate valving. An additional emergency flood protected truck fill connection is provided inside the auxiliary building at Elevation 102 feet. This additional emergency fill station is provided with a simplex filter and instrumentation similar to that on the barge/truck fill connection.

If, after a design basis event, the diesel fuel oil storage tank fill line is unable to deliver diesel fuel oil to the diesel fuel oil storage tanks, an alternate path for filling the tanks will be established. The alternate flow path will be a hose which will be temporarily routed inside the area of the diesel generator auxiliary building from the source to the diesel fuel oil storage tanks. The tank(s) can then be filled through the 4 inch spare flanged connection or the manhole opening, both of which are located on the top of the tank and are accessible for this purpose. When filling the diesel fuel oil storage tanks by this method, proper hose routing will be enforced to ensure that the hose is not crimped or damaged. Fire watches will be utilized along the length of the hose, as necessary, when this operation is in progress.

The common fill line and individual fuel oil storage tank manually operated fill valves are located outside the diesel fuel oil storage tank enclosures. The location of the common header and the individual tank fill valves in the corridor outside the diesel storage tank enclosure is 3 feet 6 inches from the wall of the enclosure. The enclosure is designed as a fire barrier in accordance with Section 9.5.1.1.10. The diesel fuel oil storage tank enclosures are provided with fire protection in accordance with Section 9.5.1.1.13. The system design normally has all of the tanks isolated through normally closed fill valves. Fire protection boundaries are shown on Plant Drawings M-5001, M-5002 and M-5003.

The fill connection is located in an area which is flood protected by the Auxiliary Building main service entry doors (see Plant Drawing M-5001). System Operation Procedures (SOP) will address the refilling of the storage tanks from any fill connection and include proper fuel hose routing and establishment of a fire watch, if necessary. Abnormal Operating Procedure "Acts of Nature" shall provide direction to the operator as to which SOP is used, dependent upon environmental conditions.

The connection will be sealed off to prevent water intrusion into the pipe. If water does enter into the pipe two normally closed isolation valves are provided to prevent it from entering the system. A drain valve with a capped end is provided between the truck/barge fill connection and the isolation valves to drain off any water that may have intruded into that section of pipe.

The diesel fuel oil storage tank vent lines are located in the standby diesel generator Auxiliary Building except for the end which is located outdoors. The vent line terminates at Elevation 162 feet - 9 inches, and has a conservation vent and a flame arrestor. The conservation vent and flame arrestor are designed to prevent water intrusion during adverse environmental conditions. The vent line is designed with a loop seal, as shown in Plant Drawing M-30-1. The loop seal will trap any water that may enter the pipe and route it to the oily waste system.

Filling of all storage tanks is controlled from the fill station control panel, which is located near the remote SDG control panel at Elevation 130 feet 4 inches. A solenoid valve automatically closes the common fill line when the selected storage tank reaches its high level setpoint. The remote diesel engine control panels and the fill station control panels are provided with appropriate display instruments and hand switches so that the operator is kept informed and can take necessary action during the filling or replenishing operation.

Overflow from the day tank is drained by gravity back to the storage tanks. Excess fuel oil from the engine injection system is returned to the day tank.

The storage tanks and the day tank are vented to the atmosphere through a common vent manifold ending with a conservation vent and an emergency relief vent. The conservation vent has a built-in flame arrestor as listed in Table 9.5-4. The vent manifold has a water loop seal to prevent overpressurization of the storage tank in the event of tank overfill. Each storage tank has drain and sample lines manifolded together into a single connection.

The diesel fuel oil can be transferred to the auxiliary boiler fuel storage tank through a one way common line that is connected by a normally closed manual valve branched off of each fuel oil transfer pump discharge line.

The day tank of any SDG set can be replenished from the storage tanks associated with other SDG sets via an intertie that bypasses the fill station.

9.5.4.3 Safety Evaluation

The SDG fuel oil storage and transfer system is designed so that failure of any one component results in the loss of fuel supply to no more than one SDG. Physical redundancy of active components in each fuel oil system is not provided. An independent fuel oil supply train is provided for each SDG. Each transfer pump is powered from the bus served by its respective SDG. Failure of one pump or SDG will not affect the operability of any component in another train. Only three of the four SDGs supplied for each unit are required during LOP and/or DBA to meet the safeguard load requirements. Therefore, failure of any one component of the SDG fuel oil storage and transfer system does not preclude safe shutdown of the plant following a LOCA and/or LOP. See Table 9.5-5 for a failure mode and effects analysis of the system.

Protection against hurricanes, tornadoes, and missiles is provided by locating system components within the SDG area of the auxiliary building. Each independent SDG fuel oil storage transfer system is completely enclosed in concrete, missile protected cells that are isolated from the other systems, except for the underground portion of the common supply line and the diesel fuel oil fill barge and truck connection. The SDG emergency diesel fuel oil fill connection is located in the SDG Auxiliary Building which provides protection from hurricanes, tornados and missiles as described in Section 9.5.4.2.6.

The SDG fuel oil storage and transfer system is designed to Seismic Category I requirements as defined in Section 3.7. The system components are housed in the SDG area of the Auxiliary Building, which is designed to Seismic Category I requirements as discussed in Section 3.8.

Evaluation of the SDG fuel oil storage and transfer system with respect to the following areas is discussed in separate FSAR sections as indicated:

1. Protection against wind and tornado effects - Section 3.3

2. Flood design - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1.

Exposure of the fuel oil system to ignition by flame or hot surfaces is minimized by separation of the individual fuel oil systems within the Auxiliary Building. Storage tanks and transfer

pumps of any individual system are located in a separate concrete vault below the corresponding SDG room (Elevation 54 feet). Access to the vault is through a door in the upper section of the wall.

The total capacity of all the SDG fuel oil storage tanks – each SDG has two 26,500 gallon nominal sized tanks - is sufficient to support 7 days of continuous operation of any three of the four SDGs at the rated full load indicated in Section 8.3 for mitigating a DBA LOP or LOP-LOCA. Within this period, additional fuel could be delivered to the plant site by truck or barge, but it would not be necessary for achieving safe shutdown.

In the event of probable maximum flood (PMF) with loss of offsite power, all four diesel generators would not be required to achieve and maintain cold shutdown. Based on time dependent loading for this case, there would be approximately 14 days fuel supply for diesel generator operation. Since it is unlikely for PMF site flooding to persist any longer than 24 hours, and any credible snowfall or debris may be cleared well within the 14 day period, there should be ample time to permit delivery of fuel and lube oil to the site.

While extremely adverse wind, weather and tidal conditions at the Hope Creek Site could interfere with diesel oil delivery for approximately 24-36 hours, it would be a very improbable situation that would preclude delivery by truck or barge for as long as 60 hours.

There are three key factors which support this conclusion. First, while any storm can remain stationary for an extended period, one in an adverse position (onshore) will lose its energy source and be eroded by surface friction. Secondly, any storm remaining offshore where it can retain all or some of its energy source will be in a position either to cause unusually low tides following the initial surge, or at least to provide shelter from the maximum winds because of the long fetch over the lower Jersey peninsula. Thirdly, the storm surge capable of seriously flooding the area is an enormous wave and it will not maintain site area flooding condition for prolonged periods (24-36 hours) even if the driving force continues.

A procedure will be implemented which requires PSE&G to order a fuel shipment to top off all the diesel fuel oil tanks once the National Weather Service issues a hurricane, tornado, or tropical storm alert for the Artificial Island area. Lube oil would also be ordered to bring the onsite supply to an amount required for fourteen days operation of the diesels.

Sediment in the fuel oil is retained by the simplex filter at the fill connection so that the overall quality of the stored fuel oil remains acceptable during replenishment.

If the barge/truck fill connections used under normal conditions are not available, the truck fill connection inside the building can be substituted for replenishing the fuel storage tanks.

9.5.4.4 Tests and Inspections

The SDG fuel oil storage and transfer system is preoperationally tested in accordance with the requirements of Section 14 and periodically tested in accordance with the requirements of Section 16. Periodic testing includes fuel oil sampling from each fuel oil tank to ensure that the fuel quality requirements are met.

The fuel oil storage tanks are provided with manholes for periodic inspection of the tank interior coating. The day tanks, booster pumps, and associated piping and valves are accessible for inspection.

9.5.4.5 Instrumentation Applications

Local and remote indicators, alarms, and pressure relief valves are provided to monitor the system's process and protect system components. There is only one trouble alarm annunciator window provided in the main control room for the four SDGs. The CRT is used to identify the problem SDG and indicate whether the alarm is high or low priority. All the alarms are individually annunciated at the remote control panel.

The following functions are alarmed at the SDG remote control panel and as a common high priority trouble alarm at the main control room:

1. Fuel oil pressure, low
2. Fuel oil day tank level, low.

The following functions are alarmed at the SDG remote control panel and as a common low priority trouble alarm at the main control room:

1. Fuel oil day tank level, high
2. Fuel oil storage tank 1 level, low-low
3. Fuel oil storage tank 2 level, low-low
4. Fuel oil storage tank 1 level, low
5. Fuel oil storage tank 2 level, low
6. Fuel oil filter differential pressure, high
7. Fuel oil strainer differential pressure, high
8. Fuel oil transfer pump 1 malfunction
9. Fuel oil transfer pump 2 malfunction.

The Instrumentation and Control Department will calibrate the instruments, controls, sensors and alarms required to assure operability of the diesel engine fuel oil transfer system. Table 9.5-20 provides an equipment summary and surveillance frequency. Calibration checks and calibration of the instruments, controls, sensors and alarms will be performed using written procedures.

Operator actions to preclude loss or conditions harmful to the diesel engine are provided in Table 9.5-21.

The fill portion of the diesel engine fuel oil transfer system is controlled from one of four control stations. Interlocks are provided to prevent more than one control station from opening fill valve HV-7534. Additional interlocks close fill valve HV-7534 when the selected fuel oil storage tank has reached a high level setpoint and the control mode selection switch is in automatic. Solenoid valve SV-7534 and air operated fill valve HV-7534 are configured to automatically close the fill valve on either a loss of solenoid electrical power or a loss of control air. All interlocks provide protection against inadvertent fuel oil storage tank overfill.

The fuel oil transfer pumps are operated automatically by level switches at the day tank. The transfer pumps can also be manually operated by switches mounted on the remote engine control panel. The fuel oil transfer pump discharge head is also displayed in both local and remote engine control panels. Indicating lights on the remote engine control panel show the fuel oil pumps in either an on or off condition. Indicating lights on the local control panel show that the transfer pumps are in either an on or off condition.

Indications of tank levels are displayed in the remote engine control panel. A secondary means of storage tank level determination is provided by a measuring tape.

The low-low level alarm setpoint in the storage tanks and the day tank are adjusted to enable the operator to accomplish minor repairs or maintenance before all the fuel oil is consumed by the SDG operating at rated capacity.

Since the fuel oil tanks and piping are within the auxiliary building or buried in the ground, the diesel fuel oil (Number 2) temperature is always above the cloud point. Fuel oil temperature is monitored by a temperature display instrument on the day tank

and by input to the computer from a sensor mounted on the transfer pump.

Except for the shutoff valve on the common fill header, all valves in the SDG fuel oil storage and transfer system are manually operated.

9.5.5 Standby Diesel Generator Cooling Water System

The Standby Diesel Generator (SDG) Cooling Water System provides cooling water to the SDGs and is safety-related.

9.5.5.1 Design Bases

The design bases of the SDG cooling water system are as follows:

1. Cool the engine cylinder jackets, turbocharger, combustion air, generator outboard bearings, speed governor oil, and the lubricating oil sufficiently to permit continuous operation of the SDG at full load.

2. Maintain the jacket coolant in a warmed condition while the diesel engine is in normal standby status to promote reliable starting.

3. Ensure that the single failure of any active component will not affect the operation of more than one SDG.

4. Remain functional during and after a safe shutdown earthquake (SSE).

5. Remain operational after 12 hours of no-load operation, provided that the SDG runs up to a minimum of 50 percent of full load for 1 hour immediately after such no-load operation.

6. Permit testing and inspection of active system components during plant operation.

7. Withstand wind, tornadoes, floods, and missiles.

The SDG cooling water system is designed to Seismic Category I requirements and complies with IEEE Standard 387. The quality group classification and corresponding codes and standards that apply to the design of the system are discussed in Section 3.2.

Compliance with Regulatory Guides 1.9, 1.115, and 1.117 is discussed in Section 1.8. Compliance with GDC 2, 4, 5, 17, 45, and 46 is discussed in Section 3.1. The SDG cooling water system is in compliance with the recommendations of NUREG/CR-0660.

9.5.5.2 System Description

The SDG cooling water system consists of two separate cooling loops: the jacket water cooling loop, and the intercooler cooling loop. The cooling water system is shown schematically on Vendor Technical Documents PM018Q-0052, PM018Q-0050 and Plant Drawing M-30-1. The intercooler cooling loop also cools the outboard bearing as shown on Vendor Technical Document PM018Q-0052. Each loop is cooled by the Safety Auxiliaries Cooling System (SACS), discussed in Section 9.2.2. The SDG cooling water system has sufficient heat removal capability to permit SDG operation under all loading conditions. The general arrangement of the SDG system is shown on Plant Drawings P-0051-0 and P-0053-0. The SDG cooling water system circulates demineralized water treated in accordance with the manufacturer's recommendations.

9.5.5.2.1 Jacket Water Cooling Loop

The jacket water cooling loop circulates demineralized water with a corrosion inhibitor to cool the SDG cylinder jackets,

turbocharger, and speed governor oil cooler. The loop consists of the following components:

1. An expansion tank

2. An engine driven jacket water pump

3. An ac motor driven keep warm pump and an electric heater to keep the engine warm during shutdown periods

4. An automatic thermostatic control valve

5. A jacket water heat exchanger

6. Alarms, indicators, valves, and piping.

The jacket water cooling loop component design parameters are given in Table 9.5-6.

The engine driven jacket water pump discharges the cooling water through the engine passages, the engine jacket header, the speed governor oil cooler, and the turbocharger, and delivers it to a three way thermostatically controlled valve. This valve directs the flow through or around the jacket water heat exchanger, depending on the water temperature, and back to the pump suction. Water inventory is maintained within the established limits of the system by an expansion tank that is connected to the pump suction piping. The expansion tank also serves the intercooler coolant loop. The expansion tank is located such that the cooling water system is properly vented.

The jacket water heat exchanger is a shell and tube heat exchanger. The tube side of the exchanger is served by the SACS.

The heat exchangers are procured to ASME Section III design and quality requirements.

The cooling water for the tube and shell side of the jacket water cooler and the intercooler heat exchanger, and the tube side of the lube oil heat exchanger is demineralized water treated with corrosion inhibitors. Treated demineralized water is also used to cool the governor oil. The tube material for lube oil, jacket water and intercooler heat exchangers is corrosion resistant 90/10 copper nickel. These design provisions give reasonable assurance that the heat exchangers will last the 40 years design life without leakage. The diesel manufacturer has confirmed that their past operating experience with similar designs has not shown leakage to be a problem.

Generally, lube oil in the water system has no detrimental effect on the engine. However, since the SACS cooling water pressure will always be higher than the pressure in the oil systems it is cooling, leakage will always be from the water systems into the oil systems, thus water in the lube oil could be of concern. The diesel engine manufacturer does not have prescribed acceptable leak rates or limits since these parameters are peculiar to the type of lube oil being used in the units. The diesel engine lube oil will be monitored and analyzed in accordance with the particular lube oil supplier's recommendations and diesel manufacturer operation and maintenance procedures.

The rocker arm lubrication system is separated from the main lubrication system because of the proximity of the rocker system to sources of water (cylinder heads, rocker assemblies, etc). Addition of water to that system, due to leakage, would be detected by the high rocker arm tank level alarm.

The intercooler (combustion air coolers) cools the combustion air after compression. During the cooling process moisture in the combustion air is condensed. The condensate collects at the outlet of the cooler after passing through stationary baffle plates which

remove moisture, and is drained through an open 3/4 inch line which is vented. If a leak in the intercooler occurs the excessive moisture would be detected by the presence of higher than normal spray from the drain line. The diesel engine manufacturer has indicated that during engine operation there is little or no moisture dripping from the drain. However, during operation in high humidity (95-100 percent) and high air temperature there would be a spray from the drain.

The governor control oil is sensitive to contamination by sludge, dirt, air and water. The governor oil will be checked according to plant operating procedures. If the sample is found to have water contamination, the governor oil will be drained and the cooler checked for leaks. If a leak is found, the cooler will be replaced.

The capacity and design requirements of the cooling water system expansion tank are given in Table 9.5-6. The tank is wall mounted in the diesel generator room, with the bottom of the tank elevated above the highest point in the diesel generator cooling water system to ensure proper pump NPSH and system venting.

An analysis based on the manufacture's estimates of maximum leakage rates from pump seals, valves, and piping components yields a total cooling water leakage rate of 33.6 gallons per week. This represents approximately 1/3 of the capacity of the 100 gallon jacket water expansion tank.

Under normal operation, makeup water tank to the expansion water tank will be supplied from the demineralized water system. The jacket water solenoid makeup valve, shown as Item No. 21 in Vendor Technical Document PM018Q-0050, will open to refill the expansion tank with demineralized water via the level control switch, shown in Vendor Technical Document PM018Q-0050 as Item No. 15. This level switch has displacers for a low level alarm and an overflow alarm which are annunciated in the control rooms.

The expansion tank overflow line is seismic Category I, ASME B&PV Code, Section III, Class 3. Routing from the expansion tank to the

equipment drain is all within the related diesel generator compartment. The jacket water expansion tank has a high-low level alarm which would indicate a problem in the system prior to overflowing of the expansion tank. There is no 1E equipment located in the area between the overflow line and the floor drains, therefore, no 1E equipment would be affected by a line break. Water from the overflow line flows into an equipment drain which leads to the plant oily water waste collection system. A line break in the expansion tank overflow line will have no effect on the operation of the corresponding diesel generator or on any diesel generator auxiliary equipment. Any water accumulated in a ruptured overflow line will be routed to one of two floor drains present in each diesel generator room. Both floor drains, which are adequately sized to handle any water accumulated in the overflow line, are routed to the oily waste system. The drainage system for the standby diesel generator areas is a nonsafety-related system. However, the drainage system is embedded in Seismic Category I concrete flooring and walls. The standby diesel generator room drainage system consists of two floor drains and six equipment drains. The drains in each standby diesel generator room are headered together to a common line. The drain line is provided with a normally closed isolation valve which will isolate that diesel generator room from the other diesel generator rooms, and the remaining portions of the system.

Each standby diesel generator room drain header is routed vertically down to Elevation 54'-0", in a Seismic Category I concrete wall, to a common horizontal drain header which is routed to an oily waste sump. The horizontal drain header accepts drains from the standby diesel generator ventilation rooms, which are located on elevation 77'-0", and from the diesel fuel oil storage tank rooms at elevation 54'-0". The drain header from each of the diesel fuel oil storage tank rooms is provided with a normally closed isolation valve, providing isolation capability for each diesel generator fuel oil storage tank room. The ventilation room and fuel oil storage tank room drainage lines are routed separately to the common horizontal drain header. The vertical drain header from each of the standby

diesel generator rooms and the common horizontal drain header are four inch cast iron piping which are provided with clean out connections. The drains from the diesel generator ventilation rooms and fuel oil storage rooms are four inch cast iron pipe provided with clean out connections.

The drainage sump, which accepts drains from the common horizontal header, is provided with two 100 percent sump pumps, which pump the oily waste to the oily waste processing system, level controls, and high level alarm. The pumping system is provided with a back flow preventer to prevent fluids from flowing back to the sump from the oily waste processing system.

Failure of a drainage system from any diesel generator room will not affect the operation of the other diesel generator rooms.

During shutdown periods, an ac motor driven keep warm pump and an electric immersion heater, which have a Class 1E power source, keep the jacket water warm to maintain the engine at or above the minimum temperature required for optimum starting under design conditions. The recirculation pump takes suction from the engine jacket discharge header, directs the water through the thermostatically controlled heater, and discharges it to the engine passages. The water chemistry of the demineralized water used for makeup is discussed in Section 9.2.3.

9.5.5.2.2 Intercooler Cooling Loop

The intercooler cooling loop is a closed loop that provides cooling for the SDG combustion air intercoolers and generator outboard bearings. The system consists of the following components:

1. Two combustion air intercoolers

2. An engine driven intercooler water pump

3. An automatic thermostatic valve

4. Heat exchanger

5. Indicators, valves, and piping.

The intercooler cooling loop design parameters are given in Table 9.5-7.

The engine driven intercooler pump discharges demineralized cooling water through a three-way thermostatically controlled valve. The valve directs the flow through or around the heat exchanger, depending on coolant temperature. The cooling water is directed back to the engine, where it goes through the intercooler and outboard bearing and back to the pump suction, as shown on Vendor Technical Document PM018Q-0052. The combustion air intercoolers are jackets that surround the turbocharger discharge piping. Water flowing through the combustion air intercooler removes heat from the combustion air. Cooling water flow through the combustion air cooling water heat exchanger (tube side) removes heat from the combustion air cooling water (shell side). Water inventory is maintained within the established limits of the system by the expansion tank, which is connected to the pump suction piping. The expansion tank also serves the jacket water cooling loop. The heat exchanger is a shell and tube type, served by the SACS. The water quality of the demineralized water used for makeup is discussed in Section 9.2.3.

9.5.5.3 <u>Safety Evaluation</u>

The SDG cooling water system is designed so that failure of any one component results in the loss of no more than one SDG. Since only three of the four SDGs are required for safety loads, failure of any one component of the SDG cooling water system does not preclude safe shutdown of the plant following a loss-of-coolant accident (LOCA) and/or loss of offsite power (LOP). For a failure mode and affect analysis, see Table 9.5-8.

Protection against hurricanes, tornadoes, and missiles is provided by locating system components within the SDG area of the auxiliary building. Each independent SDG cooling water system is completely enclosed with its respective SDG in a concrete, missile protected cell that is isolated from the other units.

The SDG cooling water system is designed to Seismic Category I requirements as defined in Section 3.7. The system components are housed with their respective SDG unit in the SDG area of the auxiliary building, which is designed to Seismic Category I requirements as discussed in Section 3.8.

The electrical relays and switches associated with starting the diesel engine are housed in dust tight and drip tight panels (NEMA Type 12 indoor enclosures).

The cooling water piping in these areas is ASME Section III, Seismic Category I, moderate energy piping. This piping is routed at lower elevations and away from the panels as much as practicable in the limited space of the SDG enclosure. The demineralized water line used to fill the jacket water expansion tank and the HVAC piping located in the standby diesel generator rooms are remotely located with respect to the standby diesel generator control panels. No water lines are routed over the standby diesel generator control panels. Fire protection in these areas is by CO_2 and therefore, water spray due to leakage from fire protection piping is not possible.

Evaluation of the SDG cooling water system with respect to the following areas is discussed in separate FSAR sections as indicated:

1. Protection against wind and tornado effects - Section 3.3

2. Flood design - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1.

9.5.5.4 Tests and Inspections

The SDG cooling water system is preoperationally tested in accordance with the requirements of Section 14 and periodically tested in accordance with the requirements of Section 16.

9.5.5.5 Instrument Applications

Local and remote indicators and alarms at the SDG remote control panel at the 130-foot elevation are provided to monitor the system's processes. Pressure relief valves protect system components. Only one trouble alarm annunciator window is provided in the main control room for the four SDGs. The CRT is used to identify the problem SDG, and indicate whether it is a high priority or low priority alarm. All the alarms are annunciated individually at the remote control panel.

The following functions are alarmed at the SDG remote control panel and as a common high priority trouble alarm at the main control room CRT:

1. Jacket water low pressure, alarms at 25 psi (decreasing)

2. Jacket water high temperature, alarm at 185°F (increasing)

3. Jacket water low temperature, alarms at 145°F (decreasing)

4. Jacket water low expansion tank level, alarm at elevation 118'-8".

The following functions are alarmed at the SDG remote control panel and as a low priority trouble alarm on the main control room CRT:

1. Jacket water keep-warm high temperature, alarms at 175°F (increasing)

2. Jacket water keep-warm low temperature, alarms at 140°F (decreasing)

3. Jacket water high expansion tank level, alarms at elevation 120'-5"

4. Jacket water expansion tank, filling.

The jacket water keep warm heater will not start unless the keep warm pump is started.

The alarm system is discussed in Section 8.3.1.

The Instrumentation and Controls Department will perform the calibration checks and calibration of instrumentation controls, sensors and alarms necessary to maintain and assure operability of the diesel engine cooling water system. The equipment, function and surveillance frequency is provided in Table 9.5-22. Equipment testing will be performed in accordance with written procedures. Alarm locations are discussed in Section 8.3.1.1.3. Section 9.5.5.5 has been revised to identify the temperature, pressure and level parameters which alert the operator when the manufacturer's recommended ranges are exceeded. Operator response to alarm conditions is summarized in Table 9.5-23.

The diesel generator cooling water system is provided with automatic refill of the jacket cooling water expansion tank from the demineralized water system. Heaters prewarm the jacket cooling water when water temperature decreases below a preset temperature limit. These automatic controls maintain the diesel engine cooling water system in standby readiness.

The diesel engine starting logic does not require permission signals from the diesel engine cooling water system. Normal and emergency starts of the diesel engine will not be inhibited. The diesel engine trip and stopping circuits cannot be actuated by cooling water system malfunctions or related instrument failures.

9.5.6 Standby Diesel Generator Starting and Control Air System

The standby diesel generator (SDG) starting and control air system supplies compressed air to initiate an engine start, so that the SDG is ready to accept load within 10 seconds after receipt of the start signal. The SDG starting and control air system is safety-related except for the air compressor, the air dryer with its fan, and their motors.

9.5.6.1 Design Bases

1. An engine start is initiated so that the SDG is ready to receive load within 10 seconds after receipt of the start signal.

2. The SDG starting and control air system remains functional during and after an SSE.

3. The single failure of any active component does not result in the loss of the starting function of any SDG.

4. Active components of the system can be tested and inspected during plant operation.

5. The system can withstand wind, tornadoes, floods, and missiles.

6. The SDG starting and control air system shall comply with IEEE Standard 387, Standard Criteria for Diesel Generator Units Applied as Standby Power Supplies for Nuclear Generating Stations.

The seismic category, quality group classification, and corresponding codes and standards that apply to the design of the safety-related components of the SDG starting and control air system are discussed in Section 3.2. Compliance with Regulatory Guides 1.9, 1.115, and 1.117 is discussed in Section 1.8. Compliance with GDC 2, 4, 5 and 17 is discussed in Section 3.1.

9.5.6.2 System Description

Each SDG is equipped with two independent air starting systems. Each consists of one air receiver, line filters, and associated piping and valves. A single motor driven air compressor and an air dryer provide compressed air for both systems. The standby diesel generator starting air compressor motor is a non-Class 1E load which is powered from a Class 1E distribution system, reference Table 8.3-1. The SDG starting and control air system is shown on Vendor Technical Document PM018Q-0048. Major component design parameters are listed in Table 9.5-9. The SDG general arrangement is shown on Plant Drawings P-0051-0 and P-0053-0.

Piping, valves, and air receivers are constructed of stainless steel designed to ASME Section III, Class 3 requirements to eliminate the effects of corrosion created by condensation in the system. Drains are provided to blowdown the system to remove any moisture and foreign material.

The motor driven air compressor cycles on and off to maintain the pressure within the proper range. An air dryer at the discharge of the compressor dries the compressed air to a dewpoint of 35°F. Each air receiver set can supply starting air for a minimum of five consecutive engine starts with a beginning receiver pressure of 325 psig. Additional redundancy is provided to cross connect air compressors in the event of a compressor outage. High pressure hose connections (Vendor Technical Document PM018Q-0048) are located in the non-Q portion of the air compressor piping to permit temporary installation of a cross tie high pressure hose to supply the air receivers on one SDG from the air compressor associated with another SDG.

The basic control sequence is that the compressor cycles on at 380 psi, decreasing pressure, and off at 450 psi, increasing pressure. The low pressure alarm, to the remote panels and the control room is set at 347 psi decreasing pressure and there is no low-low pressure

alarm. There is no high pressure alarm; however, the receiver safety relief valves relieve pressure at 475 psi.

Each air receiver is provided with relief, drain, check, and shutoff valves to permit any receiver to be removed from service, repaired, and replaced without affecting the air compressor or the other air receiver.

Water (and oil if any is present) is automatically drained from the compressor by means of a solenoid valve. Water, as a result of condensation in the receivers, is drained manually on a periodic basis. With the moisture removed and the entire system made of stainless steel materials (except the compressor) rust will not be a problem. As a final protective measure, in-line air filters are located upstream of the air start solenoid valves to prevent any contaminants from fouling the valves (Reference Vendor Technical Document PM018Q-0048).

A start signal causes starting air to be released to the diesel engine cylinders by solenoid actuated control valves. The solenoid actuated air start valves admit starting air to the engine mounted air start distributors through the air start headers. Each air start distributor is mechanically linked to the engine rotation so as to match the firing sequence of the engine. The distributor in turn allows starting air to enter the engine cylinders in the proper sequence to start the engine rotating. Normally the engine starts and is ready to receive load in 10 seconds or less. Consequently the air start attempt is limited to a nominal 7 seconds by a time control relay to conserve starting air in the event of an unsuccessful engine start. The air start solenoid valve also releases compressed air to the fuel rack booster when the engine is to be stopped. Pressure switches on the air receivers cause the air compressor to start in order to restore pressure in the receivers or to stop the compressor when normal pressure is reached. When the SDG is on the barring gear, an interlock prevents an inadvertent start of the engine. An alarm and light indicating that the SDG is locked out for maintenance and provided on the local and remote

engine control panels and it also alarms in the control room. When the engine is locked out for maintenance, the starting air headers are pneumatically and electrically locked out to prevent inadvertent starting attempts.

The normal diesel air start utilizes both air start headers and both air receivers.

The starting and control air system is designed such that one receiver supplies starting air to one bank of cylinders, and the other receiver supplies starting air to the other bank of cylinders. The air headers are normally not connected together. The SDG can be started using only one receiver and one bank of cylinders. Therefore, if one receiver or the piping from the receiver to the cylinder bank should fail, the operation of the SDG would not be affected.

The starting air system is also connected to the air shutdown tank. The tank is actually an enlarged 6 inch section of ASME pipe in the air start supply piping on the engine skid which serves the sole purpose of closing the fuel racks to shutdown the engine on a stop signal.

The diesel generator control design has a time delay relay which holds the fuel racks closed for 140 seconds to allow the unit to come to a complete stop. However, in the event of an emergency start signal during this count-down time this relay is functionally overridden and the fuel racks open to allow the diesel to continue to run or restart through the normal starting air sequence.

Figure 9.5-46 is the schematic of the time delay and shutdown circuit. The time delay relay is designated as "Stopping Timer 5A". For a normal stop function, actuation of control switch "CS-1" to the stop position (switch located on the local engine control panel), the stop pushbutton (located in the main control room), or the stop switch at the remote engine control panel will energize the 5A timer. The relay coil 5AX is energized when either the stop

pushbutton or the stop switch is actuated. Once the 5A timer is energized its contact, 5A, will close for 140 seconds to energize the "shutdown solenoid SDS". The shutdown solenoid will supply air pressure to the engine stop tank which also supplies air to the fuel rack solenoid valve to drive the fuel racks to the zero fuel position. Vendor Technical Document PM018Q-0048 shows the fuel rack solenoid as item 3.

In the event that an emergency start signal is received during the normal stop sequence, the "shutdown solenoids SDS" will be deenergized by contacts ESA or ESB, and the engine will restart and run in the emergency mode.

9.5.6.3 Safety Evaluation

Safety-related components of the SDG starting and control air system, including supporting structures, are designed to Seismic Category I requirements as defined in Section 3.7. The system is located in the SDG area of the Auxiliary Building, which is designed to Seismic Category I requirements as discussed in Section 3.8.4.

The starting air system does not have any operating control functions, and a failure of any of the valves or piping in the air start system supplying control air to the servo fuel rack shutdown and control air supply systems would not affect the continued, safety-related operation of the engine. Valves 34b and 35 are located in pressure monitoring piping used for testing purposes to cross connect the "a" and "b" air headers. They should remain closed to prevent a possible single failure of both air trains.

The SDG starting and control air system is designed so that failure of any one active component does not result in the loss of starting air to any SDG. Therefore, failure of any one component of the SDG starting and control air system does not preclude safe shutdown of the plant following a loss-of-coolant accident (LOCA) and/or loss of offsite power (LOP). See Table 9.5-10 for the failure modes and effects analysis of the system.

Each SDG set is located in the Auxiliary Building, which is protected against the effects of natural phenomena such as tornadoes, hurricanes, and floods. Evaluation of the SDG starting and control air system with respect to the following areas is discussed in separate FSAR sections as indicated:

1. Protection against wind and tornado loadings - Section 3.3

2. Water level (flood) design - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design of mechanical and electrical equipment - Section 3.11

6. Fire protection program - Section 9.5.1.

Adequate compressed air for each diesel is stored in its two individual storage systems so that each system can start the diesel at least five times without compressor assistance.

Two solenoid air start valve trains are installed on each diesel. Each train supplies air to half of the cylinders. If one valve train fails, the other valve train supplies sufficient starting air. Failure of the compressor is indicated by pressure gauges mounted on the air receivers. Pressure in each valve train is indicated by pressure gauges mounted on the local and remote engine control panels. Low starting air pressure on either of these valve trains is alarmed on the remote engine control panel. The SDG starting and control air systems also have a common trouble alarm in the main control room. A single active failure in either starting system does not compromise the ability of the systems to accomplish their function.

9.5.6.4 Tests and Inspections

The SDG starting and control air system is preoperationally tested in accordance with the requirements of Section 14 and periodically tested in accordance with the requirements of Section 16, and as referenced in 10CFR50 Appendix A, GDC 18.

Procedure MD-PM.KJ-002(Q), Starting Air System Preventive Maintenance procedure provides instructions for maintaining a high degree of reliability for the air dryers in the diesel engine starting air system. The air dryers used in this application are refrigerant type. The performance of the dryers will be verified every 3 months by obtaining dryer outlet temperature and comparing it to manufacturer recommendations. In addition, the Operations Department will include in its daily rounds a check of compressor oil levels and will drain moisture from the starting air storage tanks on a weekly basis.

9.5.6.5 Instrument Applications

Each starting air system is provided with a pressure switch, a pressure indicator on the starting air skid, and a low pressure alarm at the remote SDG control panel. The low pressure alarm is annunciated at 347 psi (decreasing pressure) on the remote engine control board and at a common trouble alarm in the main control room. The pressure switch cycles the motor driven air compressor on at 380 psi (decreasing pressure) and off at 450 psi (increasing pressure) to maintain the pressure in the receiver with in the proper range. Safety relief valves on the receiver are set at 475 psi.

Only pressure controls and instrumentation are supplied air by the starting air system; temperature and level sensors are not applicable. A summary of the equipment and surveillance frequency is provided on Table 9.5-24.

A low pressure alarm on each of the air trains alerts the operator of system trouble in the control room. Operator response to diesel engine starting air system alarms is summarized in Table 9.5-25.

9.5.7 Standby Diesel Generator Lubrication System

The Standby Diesel Generator Lubrication System provides lubrication to the components of the standby diesel generators (SDGs). The system is safety-related.

9.5.7.1 Design Bases

The Standby Diesel Generator Lubrication System is designed to perform the following functions:

1. Supply a continuous flow of oil to all surfaces requiring lubrication at controlled pressure, temperature, and cleanliness.

2. Warm and circulate the oil in normal standby status to promote SDG starting and prevent excessive lube oil viscosities.

3. Ensure that the failure of any single active component does not affect the operation of more than one SDG.

4. Remain functional during and after a safe shutdown earthquake (SSE).

5. Withstand wind, tornadoes, floods, and missiles.

6. Permit testing of active system components during plant operation.

The SDG lubrication system is designed to Seismic Category I requirements and complies with IEEE Standard 387. The quality group classification and corresponding codes and standards that

apply to the design of the system are discussed in Section 3.2. Compliance with Regulatory Guides 1.9, 1.115, and 1.117 is discussed in Section 1.8. Compliance with GDC 2, 4, 5, and 17 is discussed in Section 3.1. The SDG lubrication system is in compliance with the recommendations of NUREG/CR-0660.

9.5.7.2 System Description

The SDG lubrication system consists of two subsystems, the Engine Lube Oil System and the Rocker Arm Lube Oil System. The engine lube oil system consists of an engine driven lube oil pump, a suction strainer, a lube oil heat exchanger, a Class 1E motor-driven prelube/keep warm pump, a Class 1E immersion heater, a wye strainer at the motor driven pump suction, a simplex strainer, a simplex filter, and a lube oil makeup tank. The rocker arm lube oil system consists of an engine driven rocker arm lube oil pump, a Class 1E motor driven rocker arm prelube pump, a rocker arm lube oil reservoir, and a duplex rocker arm lube oil filter. A Class 1E ac power source of the same channel as the SDG is used to supply power to the immersion heater and the rocker arm prelube pump. Major component design parameters for these two systems are shown in Table 9.5-11. The SDG general arrangement is shown on Plant Drawings P-0051-0 and P-0053-0. A schematic diagram of the lubrication system is shown on Vendor Technical Document PM018Q-0056 and Plant Drawing M-30-1.

Each SDG crankcase is the main source of lube oil for the engine and rocker arm lube oil systems. If the lube oil level drops below set limits, a solenoid valve actuated by a low level switch in the crankcase opens, and lube oil flows by gravity from the makeup tank into the crankcase. A high level switch actuates valve closure. Degraded oil from the engine crankcase can be drained for reclaiming by the motor driven pump of the engine lube oil system via a three way valve on the pump discharge and a drain header. As shown on Plant Drawing M-30-1, each diesel generator is provided with a lube oil sampling and drain line which is used for taking lube oil samples from the crankcase. The line is routed just off the skid and capped.

Referring to Vendor Technical Document PM018Q-0056, the "Oil Drain and Fill" line is connected through a three-way valve to both the fill header and the drain header which is routed off the skid and capped. This makes it possible to add oil directly to the crank case, through a basket strainer, from the lube oil delivery truck using the pump on the truck. It is also possible to drain the diesel crankcases to a truck or storage oil drums.

There are no interties between these lines and any other systems. The lines are Quality Group D, and non-seismic Category I except for the interface portion next to the Q pipe/equipment which is seismically analyzed to assure the piping will maintain its integrity, including retention of fluid inventory, during and after a seismic event (SSE).

Lubricating oil quality is maintained through the use of full flow filters and strainers and is verified by periodic laboratory testing. Deleterious material is prevented from entering the diesel engine lube oil make-up tank by:

1. Procuring high quality, high purity lube oil with lubricating properties in accordance with the manufacturer's recommendations.

2. Insuring that filling operations to increase make-up tank level are performed through the installed basket strainer in the fill line or other method using a $\leq$ 5 micron filter.

The lube oil make-up tank conservation vent permits tank venting when required and prohibits airborne impurities from continuously entering the tank.

Make-up tank filling is accomplished in accordance with a written procedure. A controlled copy of the procedure is posted in the vicinity of the lube oil fill line. The lube oil fill line is labeled to identify the fill line connection purpose and the applicable procedure.

a. Algae formation may occur due to the condensate accumulation in the make-up lube oil tank. Prior to diesel engine monthly operability testing, and in accordance with plant Technical Specifications, the lube oil make-up tank drain is opened to remove any water, sediment, algae or other deleterious material. If lube oil purity is degraded any of the following methods can be implemented to restore lube oil purity in the make-up tank:

   1. All deleterious material may be removed by draining lube oil through the drain line.

   2. The lube oil make-up tank can be drained, cleaned and refilled with fresh lube oil.

   3. A chemical additive can be added to remove algae or other biological growth if advised by a tribology specialist.

b. The standby diesel generator lube oil make-up tank material is carbon steel, SA 515 GR. 70. The exterior of the tank is coated using Colt Industries standard protection system. The system consists of a primer of Gordon Bartells 13409, yellow, and a finish coat of Gordon Bartells 14-811, suede grey, both applied according to the paint manufacturer's recommendations. The interior of the tank is not coated because the lube oil is non-corrosive. Corrosion of the SDG lube oil makeup tank in the unfilled areas is prevented by lube oil vapor coating, normally found on unflooded sections of lube oil tanks.

   Prevention of corrosion of the lower head of the SDG lube oil makeup tank due to moisture accumulation is addressed in part d below.

c. The vent and emergency pressure relief vent are terminated indoors, directly above the tank. The fill line is routed to the outside (west) of the auxiliary building at elevation 105 feet 0 inches, 3 feet above grade. The line is capped and has a normally closed isolation valve located in the building to prevent water from entering the line. It is not protected from missiles and tornadoes because it is not safety-related.

d. In accordance with Station Administrative Procedures, twenty 55-gallon drums of diesel engine lubricating oil are stored and available for use if diesel operation is required for a prolonged period. Additional information on lube oil make up requirements is provided in Section 9.5.7.2.1. The lube oil make-up tank bottom is hemispherical. The line to the diesel generator sump is approximately 1.75 inches above the bottom of the dish and is located ten inches off the centerline of the tank, see Figure 9.5-48. Should there be any carry over into the transfer line, it would be trapped in the strainer and/or filter after entering the engine sump.

   A normally closed drain valve is provided at the low point of the tank; reference Vendor Technical Document PM018Q-0056 and Figure 9.5-48. The drain valve is opened in accordance with plant operating procedures to remove any deleterious sediment, water or other material that may accumulate in the bottom of the tank.

Each crankcase is provided with a built-in crankcase evacuation system using an ejector to maintain a negative pressure in the crankcase. This minimizes seepage of lube oil from seals and gaskets.

The crankcase evacuation systems failure will not affect engine performance. The vacuum is generated by an ejector, powered by higher pressure air from turbocharged air intake manifold. Gas

from the crankcase passes through an oil separator to remove oil mist before going to the ejector; liquid oil is returned to the engine sump. The system discharge is piped outside the building. In the unlikely event of a crankcase explosion, all crankcase covers on the left side of the engine have large safety valves to release pressure preventing the engines internals from being damaged.

The crankcase evacuation system is located in the SDG Auxiliary Building which is designed for tornado and missile impact as described in Section 3.3 and 3.5. The ejector system is shown on Vendor Technical Document PM018Q-0047.

The flow rate and temperature of the safety auxiliaries cooling water through the lube oil heat exchangers is adequate to remove the amount of heat specified by the SDG manufacturer for all operating conditions.

The intercooler heat exchanger, the jacket water heat exchanger, and the lube oil heat exchanger are cooled by the series arrangement shown in Vendor Technical Documents PM018Q-0052, PM018Q-0050 and PM018Q-0056. The requirements for the inlet cooling water to these diesel generator coolers are shown in Table 9.2-4.

Colt confirms that 95°F inlet temperature of cooling water is adequate for proper cooling of this unit. The series system as outlined (intercooler heat exchanger, jacket water heat exchanger, and finally, lube oil heat exchanger) is the manufacturer's proven standard design. The lube oil heat exchanger has been sized for the expected water temperature at the outlet of the jacket water heat exchanger.

Hope Creek Generating Station SDG is not different than all of the other Colt SDGs. HCGS uses Colts "standard" design. Some other units have been different as a result of either specification requirements or specific site requirements. In all cases, Colt

analyzes the specific requirements and sizes all heat exchanger equipment accordingly.

9.5.7.2.1 Lube Oil Consumption

Each SDG and its makeup tank contains an adequate supply of lube oil for the SDG to operate for a minimum of 7 days at maximum rated load.

The system has been designed so that oil may be added to the sump. Normally, lube oil will be added via the fill line, or other method using a $\leq$ 5 micron filter, to the lube oil makeup tank as shown on Vendor Technical Document PM018Q-0056 and Plant Drawing M-30-1. It would then flow through the solenoid level control valve to the engine sump. Oil may also be added directly to the oil sump via the fill line or, if required, directly to the engine sump via the gravity fill line on the side of the crankcase.

Administrative Procedures include a distribution list for field approved procedures. The diesel generator control panel rooms are listed for containing a controlled copy of the procedures required for local diesel operation.

The level is verified by the level indicator on the lube oil makeup tank or, if the oil is added directly to the sump, it will be verified by the nonrecurrence of the low level alarm after its acknowledgement and a dipstick from the sump.

Diesel engine lubricating oil fill points are clearly labeled to identify the fill point, type of lubricating oil required, and the number of the applicable operating procedure.

Operations personnel will be trained in the use of diesel generator operating procedures during operator requalification.

The lube oil consumption rate for the standby diesel generator at the rated 4430 KW (6148 BHP) is 1.12 to 1.55 gallons per hour. The

engine manufacturer, Colt Industries, indicates that the lube oil consumption rate does not vary appreciably with the engine load level.

The engine manufacturer indicates that a lube oil consumption rate of 3 gallons per hour would be considered excessive and should be investigated and remedied.

The diesel engine manufacturer recommends that the diesel engine sump be kept "topped off" in the standby condition and not allowed to be at the "minimum level" condition so that it is always ready to operate for the maximum duration required.

To raise the lube oil level in the diesel engine sump from the minimum level to the full running depth, approximately 220 gallons of lube oil is required, which is the capacity of four 55 gallon storage drums of oil. At a consumption rate of 1.55 gallons per hour the engine can operate for 142 hours. To operate for 168 hours, an average consumption rate of 1.31 gallons per hour should not be exceeded, which is in the expected consumption range. The lube oil make up tank contains 250 gallons of oil; therefore, the make-up tank can raise the sump level from minimum level to full with an additional 30 gallon in reserve. The lube oil make up tank can therefore maintain the diesel engine in the operating lube oil range for 161 hours at a consumption rate of 1.55 gallons per hour.

In the unlikely event that the SDGs are required to operate for a prolonged period of time, a minimum of 275 gallons of lube oil per diesel generator (twenty 55 gallon drums, total) will be stored on site for emergency makeup. The 275 gallon storage of lube oil per diesel generator exceeds the required lube oil makeup for a 7-day supply at a maximum, worst case, consumption rate of 1.55 gallons per hour.

Therefore, with the additional onsite storage of twenty 55 gallon drums of lube oil, as required by administrative controls, there

will be sufficient lube oil to operate the diesel engines for 7 days from the low level sump indication.

Operator action on failure of the solenoid valve to provide adequate engine lube oil sump makeup capability is specified in the appropriate alarm response procedure. Lube oil can be directly added to the lube oil sump by removing the crankcase dip stick and manually adding lube oil with the aid of a funnel.

If during the course of routine SDG operation, it becomes apparent that the lube oil consumption rate is excessive, engineering and vendor services will be drawn-on to assist in identifying and correcting the abnormal condition.

Operating department shift reading sheets require the visual verification and logging of the SDG lube oil make-up tank levels on a daily basis when the SDG is in "standby" condition. Additionally, SDG periodic test procedures require the visual verification of lube oil make-up tank level(s), both before and after such testing is performed. Upon completion of testing, the findings will be compared against the previous months test results and the normal oil usage rates. In this manner, any appreciable changes in engine performance will be immediately identified and corrective measures taken as necessary.

Plant operator training, and subsequent requalification training, adequately stress the importance of proper equipment lubrication, logkeeping and systems training. This training, combined with "in-house" plant experience, suffices to alert operators to any abnormal diesel generator condition.

Site flooding (i.e. flooding above plant grade elevation) is a highly unlikely event. The highest historical high water was 97.5 feet (PS Datum), recorded November 1950, 4 feet below plant grade. As an estuarine, site flooding is primarily a result of the effects of tide combined with severe storms. The tidal cycle being approximately 12 hours in duration would reasonably be expected to

contribute to site or local flooding for only a few hours. This would afford the opportunity to refuel the lube oil make up tanks within a few hours of any scheduled refueling.

Severe site flooding to the design flood level is due to the PMH as defined in Regulatory Guide 1.59. Precise track position and forward speed (27 knots) as well as other assumptions are necessary to develop the flood levels calculated for the design basis event. A description of the analysis is presented in Section 2.4.5. A forward speed of 27 knots would cause the hurricane to move over 300 miles past the site in 10 hours. The maximum winds are assumed to extend 39 nautical miles. The forward travel speed is a critical parameter in the calculation, as this is what causes the large volume of water to be first forced into the Delaware and then carried up the estuary past the site. Even in the event that the storm should stall, flood water will tend to drain out the bay as the forcing function is no longer available to push water into the bay. There would also be a further reduction of flood waters due to the tidal change. It would be unrealistic as to expect site flooding to persist for more than 24 hours. Upon continuous operation of the diesel generators for any 2 day period, a new lube oil shipment will be delivered. For additional information, see Section 9.5.4.3.

9.5.7.2.2 Engine Lube Oil System

When the SDG is in operation, oil is drawn from the crankcase through the pump strainer by the engine driven lube oil pump and circulated through the heat exchanger and the simplex strainer to the lube oil header. Large particles in the lube oil are trapped by the pump suction strainer. Particles over 40 microns are trapped by the simplex strainer. A thermostatic three-way valve directs oil flow through the heat exchanger or through the heat exchanger bypass to ensure the oil temperature is within the manufacturer's recommended range. The lube oil header feeds oil under pressure to engine components. From there, oil flows by gravity back to the crankcase. The lube oil header also feeds the rocker lube oil

system by means of a level control valve on the rocker reservoir feed line.

When the SDG is not operating, oil is continuously drawn from the crankcase by the motor driven prelube/keep-warm pump and circulated through the immersion heater, the simplex filter, the thermostatic three way valve, and the simplex strainer to the lube oil header. The immersion heater cycles on and off to keep the lube oil temperature within the manufacturer's recommended range. Large particles in the lube oil are trapped by the pump suction wye strainer. Particles over 5 microns are trapped by the simplex filter. The standby diesel generator prelube system feeds oil under pressure through the lube oil header to engine components that are normally lubricated when the engine is in operation. The lubricating oil drains internally in the engine and falls, unrestricted, back to the engine sump. The continuous operation of the SDG prelube system will not result in dangerous accumulations of lubricating oil that could ignite.

Flow rate and heat removal rate of the Safety Auxiliaries Cooling System (SACS) is provided in Table 9.2-4. The maximum cooling water inlet temperature to the diesel generator skid is 95°F as given in Table 9.2-3. The outlet temperature will vary with the actual heat load and actual inlet temperature of the cooling water. It has been verified that these parameters are in accordance with the recommendations of the diesel generator manufacturer.

Procurement specifications for diesel engine lubricating oil and governor oil incorporate the engine manufacturer's recommendations for quality, purity and lubrication properties. Sampling will be performed every 18 months or after 750 hours of engine operation. Oil samples will be analyzed to assure that:

1. Oil degradation has not occurred

2. The oil continues to meet the specifications of MIL-L-2104D.

The analysis report will determine the need for replacement of the lubricating oil.

The HCGS lubrication manual is used to identify the proper oil and instruction/procedures used during recharging and normal operation of the SDGs. Additionally, prominently mounted labels are provided that will specify the proper oil to be used. These labels are appropriately placed at all SDG lube oil fill connections.

9.5.7.2.3 Rocker Arm Lube Oil System

When the SDG is operating, oil is circulated by the engine-driven rocker arm lube oil pump from the rocker arm lube oil reservoir through the duplex filter to the cylinder heads for rocker arm lubrication. From there, the oil returns to the rocker arm lube oil reservoir. Particles larger than 5 microns are trapped by the filter. An oil level control valve in the makeup line from the engine header to the reservoir controls the oil level in the reservoir.

Once a week when the SDGs are not operating, and immediately before manual starts, the rocker arm prelube pump will be started manually in accordance with vendor recommended operating procedures. It will run for five minutes and then stop automatically. The rocker arm lubricating oil drains freely back to the rocker arm lube oil reservoir through manufacturer designed drain ports which prevents the accumulation of lubricating oil that could ignite. The diesel generator manufacturer does not require the rocker arm prelube pump to start on an emergency start signal. However, when the engine reaches 125 rpm the prelube pump is armed to start if header pressure drops to a predetermined low pressure level.

The rocker arm lubricating oil is not pre-heated, since the rocker arm section of the engine is insensitive to oil viscosity. The main requirement is that there be a supply of oil. The rocker arm area is heated by its proximity to the cylinder heads which are part of the jacket water system. This system was designed by the diesel engine

manufacturer, and based upon their many years of experience, they have determined that specific heating (pre-heating) or cooling of the rocker arm lube oil system is not required, and the other preheating keep warm engine systems are all sized to allow for all environmental conditions as described in Section 9.4.6.3 and 9.5.8.2. The manufacturer's recommendation is that the rocker arm prelube pump be run once a week for 5 minutes when the SDGs are not operating as is discussed above.

9.5.7.3 Safety Evaluation

The SDG lubrication system is designed to the Seismic Category I requirements discussed in Section 3.7. The system is located within the SDG enclosure, which is designed to Seismic Category I requirements as discussed in Section 3.8.

The SDG lubrication system is designed so that failure of any one component results in the loss of no more than one SDG. For a failure mode and affects analysis, see Table 9.5-12.

To prevent possible damage or shutdown of an SDG from low lube oil level, instrumentation is provided in the crankcase and rocker arm reservoir to monitor oil level. Setpoints for alarms are sufficient to allow plant personnel adequate time for corrective action. The rocker arm lubrication system is monitored by a rocker arm lube oil pressure low switch (KPLA), which would initiate an alarm in the event that insufficient pressure is available in the rocker arm lube oil system due to any of the following causes:

1. The filters are plugged.

2. The system has run low on oil level due to malfunction of the automatic level fill valve,

3. The engine driven pump (or its drive) has failed.

Upon the alarm, the motor driven rocker arm lube oil pump is also started. If the problem was caused by Item 1 or 2, the operator must take appropriate action.

The function of the high level alarm switch is to alert personnel that:

1. Fluids other than oil, such as a fuel oil leak at an injector, or a water leak in the cylinder head (between the jacket water system and rocker arm lube oil drain system) have entered the rocker arm lube oil system.

2. The lube oil supply valve (float valve) has malfunctioned (open).

In either case, the operator must investigate and remedy the problem.

A low level alarm for the rocker arm lube oil reservoir is not required. It is Colt's position that the rocker arm low lube oil pressure alarm is sufficient to determine a problem in this system. The unit could probably run for several minutes with a "low pressure" as long as there was some pressure to maintain flow.

If the loss of pressure was caused by a failure of the float level valve to admit oil, oil could be added to the tank by hand. This is basically a closed system and the rate of oil consumption is very low. Based on the above information, Colt does not feel their design requires a low level alarm for the rocker arm lube oil reservoir.

Additionally, Operations Department procedures include instructions to have the rocker arm lube oil tank level observed once per shift during diesel continuous operations and weekly during all other times.

Evaluation of the SDG lubrication system with respect to the following areas is discussed in separate FSAR sections as listed:

1. Protection against wind and tornado effects - Section 3.3

2. Flood design - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1.

9.5.7.4 Tests and Inspection

The SDGLS is preoperationally tested in accordance with the requirements of Section 14 and periodically tested in accordance with the requirements of Section 16.

Surveillance testing demonstrates diesel engine operability and includes performance monitoring of the diesel engine lubricating oil system. The installed strainer and filter will remove sediment or other deleterious material. Strainer or filter cleaning will be performed at the onset of increased differential pressure across the strainer or filter. Residue will be analyzed to determine:

1. The source of lube oil contamination

2. The need for lube oil replacement

3. The need for cleaning the engine lube oil sump

The monthly diesel engine operability surveillance test required by Technical Specifications will require visual examination of a sample

of the lube oil. This will verify that the lube oil heat exchanger is intact and water contamination of the oil has not occurred.

9.5.7.5 Instrument Application

Local and remote indicators, alarms, and pressure relief valves are provided to monitor the system's process and to protect system components. There is only one trouble alarm annunciator window provided in the main control room for the four SDGS. The CRT is used to identify the problem SDG and indicate whether it is a high priority or low priority alarm. All the alarms are individually annunciated at the SDG remote control panel.

The following functions are alarmed at the SDG remote control panel and as a common high priority trouble alarm at the main control room CRT:

1. Lube oil temperature, high

2. Lube oil makeup tank level, low

3. Crankcase lube oil level, high

4. Crankcase lube oil level, low

5. Lube oil pressure, low

6. Rocker arm lube oil pressure, low

The following functions are alarmed at the SDG remote control panel, and as a low priority trouble alarm on the main control room CRT:

1. Lube oil temperature, low

2. Keep warm temperature, high

3. Keep warm temperature, low

4. Rocker arm lube oil reservoir level, high

5. Lube oil strainer differential pressure, high

6. Lube oil filter differential pressure, high

7. Crankcase pressure, high.

The lube oil keep warm heater will not start unless the lube oil keep warm pump is started. A lube oil low pressure signal trips the SDG and related generator circuit breaker. The alarm system is discussed in Section 8.3.1.

Lube oil system leakage is detected by decreasing level in the lube oil makeup tank. Low level in the makeup tank is annunciated at the remote engine control panel. External leakage would be visibly evident. Internal leakage would be evident in the diesel generator exhaust. Lube oil seepage from the crankcase is prevented by the crankcase vacuum system as described in Section 9.5.7.2. Lube oil system leakage will be controlled by proper maintenance at intervals recommended in the manufacturers operation and maintenance manuals.

The Instrumentation and Control Department will perform calibration checks and calibrations on the instrumentation, controls, sensors, and alarms of the diesel engine lubrication oil system. The calibration checks and calibrations will be performed in accordance with written procedures. The equipment and surveillance frequency is summarized in Table 9.5-26.

Diesel engine lubrication system operator alarm responses are summarized in Table 9.5-27.

FSAR Section 9.5.7.5 discusses system interlocks.

9.5.8 Standby Diesel Generator Combustion Air Intake Exhaust System

The standby diesel generator (SDG) combustion air intake and exhaust system supplies combustion air to the SDGs and exhausts the combustion products to the atmosphere. The SDG combustion air intake and exhaust system is safety-related.

9.5.8.1 Design Bases

The SDG combustion air intake and exhaust system is designed to:

1. Be capable of supplying adequate combustion air and disposing of resultant exhaust products to permit continuous full load operation of the SDGs.

2. Remain functional during and after a safe shutdown earthquake (SSE).

3. Ensure that the single failure of any component does not result in the loss of more than one SDG.

4. Permit testing of active system components during plan operation.

5. Withstand hurricanes, tornadoes, floods, and missiles.

6. The combustion air intake and exhaust system complies with IEEE Standard 387, standard criteria for diesel generator units applied as standby power supplies for nuclear generating stations.

The SDG combustion air intake and exhaust system is designed to Seismic Category I requirements. The quality group classification and corresponding codes and standards that apply to the design of the system are discussed in Section 3.2. Compliance with Regulatory Guides 1.9, 1.115, and 1.117 is discussed in Section 1.8.

Compliance with GDC 2, 4, 5, and 17 is discussed in Section 3.1. The air intake and exhaust system is in compliance with the recommendations of NUREG/CR-0660.

9.5.8.2 System Description

The SDG combustion air intake and exhaust system is shown schematically on Vendor Technical Document PM018Q-0047, and the design parameters are listed in Table 9.5-13. The SDG arrangement is shown on Plant Drawings P-0051-0 and P-0053-0.

The diesel engine derating curve for ambient pressure (altitude) is shown on Figure 9.5-47. (It should be noted that this curve is applicable on the long-term basis - altitude derating - and is not applicable to short-term phenomena such as tornadoes, hurricanes, tropical storms, or other weather depressions.)

Each SDG has a separate combustion air intake and exhaust system consisting of an air intake filter, an intake silencer, an exhaust silencer, and the necessary interconnecting piping and expansion joints for connection to the engine turbochargers and exhaust manifold.

The intake system draws air from outside the SDG enclosure through an indoor type air filter and the intake silencer.

The environmental service conditions for air intake are:

a. Ambient air intake range: outdoor

Winter	-4°F	RH	25 to 95 percent
Summer	+102°F	RH	25 to 95 percent

b. The diesel engine is not sensitive to humidity. The unit will tolerate, with no effect on load capability or rating, any relative humidity from 0 to 100 percent.

Two exhaust gas driven turbochargers draw in the air at a rate of 18,600 cfm at 90°F. It is compressed by the turbochargers and cooled by the combustion air intercoolers. The intercooler cooling loop is a part of the SDG cooling water system discussed in Section 9.5.5. The compressed air is then directed to the two banks of combustion cylinders by the intake manifolds.

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Following combustion, hot exhaust gases leave the cylinders through the exhaust manifold and drive the two turbochargers. The exhaust gases leave the turbochargers through expansion joints, enter the exhaust piping, pass through the silencer, and are discharged to the atmosphere.

The exhaust silencer is constructed of welded carbon steel. The expansion joints are of the unguided bellows type for the engine exhaust and air intake system. Expansion joints are stainless steel with flanged connections. The piping is carbon steel.

A curve of the engine derating for ambient pressure (altitude) is shown in Figure 9.5-47. It should be noted that this curve is applicable on the long term basis - altitude derating - and is not applicable to short term phenomena such as tornadoes, hurricanes, tropical storms, or other weather depressions.

The SDG HVAC systems exhaust from missile protected areas located at elevation 198'-O". The possibility of significant quantities of smoke or other combustion by-products bypassing dampers or failed dampers from any of the areas and exiting at the 198 ft elevation and consequently being drawn down to other diesel generator intakes at the 130 ft elevation is not credible.

During normal plant operations, thus no diesels operating, the diesel area ventilation will exhaust air from each diesel compartment and out of the roof vent. Smoke from one compartment would have to exit to the large volume common corridor through the fire damper. It could then enter the other diesel generator compartments through that compartment's fire damper. The manufacturer has stated that the diesel generator itself is insensitive to smoke in the compartment. Should the temperature rise the recirculation coil units would automatically start.

The diesel control panels are NEMA 12, dust tight, panels. The protective relays inside the panel are further encased. The panels do not contain sensitive integrated circuits. The room temperature,

even if smoke filled, is maintained by the recirculation coil units as stated above. Therefore, the diesel generator panels will not be affected by smoke (either temperature or particulates) in the diesel generator room.

9.5.8.3 <u>Safety Evaluation</u>

All equipment and supports for this system are designed to Seismic Category I requirements as discussed in Section 3.7. This system is located within the SDG enclosure, which is designed to Seismic Category I requirements, as discussed in Section 3.8.

The control panel, master valve, selector valve, electro-manual pilot cabinets, thermal detectors and pushbutton stations have been seismically qualified to prevent spurious actuation during a seismic event (Reference Plant Drawing M-22-0 sheet 5). The carbon dioxide system piping inside the Auxiliary Building is not pressurized during normal plant operation. Therefore, if a break in the system piping did occur as a result of a seismic event, carbon dioxide would not be discharged into a diesel generator compartment because the system components, which are pressurized, are seismically qualified.

The SDG combustion air intake and exhaust system is designed such that failure of any one component results in the loss of not more than one SDG. See Table 9.5-14 for a failure mode and effects analysis of the system.

Protection against hurricanes, tornadoes, and missiles is provided by locating system components within the SDG area of the auxiliary building, a Seismic Category I structure.

Evaluation of the combustion air intake and exhaust system with respect to the following areas is discussed in separate FSAR sections as follows:

1. Protection from hurricanes and tornado effects - Section 3.3

2. Flood protection - Section 3.4

3. Missile protection - Section 3.5

4. Protection against dynamic effects associated with the postulated rupture of piping - Section 3.6

5. Environmental design - Section 3.11

6. Fire protection - Section 9.5.1.

The air intake and exhaust gas openings are designed to prevent contamination of the intake air by exhaust products. The exhaust duct has a 5-1/2-foot carbon steel pipe and exhaust stack box extension above the Auxiliary Building roof to further improve exhaust gas dispersion. The exhaust extension pipe is provided with a flat cover and screen, which are located inside of the exhaust stack box, to prevent possible clogging of the exhaust system from abnormal climatic conditions. The exhaust stack is designed to Seismic Category I requirements, as discussed in Section 3.7.

The bottom of the air intake opening is located on the upper part of the south wall at the 130-foot elevation, approximately 30 feet above grade. The opening has a fixed louvered cover to protect the intake from rain, ice, and snow. A shield is also provided for missile protection.

The exhaust silencer has a drain connection to drain any water that may occur from condensation or be blown in by the wind. The drain will be opened periodically; at intervals to be determined by operating experience.

Dust that might accumulate in the exhaust piping will be blown out by the exhaust gases during periodic testing.

The standby diesel generator exhaust stack penetrates the roof at the 198 foot elevation of the Auxiliary Building. An open box

structure (exhaust box) sheaths the SDG exhaust stack to prevent the flow of hot exhaust gas from impinging on the roof building. The SDG exhaust stack in the exhaust box has a continuous circumferential opening which is protected from rain, snow, and ice by a flat plate on the top and by the exhaust box around the perimeter.

Section 2.3.2.1.4 indicates a maximum measured 24 hr snowfall of 22.0 inches, from the Wilmington NWS records. The top of the exhaust box, surrounding the SDG exhaust stack, is 5 feet 6 inches above roof elevation 198'-O". With the maximum snow level of 22 inches, the snow will be 4 feet below the exhaust stack box, assuming no drifting occurs. As much as 6 inches of snow can build up in the exhaust box without covering any of the exhaust stack opening.

To accommodate the potential for drifting snow conditions, station operations personnel will control snow buildup in the area of the SDG exhausts and snow buildup in the exhaust boxes. An expected snow accumulation of 12 inches or more, as reported by the National Oceanographic and Atmospheric Agency (NOAA), plus a visual observation of snow on site, will trigger the following actions:

1. Snow buildup in the vicinity of the SDG exhausts will be monitored on an hourly basis.

2. Snow removal will commence when the level reaches 36" in the immediate area of the SDG exhausts.

3. Snow removal will commence when the depth of snow in the SDG exhaust boxes reaches 6 inches.

9.5.8.4 Tests and Inspections

The system is preoperationally tested in accordance with the requirements of Section 14, and periodically tested in accordance with the requirements of the Technical Specifications.

9.5.8.5 Instrument Application

The temperature of the exhaust gases and combustion air are indicated locally by temperature indicators. A high combustion air temperature alarm is provided at the remote engine control panel. Exhaust gas temperature can be read for each turbocharger exhaust inlet and outlet and for each engine cylinder on the remote engine control panel in the remote SDG control room.

The Instrumentation and Controls Department will perform calibration checks and calibrations of the instrumentation, controls, sensors and alarms of the diesel engine combustion air intake and exhaust system. The calibration checks and calibrations will be performed in accordance with written procedures. The equipment and surveillance frequency is summarized in Table 9.5-28.

Diesel engine combustion air intake and exhaust system operator response to alarm conditions is summarized in Table 9.5-29.

9.5.8.6 SRP Rule Review

In SRP Section 9.5.8, acceptance criteria item II.1 refers to Regulatory Guide 1.117 for structures, systems, and components requiring protection from tornado missiles. Affected by the regulatory positions of this guide are all Class 1E electric systems, including the onsite emergency electric power supply system with all its auxiliary systems.

On Hope Creek, the emergency electric power system is located inside the Auxiliary Building and therefore is protected from tornado missiles. The diesel combustion air intake and exhaust systems are provided with adequate protection to ensure that the diesels will remain functional following the occurrence of a design basis tornado. The combustion air intake missile barrier is shown in Figure 3.5-23. The exhaust stack roof opening missile barrier which is 2-feet thick and 1.5-foot high concrete is shown in Figure 3.5-26 and provides tornado missile protection for the exhaust stack. A

larger diameter stack sleeve with a flat cover and an exhaust stack box is provided on top of the missile barrier for protection from rain, ice and snow. In the event of a tornado missile hitting the exhaust stack sleeve (extension) and/or hood cover; it is extremely unlikely that a missile will adversely affect the proper functioning of the diesel engines. This conclusion is based on the following considerations:

1. The exhaust stack sleeve is 2.5 feet high. The sleeve overlaps the exhaust stack by 6 inches and is made of 1/2-in. steel wall construction which has an inherent resistance to damage. Because of their enlarged diameter above the roof, stack sleeve penetration or severe denting can be tolerated.

2. The probability that design basis missiles could exist at the roof elevation of 198 feet is extremely low.

3. The projection of the exhaust stacks above the roof is only 5-1/2 feet, and not likely to cause damage to any adjacent safety-related systems.

9.5.9 Auxiliary Boiler System

The Auxiliary Boiler System provides a source of low pressure, uncontaminated, saturated steam for various startup and plant service functions including building heating and freeze protection during periods of cold weather. The system is not safety-related.

9.5.9.1 Design Bases

The auxiliary boilers burn number 2 fuel oil and are designed to provide the operational flexibility necessary to accommodate the varying steam demands during all seasons and modes of operation.

The system operates independently of the Nuclear Steam Supply System (NSSS).

The boilers are designed in accordance with ASME B&PV Code, Section I, and also with the laws and regulations of the State of New Jersey. Boiler design pressure is 250 psig.

9.5.9.2 System Description

The auxiliary boiler system consists of two water-tube package boilers; a deaerator; three boiler feedwater pumps; three fuel oil pump and strainer sets; a fuel oil day tank; a fuel oil storage tank; two fuel oil transfer pumps; and associated piping, valves, controls, and instrumentation. All major components of the auxiliary boiler system are located in the auxiliary boiler structure, fuel oil transfer pump house, and tank dike areas.

Steam is supplied from the auxiliary boilers to the turbine building via the auxiliary steam header. It is distributed in the turbine building to the following steam consumers:

1. Plant heating, as required

2. High pressure coolant injection (HPCI), reactor core isolation cooling (RCIC), reactor feed pump turbines (RFPTs), during preoperational testing

3. Radwaste evaporators, during the batch process

4. Offgas recombiner preheater, during startup

5. Nitrogen vaporizer, intermittently

6. Condensate heating and deaeration, during startup

7. Main and RFPT shaft seals, during startup

8. Steam jet air ejectors (SJAEs), during startup.

In addition, the steam generated by the auxiliary boilers is used at the auxiliary boiler building for fuel oil heating and atomizing, standby boiler heating, and boiler feedwater deaeration.

Condensate recovered from the plant heating system is returned to the deaerator, which provides condensate storage. Demineralized water is used for boiler makeup.

An atmospheric blowdown tank is provided for the continuous blowdown, the bottom flow from the mud drum, and emergency overflow from the deaerator.

The feedwater may be treated in the deaerator storage tank by means of chemical injection from the chemical feed system. Two tanks, each with a pair of chemical pumps, are provided for the chemical injection service.

Each boiler is provided with a heating coil in the lower drum to protect the boiler from freezing and to maintain the highest possible pressure in the boiler when in the standby mode. Steam for the heating coils is supplied from the auxiliary steam header, and condensate is returned to the deaerator.

Steam is supplied from the boilers at 175 psig for auxiliary equipment and reduced to 50 psig for plant heating. The plant heating line is equipped with a pressure-reducing station and a relief valve downstream of that station.

The boiler control system is designed for automatic operation, except for cold startup operation of a boiler. Boilers must be started manually at the auxiliary boiler building, but may be tripped from the main control room or locally at the Auxiliary Boiler Building.

9.5.9.3 Safety Evaluation

The auxiliary steam system has no safety-related function. The system is designed so that failure of the system or a system component does not compromise any safety-related system or component or prevent a safe reactor shutdown.

The only connections between the auxiliary steam system and Seismic Category I systems are those used for preoperational testing of the HPCI and RCIC turbines. The connections are made through removable pipe spools. For plant operation, the pipe spools are removed, and the auxiliary steam system is disconnected and isolated from any Seismic Category I system. Therefore, a failure in the nonsafety auxiliary boiler piping will have no effect on the operation of the HPCI and RCIC turbine piping. The connections between the auxiliary steam system and non-Seismic Category 1 portions of the main steam system are protected by normally closed valves.

Fire protection for the Auxiliary Boiler Building and the auxiliary boiler fuel oil tanks is discussed in Section 9.5.1.

9.5.9.4 Test and Inspections

The auxiliary steam system is proven operable by its use during startup and normal plant operation.

9.5.9.5 Instrumentation Application

Local and remote indicators, alarms, and pressure relief valves are provided to monitor the system process and protect system components. A common boiler trouble alarm is located in the main control room.

9.5.10 Breathing Air System

The Breathing Air System has been abandoned in place.

TABLE 9.5-1

NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS

Number	Title
10	Installation of Portable Fire Extinguishers
10A	Maintenance and Use of Portable Fire Extinguishers
11	Low Expansion Foam and Combined Agent Systems
12	Carbon Dioxide Extinguishing Systems
12A	Halon 1301 Fire Extinguishing Systems
13	Installation of Sprinkler Systems
13A	Maintenance of Sprinkler Systems
13E	Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems
14	Standpipe and Hose Systems
15	Water Spray Fixed Systems
20	Centrifugal Fire Pumps
22	Water Tanks for Private Fire Protection
24	Outside Protection
27	Private Fire Brigades
30	Flammable and Combustible Liquids Code

TABLE 9.5-1 (Cont)

Number	Title
37	Combustion Engines and Gas Turbines
50A	Gaseous Hydrogen Systems
70	National Electrical Code
71	Central Station Signaling Systems
72	National Fire Alarm Code
72A	Local Protective Signaling Systems
72D	Proprietary Protective Signaling Systems
72E	Automatic Fire Detectors
75	Electronic Computer Data Processing Equipment
78	Lightning Protection Code
80	Fire Doors and Windows
90A	Air Conditioning and Ventilation Systems
91	Blower and Exhaust Systems
92M	Waterproofing and Draining Floors
204	Smoke and Heat Venting Guide
321	Classification of Flammable Liquids

TABLE 9.5-2

SPECIFIC AREAS COVERED BY FIRE EXTINGUISHING SYSTEM

System Used	Area or Equipment Covered
Yard loop and hydrants	Exterior coverage of all buildings
Automatic wet pipe sprinkler systems, ordinary hazard occupancy pipe schedule, except as noted	Turbine Building - Reactor feed pump lube oil reservoir rooms - Reactor feed pump turbine rooms - Areas under turbine generator operating floor (hydraulically designed) - Oil interceptor - Elevators (elevator machine room and top of elevator shaft)
	Auxiliary Building - Oil interceptors - Oily waste sump - Elevators (elevator machine room and top of elevator shaft) - Machine shop, store room, and adjacent areas - Locker rooms and adjacent areas - Solid radwaste area - Chemical laboratory storage - Clean storage room - Storage room number 3566
	Nuclear Operations Services Facility (NOSF) All areas (hydraulically designed)

System Used	Area or Equipment Covered
	Administration facility - Warehouse - Mechanical room - Walkway - Work order hold area - Clean machine/fab shop - Tool storage area - Office space - Kitchen and cafeteria - Lobby - Conference and training rooms
	Auxiliary Boiler Building - Auxiliary boiler room
Automatic wet pipe sprinkler systems, ordinary hazard occupancy pipe schedule, except as noted	Fire pump house - All areas
	Guardhouse - Lobbies and corridors - Waiting and screening area offices - Conference rooms - Storage rooms - Health physics room and office - Lunchroom - Mechanical rooms - Whole-body counting room
	Administration facility - 123 feet elevation - south

System Used	Area or Equipment Covered
Automatic preaction sprinkler systems, ordinary hazard occupancy pipe schedule, except as noted	Turbine Building - Equipment unloading area, elevation 102 feet - Exposed turbine generator lube oil piping above operating floor (hydraulically designed) Auxiliary Building - Elevator numbers 51-01 and 51-02 (control and diesel areas) - Truck bay area - Solid radwaste drum storage area - Cable spreading room (safety-related, hydraulically designed) - Corridors 5207 and 5237 (safety-related, hydraulically designed) - Electrical accesses 3204, 3425, 5339, and 5401 (safety-related, hydraulically designed) - Cable chases 5531, 5532, 5533, and 5534 including vertical portions of chases (safety-related, hydraulically designed) - H&V chase 5535 (safety-related hydraulically designed) Reactor Building - Motor control center area 4201 (safety-related, hydraulically designed)

System Used	Area or Equipment Covered
	- Corridor 4301 (safety-related, hydraulically designed) - Circulating water pump structure Circulating water pump rooms - Intake structure Service water pump room (safety-related)
Automatic wet pipe sprinkler systems special hazard occupancy	- Low Level Radwaste Storage Facility
Automatic water spray systems, hydraulically designed	Turbine Building - Motor generator units - Hydrogen seal oil unit - Lube oil receiving storage tank - Turbine lube oil reservoir and purifier Yard - Main transformers - Station service transformers - Circulating water pump structure transformers Auxiliary Building - TSC emergency supply charcoal filters - Radwaste tank vent charcoal filters
Manual water spray systems, hydraulically designed	Auxiliary Building - Control room emergency supply charcoal filters (safety-related)

System Used	Area or Equipment Covered
Manual preaction water spray systems, hydraulically designed	Reactor Building - FRVS charcoal filters (safety-related) - FRVS vent unit charcoal filters (safety-related) - Drywell prepurge cleanup charcoal filters
Wet standpipe and hose stations	Entire plant - Near stairwells, exits, and other points accessible to personnel
Wet standpipe and hose stations maintained in a dry condition	Reactor Building - Near stairwells, exits, and other points accessible to personnel
	Intake structure - Near stairwells, exits, and other points accessible to personnel
Manual deluge systems, hydraulically designed	Auxiliary Building - Diesel fuel tank rooms (safety-related) - Control equipment room mezzanine (safety-related)
Manual mechanical foam system	1,000,000 gallon - fuel oil storage tank outdoors (stores fuel oil No. 2)

System Used	Area or Equipment Covered
Carbon dioxide systems (automatic total flooding with time delay and manual override)	Auxiliary Building - Diesel generator fuel oil tank rooms (safety-related) - Diesel generator rooms (safety-related) - Control equipment room mezzanine (safety-related)
Carbon dioxide system (automatic local application)	Turbine Building - Oil piping inside generator exciter housing
Manual Halon (local application)	Auxiliary Building - Main Control Room control console and pit
Automatic Halon 1301 total flooding systems	Guardhouse - Under raised floor of room number 1 Administration facility - QA vault

System Used	Area or Equipment Covered
	Auxiliary Building - Auxiliary building wing areas - Control panel and instrument racks area near gaseous radwaste (Elevation 54 feet) - Cable tray area (Elevation 87 feet above radwaste) - Near motor control centers - Electrical chase areas with safe egress (safety-related)
Portable fire extinguishers	Entire plant site (excluding administration facility and guardhouse)
	Co_2 types - All normally accessible areas where there are small Class B & C hazards
	Dry chemical type - All normally accessible areas where there are large Class B & C hazards, such as large motors, batteries, and combustible liquids
	Halon 1211 type - Control room (safety-related) - Computer room - Remote shutdown panel room (safety-related) - Solid radwaste control room

System Used	Area or Equipment Covered
	Pressurized water type (Class A hazards) - Reactor Building and intake structure
	Administration facility, guardhouse, and Unit 2 control area office space at Elevation 137 feet
	Multipurpose dry chemical type - All normally accessible areas

(1) Portable fire extinguishers are not provided for Class A fire hazards except as noted. Fire water hose stations will be used for Class A fire hazards.

TABLE 9.5-3

HAZARDOUS MATERIALS

Material Description	Quantity	Plant Location	Condition of Use	Approximate Time of Use
Compressed Gas (1)				
Hydrogen bottles	88,000 scf	Yard	2000 psig	Continuous
Hydrogen tube trailers (2)	264,000 scf (132,000 each)	Yard	2400 psig	Continuous
Hydrogen in generator while turbine is in operation	3675 scf	Main generator, Turbine Bldg	75 psig	While the turbine is running
Nitrogen bottles	2 at 220 scf each	RB, El 102', room 4320	2500 psig	Recharge HCU accumulations
Hydrogen bottles	2 at 220 scf each	Yard	2500 psig	1/2 hours, weekly
Oxygen bottles	2 at 220 scf each	Yard	2500 psig	1/2 hours, weekly
Oxygen bottles	6 at 220 scf each	Turbine Bldg elev 54	2500 psig	Intermittent
Calibration bottle (H_2/N_2 mixtures)	1 at 220 scf	Yard	2500 psig	1/2 hour, weekly
Calibration bottle (O_2/N_2 mixtures)	1 at 220 scf	Yard	2500 psig	1/2 hour, weekly
Nitrogen - (A-R)T210, safety relief valve (SRV) accumulators	11.3 gal. each	Drywell	125 psig	Backup for Containment Instrument Gas System
Nitrogen - (A-D)T211, main steam isolation valve (MSIV) accumulators	39.5 gal. each	Drywell	125 psig	Backup for Containment Instrument Gas System
Air - (A-D)T212, MSIV accumulators	39.5 gal. each	RB, Steam tunnel	150 psig	Backup for compressed air system

Material Description	Quantity	Plant Location	Condition of Use	Approximate Time of Use
Compressed Gas[1]				
Nitrogen - Containment instrument	2-225 ft^3 each	RB, El 132' rooms 4412 & 4413	125 psig	Continuous
Nitrogen - Zinc Injection Sample Stations	2-200 scf each	RB, El 145' room 4513 TB, El 102' room 1307	2100psig	Continuous during zinc injection(power operation)
Nitrogen - HCU accumulators	185-1.35 ft^3 each	RB, El 132' rooms 4320 & 4321	580 psig	During reactor scram

Material Description	Quantity	Plant Location	Condition of Use	Approximate Time of Use
CO_2 fire protection tank 10T542	17 tons	Yard, south side of RB	300 psi/0°F	Used for fire protection only
CO_2 fire protection tank 10T109	4 tons	TB, El 102'-0"	300 psi/0°F	Used for fire protection only
CO_2 fire protection tank 10T113	6 tons	TB, El 102'-0"	300 psi/0°F	Used for generator purge at turbine trip
Air - (A,B)T277 suppression pool isolation valve accumulators	2 at 19 ft^3 each	RB, El 70'-0" torus compartment	105 psig	Backup for containment instrument gas system
Liquid nitrogen tanks	2 at 9000 gal	Yard	70 psig	4 hours for each containment inerting
Standby diesel engine air start receiver	8 at 56 ft^3 each 2 per SDG	Standby diesel generator AB, 102'-0"	425 psig	Starting standby diesel generator
Primary containment leak rate testing system-Nitrogen bottles for electrical penetration testing	Temporary portable bottles	RB, El 102'-0"	Variable	Technical Specification surveillance
Primary containment leak rate testing system - Nitrogen bottles for vent pipe expansion bellows testing	Temporary portable bottles	RB, El 102'-0" & 77'-0"	Variable	Technical Specification surveillance
PASS nitrogen supply bottle and PASS tracer gas bottle	2 at 304 ft^3	Aux Bldg - RW/service area, El 54'-0"	100 psig	Use after an accident
Solid radwaste emergency air bottles 00T398 and 00T399	2 at 220 ft^3	Aux Bldg, El 102'-0" & 124'-0"	2015 psig	When normal air supply to valves fails
Air bottles	6 at 230 scf	Intake structure - El 93'-0" (2 bottles in each service water pump room and 1 bottle in the two unoccupied areas)	2200 psig	Intermittently - air supply for fire protection sprinkler system and water tight doors
Air bottle	1 at 230 scf	Circulating water structure, El 106'-0"	2200 psig	Intermittently - air supply for fire protection sprinkler system.
Direct Torus vent subsystem-Nitrogen bottles for air operated containment isolation valves	2 at 285 scf each	RB, EL 102'-0" Room 4317	2400 psig	Backup for Control Air (KB) System

Material Description	Quantity	Plant Location	Condition of Use	Approximate Time of Use
Liquid petroleum gas bottles	6 at 100 lbs	Yard - next to auxiliary boiler building (west side)	20 psig	Intermittently - (ignition of auxiliary boilers)
Nitrogen bottles	12 at 304 ft^3 each(6 per accumulator)	Emergency diesel generator fuel oil storage area, El 54' Room 5106	165 psig	Intermittently - maintains SACS accumulator tanks water level as required
<u>Corrosives (acids, caustics)</u>				
Sulfuric acid	21,000 gal.	Yard-near cooling towers	Solution, 66° Be	Continuous
Sodium hypochlorite	90,000 gal.	Yard-near cooling towers	Solution 15% by wt	90 min/day
Sodium hypochlorite	45,000 gal.	Yard-near intake structure	Solution 15% by wt	90 min/day
Sodium hypochlorite	55 gal. drum	Aux boiler bldg domestic water tanks (yard)	Solution 15% by wt	12 h/day
Caustic soln	150 gal.	Aux Bldg - control area, El 121'	Solution 50% by wt	90 min/day
Caustic soln	200 gal.	Aux Bldg - RW/service area, El 124'	Solution 25% by wt	16 h/day (refueling) 5-1/2 h/day (normal)
Caustic soln	250 gal.	Aux Bldg - control area, El 102'	Solution 4% by wt	30 min/2.5 days
Sulfuric acid	250 gal.	Aux Bldg - control area, El 102'	Solution 4% by wt	30 min/2.5 days
Caustic, tank 00T-140	16,000 gal.	Turb Bldg, El 54'	Solution 60° Be	2.5 h per regen of 1 service vessel resin per 30 days
Caustic, tank 00T-141	16,000 gal.	Turb Bldg, El 54'	Solution 50% by wt	2.5 h per regen of 1 service resin per 30 days
Sulfuric acid	16,000 gal.	Turb Bldg, El 54'	Solution, 60° Be	
Sodium pentaborate soln, SLC storage tank	5388 gal.	RB, El 162'	Liquid	Used to shut down reactor following scram failure (1 time/40 yr)

Material Description	Quantity	Plant Location	Condition of Use	Approximate Time of Use
Boric acid	4051 lb	RB, El 162'	Granules (pellets)	Used to mix soln to fill SLC tank
Borax	4164 lb	RB, El 162'	Granules (pellets)	Used to mix soln to fill SLC tank
Sodium pentaborate soln	55 gal. drum	RB, El 162'	Liquid	Used to collect SLC system leakage and overflow
Others				
Asphalt/radwaste mixture	30 drums, approx 750 gal. of asphalt	Aux Bldg - RW/service area 38, 77, & 78 at El 102'	Liquid/solid	8 h/day
	2825 drums, approx 155,000 gal	Low Level Radwaste Storage Facility	Solid	Continuous
Asphalt	9700 gal.	Yard - asphalt storage bldg	Liquid	Intermittent
Cation resin Anion resin styrene DVB	190 ft^3 each	Aux Bldg - RW/service area at El 75'	Resin	6 months prior to startup
	5275 ft^3 total	Low Level Radwaste Storage Facility	Dewatered in high integrity container	Continuous
Mixed resin bed styrene DVB	190 ft^3 stoichiometric mixture	Aux Bldg - RW/service area at El 54', cation/anion regeneration	Resin in vessel underwater blanket	2 times/25 days
Mixed resin bed styrene DVB	190 ft^3 stoichiometric mixture	Aux Bldg - RW/service area at El 54' waste & floor drains demineralizers	Resin in demineralizers under water blanket	Continuous
Hydrazine	50 gal. drum	Yard - aux boiler bldg	Solution 30% by wt	Continuous
Ammonia	50 gal. drum	Yard - aux boiler bldg	Solution 35% by wt	Continuous
Sodium bisulfite	One 250 gal. tank at 1% soln store approx 10-50 lb bags dry	Yard - circ water pump house	Solution 1% by wt	Continuous

TABLE 9.5-3 (Cont)

Material Description	Quantity	Plant Location	Condition of Use	Approximate Time of Use
Fuel oil no. 2	2-26,500 gal. tanks in each room	Diesel Generator Building Elevation 54' room nos. 5107, 5108 5109, 5110	Atmospheric	During emergency diesel generator operation
Fuel oil no. 2	550 gal day tank	Diesel Generator Building Elevation 102' room nos. 5304, 5306, 5307	Atmospheric	During emergency diesel generator operation
Fuel oil no. 2	1,000,000 gal	Yard-adjacent to Delaware River	Atmospheric	During auxiliary boiler operation
Fuel oil no. 2	18,000 gal tank	Yard-adjacent Auxiliary Boiler Building	Atmospheric	During auxiliary boiler operation
Fuel oil no. 1 or no. 2	280 gal tank	Yard-adjacent to fire pump house	Atmospheric	During diesel driven fire pump operation
Halon 1301	120 pounds	Guardhouse - electrical equipment room	360 psi	During fire emergency
Halon 1301	160 pounds	Administration facility technical document room vault	360 psi	During fire emergency
Halon 1301	Two tanks, 268 pounds and 100 pounds	Auxiliary Building - control area - control room complex (peripheral room)	360 psi	During fire emergency
Propane	Four-100 gallon tanks	Yard, adjacent to circulation water pump structure	100 psi	For cooling tower field testing in 1986 and 1987
Diesel Fuel	6,000 gal tank	Yard-adjacent to barge slip	Atmospheric	Continuous
Gasoline	6,000 gal tank	Yard-adjacent to barge slip	Atmospheric	Continuous
Mineral Oil	42 gal (max)	Radwaste Bldg Room 3356	Atmospheric	Continuous

(1) Air receiver tanks at less than 125 psig pressure are not listed.

TABLE 9.5-4

STANDBY DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM
DESIGN PARAMETERS

Fuel Oil Storage Tanks

Quantity	Two per diesel, eight total
Type	40 feet 11 inches horizontal
Design pressure	15 psig
Capacity	26,500 gallons
Design code requirements	ASME B&PV Code, Section III, Class 3

Motor Driven Fuel Oil Transfer Pumps

Quantity	Two per diesel, eight total
Type	Horizontal, seal-less,centrifugal
Capacity, each	37 gpm at 38 psig
Motor rating	5.9 hp, 460 V, 3 phase, 60 Hz
Design code requirements	ASME B&PV Code, Section III, Class 3

Fuel Oil Day Tank

Quantity	One per diesel, four total
Type	131.5 in. x 36.75 horizontal
Design pressure	15 psig
Capacity	550 gallons
Design code requirements	ASME B&PV Code, Section III, Class 3

Engine Driven Fuel Oil Pump

Quantity	One per diesel, four total
Type	Rotary gear
Capacity	14 gpm at 38.7 psig
Design code requirements	Hydraulic Institute standards

Motor Driven Standby Fuel Oil Pump

Quantity	One per diesel, four total
Type	Rotary gear
Motor rating	2.0 hp, 460 V, 3 phase, 60 Hz
Capacity	13 gpm at 40.5 psig
Design code requirements	ASME B&PV Code, Section III, Class 3

Fuel Oil Pump Suction Strainer

Quantity	One per diesel, four total
Type	Duplex
Particle retention	40 microns
Design code requirements	ASME B&PV Code, Section III, Class 3

Fuel Oil Pump Discharge Filter

Quantity	One per diesel, four total
Type	Duplex
Particle retention	5 microns

Combination Flame Arrestor and Conservation Vent

Quantity	One per diesel, four total
Flame arrestor	Type 306 stainless steel

Combination Flame Arrestor and Conservation Vent	
Vent opening pressure	1/2 oz/in.^{2}
Venting capacity	6000 ft^3/h free air at AP = 2.5 psi
Emergency Relief Vent	
Quantity	One per diesel, four total
Type	Conservation breather vent
Venting capacity	920,000 scfm at 2.5 psig inlet pressure
Setting	1 oz/in.^{2}
Fill Connection Fuel Oil Filter	
Quantity	One
Type	Simplex
Particle retention	10 microns
Emergency Fill Station Duplex Fuel Oil Filter	
Quantity	One
Type	Simplex
Particle retention	10 microns

TABLE 9.5-5

STANDBY DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM FAILURE MODES AND AFFECTS ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Emergency (LOCA or LOCA + LOP)	Storage tanks, (2 per SDG)	Loss of one tank	Fuel supply to one SDG is lost. However, only three SDGs are required for safe plant shutdown following a LOCA or LOP & LOCA	Fuel oil storage tank level low	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Day tank	Loss of one tank	Fuel supply to one SDG is lost. However, only three SDGs are required for safe plant shutdown following a LOCA or LOP & LOCA	Day tank level low	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Transfer pump	Loss of one pump	SDG can operate 3-1/2 days with one storage tank out of service at full rated load. Fuel oil can be transferred from another tank to the affected SDG set	Day tank level low, fuel oil transfer pump malfunction alarm	No loss of safety function
Emergency LOCA or LOCA + LOP)	Line between transfer pump and day tank	Pipe failure	Fuel supply to one diesel is lost; however, only three SDGs are required for safe plant shutdown following a LOCA or LOP & LOCA	Day tank level low, fuel oil transfer pump on	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Line between storage tank and common fill header	Pipe failure	SDG can operate 3-1/2 days with one storage tank out of service at the largest anticipated load. Fuel oil can be transferred from another tank to the affected SDG set	Fuel storage tank level low	No loss of safety function
Emergency (LOCA or LOCA + LOP)	Engine driven fuel oil pump	Failure of pump	Motor driven pump automatically starts when discharge pressure drops	Motor driven pump on	No loss of safety function

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Emergency (LOCA or LOP + LOCA)	Line between day tank and fuel oil pump	Pipe failure	Fuel supply to one SDG is lost. However, only three SDGs needed for safe plant shutdown following a LOCA or LOP & LOCA	Fuel or pump discharge pressure low	No loss of safety function

TABLE 9.5-6

STANDBY DIESEL GENERATOR JACKET WATER COOLING LOOP
DESIGN PARAMETERS

Expansion Tank

Quantity	1 per diesel (4 total)
Capacity, each	100 gallons
Design code requirements	ASME B&PV Code, Section III, Class 3

Engine Driven Water Pump

Quantity	1 per diesel (4 total)
Type	Centrifugal
Capacity, each	850 gpm at 50 psi
Design code requirements	Manufacturer's standard

Motor Driven Keep Warm Pump

Quantity	1 per diesel (4 total)
Type	Centrifugal
Capacity, each	50 gpm at 8.7 psi
Motor rating	3/4 hp, 460 V, 3 phase, 60 Hz
Design code requirements	ASME B&PV Code, Section III, Class 3

Jacket Water Heat Exchanger

Quantity	1 per diesel (4 total)
Type	Shell and tube
Duty, each	5,412,000 Btu/h

<u>Jacket Water Heat Exchanger</u>

Shell design	
Fluid	Demineralized water
Flow rate	880 gpm
Inlet temperature	180°F
Outlet temperature	166.6°F
Design pressure	150 psi
Design temperature	200°F
Tube design	
Fluid	Demineralized water (SACS)
Flow rate	1176 gpm
Inlet temperature	100.3°F
Outlet temperature	109.5°F
Design pressure	200 psi
Design temperature	200°F
Design code requirements	ASME B&PV Code, Section III, Class 3

<u>Standby Jacket Coolant Heater</u>

Quantity	1 per diesel (4 total)
Type	Immersion, electric
Rating	36 kW, 480 V, 3 phase, 60 Hz
Design code requirements	ASME B&PV Code, Section III, Class 3

TABLE 9.5-7

DIESEL GENERATOR INTERCOOLER COOLANT LOOP DESIGN PARAMETERS

Engine Driven Intercooler Water Pump

Quantity	1 per diesel (4 total)
Type	Centrifugal
Capacity, each	850 gpm at 50 psi
Design code requirements	Manufacturer's standard

Intercooler Heat Exchanger

Quantity	1 per diesel (4 total)
Type	Shell and tube
Duty, each	3,118,000 Btu/h
Shell design	
Fluid	Demineralized water
Flow rate	880 gpm
Inlet temperature	118°F
Outlet temperature	110°F
Design pressure	150 psi
Design temperature	200°F
Tube design	
Fluid	SACS
Flow rate	1176 gpm (Note 1)
Inlet temperature	95°F (Note 2)
Outlet temperature	100.3°F
Design pressure	200 psi
Design temperature	200°F
Design code requirements	ASME B&PV Code, Section III, Class 3

Note 1 - The minimum flow rate to each EDG cooler is approximately 700 gpm; however, nuisance alarms may sound in the Control Room during periods of high SACS temperatures.

Note 2 - SACS heat exchangers temperature range is 95°F maximum, 32°F minimum during normal operating conditions, and up to 100°F post-accident.

TABLE 9.5-8

STANDBY DIESEL GENERATOR COOLING WATER SYSTEM FAILURE MODE AND EFFECTS ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Jacket Water System					
Emergency (LOP+LOCA)	Engine driven pump	Failure of pump	Cooling water to the diesel is lost, and the diesel will be shut down	High cooling water temperature, low cooling water pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP+LOCA)	Line between engine driven pump and engine headers	Pipe failure	Cooling water to the diesel is lost, and the diesel will be shut down	High cooling water temperature, low cooling water pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP+LOCA)	Three-way thermostatic control valve	Valve fails to operate	Engine will overheat and will be shut down	High cooling water temperature	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP+LOCA)	Line from 3-way valve to engine driven pump	Pipe failure	Cooling water to the diesel is lost, and the diesel will be shut down	High cooling water temperature, low cooling water pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP+LOCA)	Keep warm pump or keep warm heater	Loss of pump or heater	No effect on system	Low keep warm temperature	No loss of safety function

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Emergency (LOP+LOCA)	Keep warm line	Pipe failure	Cooling water to the diesel is lost, and the diesel must be removed from service	Low cooling water pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Intercooler Cooling System					
Emergency (LOP+LOCA)	Engine driven pump	Failure of pump	Cooling water to the diesel is lost, and the diesel will be removed from service	Low cooling water pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP+LOCA)	Three-way thermostatic control valve	Valve fails to operate	Engine will over heat and will be shut down.	High cooling water temperature	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP+LOCA)	System piping	Pipe failure	Cooling water to the diesel is lost, and the diesel must be shut down	Low cooling water pressure, high cooling water temperature	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP

TABLE 9.5-9

STANDBY DIESEL GENERATOR STARTING AND CONTROL AIR SYSTEM
DESIGN PARAMETERS

Starting Air Compressor

Quantity	1 per diesel, 4 total
Type	Air cooled, 3 stage
Capacity, each	21 cfm at 425 psig
Motor rating	15 hp, 460V, 30[BS]/, 60 Hz
Code design requirements	Manufacturer's standard

Air Receiver

Quantity	2 per diesel, 8 total
Type	Vertical, cylindrical
Design pressure	500 psig
Design temperature	600#F
Capacity, each	56 ft^3 - 5 normal diesel starts minimum
Code design requirements	ASME B&PV Code, Section III, Class 3

Air Dryer

Quantity	1 per diesel, 4 total
Type	Refrigerant
Capacity	30 cfm at 450 psig, cools air to 35^{o}F at line pressure of 425 psig
Code design requirements	Manufacturer's standard

Air Shutdown Tank

Quantity	1 per diesel, 4 total
Type	6 inch cylindrical pipe
Design pressure	500 psig
Design temperature	$120^{o}F$
Capacity	$330\ in^3$
Code design requirements	ASME B&PV Code Section III Class 3

TABLE 9.5-10

STANDBY DIESEL GENERATOR STARTING AND CONTROL AIR SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency (LOP or LOCA & LOP)	Air compressor	Failure of compressor to start	No effect; since the air receivers are fully charged with air, the compressor is not required to start the the SDG. Each air receiver is sized for a minimum of five starts. The SDG is started by the air stored in the receivers	A common trouble alarm will annunciate in the main control room due to low air receiver pressure	No effect
Emergency (LOP or LOCA & LOP)	Air receiver	Failure of the air receiver	No effect; there are two redundant 100 percent-capacity air receivers that have separate discharge piping to the SDG	A common trouble alarm will annunciate in the main control room due to low air receiver pressure	No effect
Emergency (LOP or LOCA & LOP)	Line between the air compressor and the air receiver	Pipe failure	No effect; there are two redundant 100 percent-capacity air receivers that have separate discharge piping to the SDG	A common trouble alarm will annunciate in the main control room due to a low air receiver pressure	No effect
Emergency (LOP or LOP & LOCA)	Line between the air receiver and the SDG	Pipe failure	No effect; there are two redundant 100 percent-capacity air receivers that have separate discharge piping to the SDG	A common trouble alarm will annunciate in the main control room due to low air receiver pressure	No effect
Emergency (LOP or LOP & LOCA)	Line between the air receiver and the SDG	Failure of valves to open	No effect; there are two redundant 100 percent-capacity air receivers that have separate discharge piping to the SDG	A common trouble alarm will annunciate in the main control room due to low air receiver pressure	No effect

TABLE 9.5-11

STANDBY DIESEL GENERATOR LUBRICATION SYSTEM DESIGN PARAMETERS

Engine Lube Oil System

Engine Driven Lube Oil Pump

Quantity	1 per diesel (4 total)
Type	Double screw rotary
Capacity, each	400 gpm at 110 psi
Design code requirements	Hydraulic Institute standards

Lube Oil Heat Exchangers

Quantity	1 per diesel (4 total)
Type	Shell and tube
Duty, each	1,353,000 Btu/h
Shell design	
Fluid	Lube oil - SAE 40
Flow rate	400 gpm
Design pressure	150 psig
Design temperature	175°F
Tube design	
Fluid	Demineralized water (SACS system)
Flow rate	1176 gpm
Design pressure	200 psig
Design temperature	175°F
Design code requirements	ASME B&PV Code Section III, Class 3

Motor Driven Prelube/Keep Warm Pump

Quantity	1 per diesel (4 total)
Type	Rotary gear
Capacity, each	50 gpm at 130 psi
Motor power rating	10 hp
Design code requirements	ASME B&PV Code Section III, Class 3
Voltage, Phase, Frequency	460V, 3 phase, 60 Hz

Lube Oil Heater

Quantity	1 per diesel (4 total)
Type	Immersion, electric
Rating	20 kW
Voltage, Phase, Frequency	460 V, 3 ϕ, 60 Hz
Design code requirements	ASME B&PV Code Section III, Class 3

Lube Oil Simplex Strainer

Quantity	1 per diesel (4 total)
Type	Simplex, full flow
Capacity	400 gpm
Particle retention	40 micron
Design code requirements	
Strainer housing	ASME B&PV Code, Section III, Class 3
Element	Manufacturers standard

Lube Oil Filter

Quantity	1 per diesel (4 total)
Type	Simplex, full flow

Lube Oil Filter

Capacity, each	400 gpm
Particle retention	5 microns
Design code requirements	
Filter housing	ASME B&PV Code, Section III Class 3
Element	Manufacturers standard

Lube Oil Makeup Tank

Quantity	1 per diesel (4 total)
Type	30-3/4 in. od by 87-1/2 in. vertical
Design pressure	15 psig
Capacity	250 gallons
Design requirements	ASME B&PV Code, Section III, Class 3

Rocker Arm Lube Oil System

Engine Driven Lube Oil Pump

Quantity	1 per diesel (4 total)
Type	Rotary gear
Capacity	2.2 gpm at 20 psi
Design code requirements	Hydraulic Institute standards

Motor Driven Prelube Pump

Quantity	1 per diesel (4 total)
Type	Rotary gear
Capacity	2.2 gpm at 20 psi

Motor Driven Prelube Pump

Motor horsepower	0.5 hp
Voltage, Phase, Frequency	460 V, 3 ϕ, 60 Hz
Design code requirements	Hydraulic Institute standards

Lube Oil Duplex Filter

Quantity	1 per diesel (4 total)
Type	Duplex
Particle retention	5 microns
Design code requirements	Manufacturers standard

TABLE 9.5-12

STANDBY DIESEL GENERATOR LUBRICATION SYSTEM
FAILURE MODES AND AFFECTS ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Engine Lube Oil System					
Emergency (LOP + LOCA)	Engine driven lube oil pump	Failure of pump	Diesel trips due to low lube pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP + LOCA)	Line between engine-driven lube oil pump and the three-way valve	Pipe failure	Diesel trips due to low lube pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP + LOCA)	Three-way thermo-statically con-controlled valve	Failure of the controller	Valve fails to open and allow lube oil to pass through the heat exchanger, causing oil to overheat. The operator would be required to shut down the diesel	High lube oil temperature	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP + LOCA)	Line between three-way valve and simplex filter	Pipe failure	Diesel trips due to low lube oil pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP + LOCA)	Simplex filter	Filter becomes plugged	Diesel trips due to low lube oil pressure	High differential pressure across filter	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Emergency (LOP + LOCA)	Line between simplex filter and engine header	Pipe failure	Diesel trips due to low lube oil pressure	Low lube oil pressure, high differential strainer pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant and a LOP
Emergency (LOP + LOCA)	Line between crankcase and keep warm pump	Pipe failure	Diesel trips due to low lube oil pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP)
Emergency (LOP + LOCA)	Motor driven prelube keep warm pump	Failure of pump	Decrease in the lube oil temperature	Low keep-warm temperature	No loss of plant safety
Emergency (LOP + LOCA)	Lube oil heater	Heater fails or heater thermostat fails	Decrease or increase in the lube oil temperature	Either low or high keep-warm temperature	No loss of plant safety
Emergency (LOP + LOCA)	Piping between keep-warm pump and lube oil heater	Pipe failure	Diesel trips due to low lube oil pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Emergency (LOP + LOCA)	Piping between lube oil heater and simplex filter	Pipe failure	Diesel trips due to low lube oil pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure on Plant Operation
Emergency (LOP + LOCA)	Piping between simplex filter and three-way valve	Pipe failure	Diesel trips due to low lube oil pressure	Low lube oil pressure	No loss of plant safety since only three SDGs are required to safely shut down the plant following a LOCA and a LOP
Rocker Arm Lube Oil System					
Emergency (LOP + LOCA)	Engine driven pump	Pump fails	Motor driven rocker arm lube oil pump start	Rocker arm lube soil pressure low	No loss of plant safety
Emergency (LOP + LOCA)	Duplex filter	Filter fails	Diesel trips due to low lube oil pressure	High differential filter pressure	No loss of plant safety since only three SDGs are required to safely shutdown the plant following a LOCA and a LOP

TABLE 9.5-13

STANDBY DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM DESIGN PARAMETERS[1]

Air Intake Filters	
Quantity	1 per diesel (4 total)
Type	Floor mounted, dry type
Intake air flow	18,600 cfm at 90°F
Design pressure drop	1.55 in. water maximum, clean
Filtering efficiency	70 percent of 5-micron particles, 95 percent of 25-micron particles
Design code requirements	Manufacturer's standard
Exhaust Silencer	
Quantity	1 per diesel (4 total)
Attenuation capability	Total dBA over octave band center frequency = 57 dB at 400 feet
Exhaust gas flow rate/ pressure drop	48,650 cfm at 900°F/5 in. water maximum, clean
Design code requirements	Manufacturer's standard
Intake Silencer	
Quantity	1 per diesel (4 total)
Attenuation capability	Total dBA over octave band center frequency = 38 dB at 400 feet
Intake gas flowrate	18,600 cfm at 90°F
Pressure drop	2.0 in water maximum, clean
Design code requirements	Manufacturer's standard

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(1) Total pressure losses have been limited to 10 inches of water at the Air Intake System and 10 inches of water at the exhaust system as recommended by the SDG supplier.

TABLE 9.5-14

STANDBY DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM
FAILURE MODES AND EFFECTS ANALYSIS

Plant Operating Mode	System Component	Component Failure Mode	Effect of Failure on the System	Failure Mode Detection	Effect of Failure On Plant Operation
Emergency (LOP + LOCA)	Air intake filter	Filter becomes clogged	Air supply to one diesel is lost; however three diesels are adequate for a safe shutdown following a LOCA or LOP	Alarm in main control room	No loss of safety function
Emergency (LOP + LOCA)	Air intake silencer	Failure of silencer causing a flow obstruction	Air supply to one diesel is lost; however, three diesels are adequate for a safe shutdown following a LOCA or a LOP	Alarm in main control room	No loss of safety function
Emergency (LOP + LOCA)	Air intake piping	Pipe failure	Air supply to one diesel is lost; however, three diesels are adequate for a safe shutdown following a LOCA or a LOP. However, unit may still operate, depending on piping failure	Alarm in main control room	No loss of safety function
Emergency (LOP + LOCA)	Exhaust gas piping	Pipe failure	No effect on system	Alarm in main control room	No loss of safety function
Emergency (LOP.+ LOCA)	Exhaust silencer causing flow obstruction	Failure of silencer causing flow obstruction	Air supply to one diesel is lost; however, only three diesels are adequate for safe shutdown following a LOCA or LOP	Alarm in main control room	No loss of safety function

TABLE 9.5-15

TABLE DELETED

TABLE 9.5-16

THIS TABLE HAS BEEN INTENTIONALLY DELETED

TABLE 9.5-17

COMMUNICATIONS AND EMERGENCY LIGHTING SYSTEMS FOR SAFE SHUTDOWN AREAS

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)
Auxiliary Building					

Security Related Information
Table Withheld Under 10 CFR 2.390

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)
Reactor Building					

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Area/Equipment	Communication Features: Components Available At Area	Communication Features: Estimated Maximum Noise Level At Area, dBA	Work Station (See Note 4)	Emergency Lighting System Features: Approximate Footcandles at Equipment From Essential AC (See Note 1)	Emergency Lighting System Features: Approximate Footcandles at Equipment From 8-Hour Battery Pack (See Note 1)

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-17 (Cont)

Legend
(See Note 2)

1 = PA Handset
2 = PA Speaker
3 = Telephone
4 = Radio
5 = ES Headset
dBA = Decibel,
A-weighted
< = Less than

Notes:

1. These average lighting levels are at the panel or equipment surface or at the egress point of the rooms listed that are not work stations.

2. The following are the maximum sound levels (db) that the communication components are capable of producing or operating in.

Component	Sound Level
PA speaker (driven by 30W amplifier)	120
PA handset and electro sound (ES) headset	110
UHF radio portable set	80
Telephone	70

3. In these rooms the UHF radio sets' sound capability is below the maximum sound level that could be experienced in the room. In these rooms the adjacent hallway can be utilized for communication with the UHF radio set.

4. The work stations identified on the table are areas that may be required to be staffed during design basis accidents or during the improbable event of a loss of all ac power.

5. These rooms have a PA handset for two way communication in the adjacent hallway, corridor or room (within approximately 50 ft of these rooms).

6. All Class 1E batteries are passive electrical components and do not require any inspection during a station blackout per the HCGS station blackout procedures. The electrical status of the Class 1E batteries is available in the control room.

7. All Class 1E dc switchgear (HPCI, RCIC, etc), inverters and battery chargers can be monitored at the control room and require no local control per the HCGS station blackout procedures.

8. These rooms and equipment are not required to be locally monitored or are not required during the station blackout condition per the HCGS procedures.

9. The average of a 2 ft candle lighting level is a design intent which will cover a sufficient area of the corridor to provide safe ingress and egress routes. Any hazards within the corridor will be lighted to provide safe passage.

10. In addition to areas of the plant which have at least an average of 10 ft candles of emergency lighting, trouble shooting during a station blackout may be required in the diesel generator rooms, diesel generator fuel oil storage tank and pump rooms and the diesel generator battery rooms. Portable lighting (5 battery packs) will be stored in the corridor near each diesel fuel oil storage tank and pump rooms (total of 20 battery packs) for use in these or other areas.

11. The diesel generator and the control panels near the diesel can be monitored or operated from the control panels at Elevation 130 ft. It is not necessary to perform any operations in the diesel generator rooms.

TABLE 9.5-18

FIRE PROTECTION WATER SYSTEM HOSE STREAM FLOWS

System No.	Hazard Area	Minimum[2] Hose Stream Flow, gpm	Number of Fire Hoses Available	Actual Hose[2] Stream Flow, gpm
1WS7	Turbine area	500	4	300
1WS8	Turbine area	500	3	220
1WS13	Turbine area	650	4	300
1D1[1]	Control room emergency charcoal filter	750	2	150
1D2[1]	Control room emergency charcoal filter	750	2	150
1D5	Turbine area MG sets	750	2	150
1D6	Turbine area MG sets	750	2	150
1D7	Turbine area H_2 seal oil unit	750	2	150
1D8	Turbine bearings	750	2	150
1D9	Turbine bearings	750	2	150
1D10	L.O. reservoir & L.O. purifier	750	3	225
1D12	Main transformer	750	Yard hydrants	Yard hydrants
1D13	Main transformer	750	Yard hydrants	Yard hydrants
1D14	Main transformer	750	Yard hydrants	Yard hydrants
1D15	Station service transformer	750	Yard hydrants	Yard hydrants
1D16	Station service transformer	750	Yard hydrants	Yard hydrants
1D17	Station service transformer	750	Yard hydrants	Yard hydrants
1D18	Station service transformer	750	Yard hydrants	Yard hydrants
1D19	Station service transformer	750	Yard hydrants	Yard hydrants
1D20	Station service transformer	750	Yard hydrants	Yard hydrants
1D21	L.O. receiving storage tank	750	3	225
1D22[1]	Diesel fuel oil storage tank room	550	1	75
1D23[1]	Diesel fuel oil storage tank room	550	1	75
1D24[1]	Diesel fuel oil storage tank room	550	1	75
1D25[1]	Diesel fuel oil storage tank room	550	1	75
OD3	R/W tank vent charcoal filter	750	2	75
OD4	R/W tank vent charcoal filter	750	2	150
1PD3[1]	FRVS recirc charcoal filter	270	1	70
1PD4[1]	FRVS recirc charcoal filter	280	1	75
1PD5[1]	FRVS vent unit charcoal filter	400	1	75
1PD6[1]	FRVS vent unit charcoal filter	400	1	75
1PD7[1]	FRVS recirc charcoal filter	300	1	70
1PD8[1]	FRVS recirc charcoal filter	300	1	70

TABLE 9.5-18 (Cont)

System No.	Hazard Area	Minimum[2] Hose Stream Flow, gpm	Number of Fire Hoses Available	Actual Hose[2] Stream Flow, gpm
1PD9	Containment prepurge cleanup charcoal filter	400	1	70
1PD10[1]	FRVS recirc charcoal filter	275	1	70
1PD11[1]	FRVS recirc charcoal filter	275	1	70
OD5	TSC emergency charcoal filter	380	1	70
1PS4[1]	Cable spreading room	750	2	150
1D26	Station service transformer	750	Yard hydrants	Yard hydrants
1D27	Station service transformer	750	Yard hydrants	Yard hydrants
OFS1	Fuel oil storage tank	750	Yard hydrants	Yard hydrants
1PS6[1]	Cooridor 5207 and electrical access 3204	500	3	210
1PS7[1]	Corridor 5237	500	3	210
1PS8[1]	Electrical access 5339	500	3	210
1PS9[1]	Electrical access 3425 and 5401	300	2	140
1PS10[1]	Electrical chase	500	2	140
1PS11[1]	Electrical chase	500	2	140
1PS12[1]	Electrical chase	500	2	140
1PS13[1]	Electrical chase	500	2	140
1PS14[1]	H&V chase	500	2	140
1PS15[1]	Motor control center area 4201	500	2	140
1PS16[1]	Corridor 4301	500	2	140
1D28	Control Equipment Room Mezzanine	300	2	140

(1) Denotes systems serving safety-related areas or equipment.
(2) See Section 9.5.1.6.19 for explanation of values.

TABLE 9.5-19

SAFETY RELATED AREAS WITHOUT DETECTION

ELEV. FT-IN.	ROOM	DESCRIPTION

Auxiliary Building - R/W Service Wing Area

Security Related Information
Table Withheld Under 10 CFR 2.390

Reactor Building

Security Related Information
Table Withheld Under 10 CFR 2.390

ELEV. FT-IN.	ROOM	DESCRIPTION

Security Related Information
Table Withheld Under 10 CFR 2.390

ELEV. FT-IN.	ROOM	DESCRIPTION

Security Related Information
Table Withheld Under 10 CFR 2.390

ELEV. FT-IN.	ROOM	DESCRIPTION

Security Related Information
Table Withheld Under 10 CFR 2.390

Auxiliary Building Control & Diesel Genrator Area

Security Related Information
Table Withheld Under 10 CFR 2.390

ELEV. FT-IN.	ROOM	DESCRIPTION

Security Related Information
Table Withheld Under 10 CFR 2.390

Station Service Water Intake Structure

Security Related Information
Table Withheld Under 10 CFR 2.390

TABLE 9.5-20

DIESEL ENGINE FUEL OIL TRANSFER SYSTEM
INSTRUMENTS, CONTROLS, AND SENSORS[(1)]

Instrument No.	Function
JE LI-7517 A-D	Day Tank Level
JE TI-7502 A-D	Day Tank Temperature
JE LSHL-7501 A-D	F.O. Day Tank
JE LSHL-7530 A-D	F.O. Day Tank level controller
KJ PDI-7505 A-D	F.O. Suction Strainer ΔP
KJ PDI-7506 A-D	F.O. Filter ΔP
KJ PDSH-6804 A-D	F.O. Strainer ΔP
KJ PDSH-6805 A-D	F.O. Filter ΔP
KJ PSL-7508 A-D	F.O. Header
KJ PT-7518 A-D	F.O. Pump Discharge
KJ PT-7520 A-D	F.O. Header Pressure
KJ TI-7507 A-D	F.O. Temperature
KJ PI-6801 A-D	F.O. Filter In/Out
KJ PI-6802 A-D	F.O. Pump Discharge
JE LT-7521 A-H	F.O. Storage Tank Level A/B
JE LI-7521 A-H	F.O. Storage Tank Level
JE PT-7514 A-H	F.O. Transfer Pump Pressure

NOTES:

(1) The SDG instrumentation listed below will be calibrated on an 18 month schedule until RCM analysis, in accordance with NC.NA-AP.ZZ-0010(Q), on the calibration records and failure records is complete, at which time the frequency will be based on the analysis.

TABLE 9.5-21

SUMMARY OF OPERATOR ACTIONS TAKEN IN RESPONSE TO DIESEL ENGINE FUEL OIL STORAGE AND TRANSFER SYSTEM ALARMS

High Priority Alarms

a) FUEL OIL PRESSURE LOW

Check	Action
Operating pressures (locally)	If normal: Attempt to clear alarm; If low, proceed to next check
Suction valve open	Open valve in pump suction line if closed
Filter and strainer differential pressure	If high - see applicable response summary
Day tank level	If low - see applicable response summary
Motor driven pump auto start	If not, confirm: Control switch CS-33 in AUTO; Power is available. Take manual control at CS-33 if necessary.
Valve lineup to instrumentation and alarm switches	Open valves found in closed position
Piping system integrity from day tank injectors	If piping is breached or restricted; notify OS/CRS

b) FUEL OIL DAY TANK LEVEL LOW

Check	Action
Tank level locally	If normal: Attempt to clear alarm If low: Proceed to next check
Verify transfer pump auto start	If not: Check for proper operation of LSHL7530. Control pump manually if required. If running: Confirm valve lineup to day tank.
Piping integrity	If piping is breached or restricted: Notify OS/CRS. Crosstie and fill from fuel oil storage tank of another diesel if required.

Low Priority Alarms

a) FUEL OIL DAY TANK LEVEL HIGH

Check	Action
Tank level (locally)	If normal: Attempt to clear alarm. If high: Proceed to next check.
Confirm transfer pump shutoff	If running: Stop pump manually; Monitor day tank level; Prevent low level alarm; Notify I&C to repair level control.

b) FUEL OIL STORAGE TANK NO. 1 LEVEL LOW

Check	Action
Tank level	If normal: Attempt to clear alarm. If low: Proceed to next check.
Tank and piping integrity	If leaks or obstructions are found: Isolate if possible; Notify OS/CRS.
Transfer pump running	Ensure fuel oil is not being pumped to main fuel oil storage tank

c) FUEL OIL STORAGE TANK NO. 2 LEVEL LOW

Check	Action
Same as b.	Same as b.

d) Intentionally Deleted

e) Intentionally Deleted

f) FUEL OIL FILTER DIFFERENTIAL PRESSURE HIGH

Check	Action
Confirm high filter dP	If normal: Attempt to clear alarm. If high: Confirm instrumentation valves lineup; Swap and clean filter.

g) FUEL OIL STRAINER DIFFERENTIAL PRESSURE HIGH

Check	Action
Confirm high strainer dP	If normal: Attempt to clear alarm. If high: Confirm instrumentation valve lineup; Swap and clean filter

h) FUEL OIL TRANSFER PUMP NO. 1 MALFUNCTION

Check	Action
Confirm: Alarming pump is running; Discharge pressure is low	If pump has not received a run signal, Attempt to clear alarm. If pump is running and pressure is normal: Notify I&C to repair alarm. If pump has failed to run: Confirm CS-35 is in AUTO; Attempt to control pump manually If discharge pressure is low: Confirm valve lineup to pump; Notify I&C and Maintenance as required.

i) FUEL OIL TRANSFER PUMP NO. 2 MALFUNCTION

Check	Action
Same as h.	Same as h

j) FUEL OIL TRANSFER SYSTEM NOT IN AUTOMATIC

Check	Action
Position of CS34 and and CS35 Fuel oil transfer pump control switches	If both switches are on AUTO: Attempt to clear alarm. If either switch is not on AUTO: Confirm reason for switch position; Return to AUTO when possible.

TABLE 9.5-22

DIESEL GENERATOR COOLING WATER SYSTEM
INSTRUMENTS, CONTROLS, AND SENSORS (1)

Instrument No.	Function
KJ PSL-6621 A-D	Intercooler Water Pressure
KJ PT-6631 A-D	Intercooler Pump Discharge
KJ TI-6624 A-D	Intercooler Pump Out
KJ TI-6625 A-D	Intercooler HX Out
KJ TI-6626 A-D	Intercooler HX In
KJ TI-6627 A-D	D.G. Water Out Temperature
KJ TSH-6620 A-D	Intercooler Water Temperature
KJ LSHL-7527 A-D	Jacket Water Expansion Tank
KJ PSL-6612 A-D	Jacket Water Pressure
KJ PSL-6613 A-D	Jacket Water Pressure
KJ PT-7799 A-D	Jacket Water Pressure
KJ TI-7840 A-D	Jacket Water HX Out
KJ TI-7841 A-D	Jacket Water HX In
KJ TI-7842 A-D	Jacket Water Keepwarm HX Out
KJ TI-7843 A-D	Jacket Water Pump Out
KJ TS-6611 A-D	Jacket Water Heater Thermostat
KJ TSH-6609 A-D	Jacket Water Temperature
KJ TSH-6610 A-D	Jacket Water Keepwarm Temperature
KJ TSL-6607 A-D	Jacket Water Temperature
KJ TSL-6608 A-D	Jacket Water Keepwarm Temperature
KJ PI-7799 A-D	Jacket Water Pump Discharge
KJ TI-6614 A1-D1	Jacket Water Temperature
KJ TI-6614 A2-D2	Jacket Water Temperature

NOTES:

(1) The SDG instrumentation listed below will be calibrated on an 18 month schedule until RCM analysis, in accordance with NC.NA-AP.ZZ-0010(Q), on the calibration records and failure records is complete, at which time the frequency will be based on the analysis.

TABLE 9.5-23

SUMMARY OF OPERATOR ACTIONS IN RESPONSE TO DIESEL ENGINE COOLING WATER SYSTEM ALARMS

High Priority alarms:

a) JACKET WATER PRESSURE LOW

Check	Action
Instrument valve lineup	Open valves to switch and gauge if closed
Pressure indication	If normal: Attempt to clear alarm
Piping and flex coupling integrity	If leaks or obstructions exist, notify maintenance to repair
Engine driven pump operability	Notify maintenance to repair

b) JACKET WATER TEMPERATURE HIGH

Check	Action
Operating Temperature indicators	If normal: Attempt to clear alarm
Operation of temp. control valve	Notify maintenance to repair when possible
Engine driven pump operability	Notify maintenance to repair when possible
Flow of SACS cooling water	Open SV2395 if closed

c) JACKET WATER TEMPERATURE LOW

Check	Action
Operating temperature indicators	If normal: Attempt to clear alarm
Operation of temp. control valve	Fail open design may cause this condition; Notify maintenance to repair when possible

d) JACKET WATER EXPANSION TANK LEVEL LOW

Check	Action
LSHL 7527 operating properly	If normal: Attempt to clear alarm
	If switch has failed: Operate SV6615 manually until alarm condition is cleared.
Makeup demineralized water is available	Ensure pump is running and pipe valve line up
Drain valve position	Close drain valve and cap discharge pipe if leak exists
Piping and flex coupling integrity	Notify maintenance to repair when possible.

Low Priority Alarms

a) JACKET WATER KEEP WARM TEMPERATURE HIGH

Check	Action
J.W. heater outlet temperature	If normal: Attempt to clear alarm
J.W. keep warm pump	Confirm: Power is available to the pump. Pump control switch is in AUTO. Notify Maintenance if required.
Heater thermostat operating	If not: Manually control heater to clear alarm
	Notify I&C to repair thermostat

b) JACKET WATER KEEP WARM TEMPERATURE LOW

Check	Action
J.W. heater outlet temperature	If normal: Attempt to clear alarm
Position of pump and heater controls	Place control switches in AUTO
Keep warm pump and heater operating	Confirm: Power is available to both components. Heater thermostat is operating. Notify Maintenance if required.

c) JACKET WATER EXPANSION TANK LEVEL HIGH

Check	Action
LSHL 7527 operating properly	If normal: Attempt to clear alarm
Position of Demin Water Makeup Valve	Manually close SV6615 if open
Tank overflow	If overflowing, drain tank to clear alarm

d) JACKET WATER EXPANSION TANK FILLING

Check	Action	
SV6615 is open	If not:	If low level alarm occurs, manually open SV6615 to clear alarm
	If open:	Confirm SV6615 closes before high level alarm is initiated

TABLE 9.5-24

DIESEL ENGINE STARTING AND CONTROL AIR SYSTEM
INSTRUMENTS, CONTROLS, AND SENSORS (1)

System I.D.	Instrument No.	Function
KJ	PI-7538 A-H	Air Start Receiver Tanks
KJ	PIC-7543 A-D	Compressor Air Pressure
KJ	PSHL-6825 A-H	Start Air Compressor Control
KJ	PI-7554 A1-D2	Start Air Pressure
KJ	PSL-7555 A1-D2	Start Air Pressure

(1) The SDG instrumentation listed below will be calibrated on an 18 month schedule until RCM analysis, in accordance with NC.NA-AP.ZZ-0010(Q), on the calibration records is complete, at which time the frequency will be based on the analysis.

TABLE 9.5-25

SUMMARY OF OPERATOR ACTIONS IN RESPONSE TO DIESEL ENGINE AIR STARTING SYSTEM ALARMS

High Priority

a) Starting Air Pressure Low

Check	Action	
Air header pressure	If normal:	check valve lineup to sensors Attempt to clear alarm
	If low:	Proceed to next step
Receiver pressure	If normal:	Check valve lineup to air Start distributors
	If low:	Proceed to next step
Valve lineup to receivers	Open valves if closed	
Compressor running	If stopped:	Confirm valve lineup to start switch ensure power to compressor
Piping and flex Coupling	If leaks or obstructions exist: Isolate leak if possible Notify OS/CRS	

b) Start Failure Crankshaft Not Rotating.

Check	Action	
Barring device	If engaged:	Check reason for engagement Disengage when possible
Engine trouble shutdown	Ensure shutdown has been reset	

Check	Action
Control power available	Ensure circuit #3 is energized Notify maintenance if repairs are required
Maintenance switch position	If (43) switch is not in REMOTE: Check reason for position Return to REMOTE when possible
Hand switch position	If HSS switch is not in NORMAL: Check reason for position Return to NORMAL when possible

If the diesel still fails to start, manually start at:
Control room panel
remote engine panel
local engine panel
air start solenoid valve

c) Start Failure Crankshaft Rotating

Check	Action
Fuel system	If fuel system problems exist, respond in accordance with applicable alarm response
Air intake system	Check condition of air intake filters, piping, flex connectors, and intake manifolds.

Low Priority

a) Engine Locked Out For Maintenance

Check	Action
Position of maintenance switch (43)	If switch is in MAINTENANCE position: Check reason for switch position Return to REMOTE when possible If switch is in REMOTE position: Attempt to clear alarm

TABLE 9.5-25 (Cont)

b) Diesel Engine in Local Control

Check	Action
Position of maintenance switch (43)	If switch is in LOCAL position: Check reason of switch position Return to REMOTE when possible If switch is in REMOTE position: Attempt to clear alarm

c) Remote Emergency Takeover

Check	Action
Position of control (HSS)	If switch is in EMERGENCY TAKEOVER Check reason for switch position Return to NORMAL when possible If switch is in NORMAL: Attempt to clear alarm

TABLE 9.5-26

DIESEL GENERATOR LUBE OIL SYSTEM INSTRUMENTS, CONTROLS, AND SENSORS (1)

Instrument No.	Function
KJ LI-7557 A-D	Lube Oil Makeup Tank
KJ LSH-7523 A-D	Rocker Arm Lube Oil Level
KJ LSHL-7556 A-D	Crankcase Lube Oil Level Contact
KJ LSHL-7558 A-D	Crankcase Lube Oil Level
KJ LSL-7544 A-D	Lube Oil Makeup Tank
KJ PDI-7783 A-D	Lube Oil Filter ΔP
KJ PDI-7784 A-D	Lube Oil Strainer ΔP
KJ PDSH-7400 A-D	Lube Oil Filter ΔP
KJ PDSH-7514 A-D	Lube Oil Strainer ΔP
KJ PSL-7542 A1-D1	Lube Oil Pressure Low
KJ PSL-7542 A2-D2	Lube Oil Pressure Low
KJ PSL-7542 A3-D3	Lube Oil Pressure Low
KJ PSL-7542 A4-D4	Lube Oil Pressure Low
KJ PSL-7560 A-D	Rocker Arm Lube Oil Pressure Low
KJ PT-7780 A-D	Lube Oil Pressure
KJ TI-6796 A-D	Lube Oil Keep warm Pump Discharge
KJ TI-6797 A-D	Lube Oil Heater Out
KJ TI-6798 A-D	Lube Oil Heater Out
KJ TI-6799 A-D	Lube Oil HX In
KJ TI-6800 A-D	Lube Oil HX Out
KJ TS-7539 A-D	Lube Oil Heater Thermostat
KJ TSH-7550 A-D	Lube Oil Keep warm Temperature
KJ TSH-8579 A-D	Lube Oil Engine Temperature
KJ TSL-7561 A-D	Lube Oil Keep warm Temperature
KJ TSL-7562 A-D	Lube Oil Engine Temperature
KJ PI-7780 A1-D1	Lube Oil Engine Manifold
KJ TI-7548 A1-D2	Lube Oil Temperature (Remote)

(1) This SDG instrumentation listed below will be calibrated on an 18 month schedule until RCM analysis, in accordance with NC.NA-AP.ZZ-0010(Q), on the calibration records and failure records is complete, at which time the frequency will be based on the analysis.

TABLE 9.5-27

SUMMARY OF OPERATOR ACTIONS IN RESPONSE TO DIESEL ENGINE LUBRICATING OIL SYSTEM ALARMS

High Priority

a) LUBE OIL TEMPERATURE HIGH

Check	Action
Lube Oil Temperature	If normal: Attempt to clear alarm. If high, proceed to next step.
SACS flow through cooler	Open SV2395 if closed.
Proper operation of temperature control valve	If stuck closed, monitor Lube Oil Temperature and Notify CRS

b) LUBE OIL MAKEUP TANK LEVEL LOW

Check	Action
Tank level	If normal: Attempt to clear alarm If low: Proceed to next step.
Drain valve	Close valve if open and leaking.
Proper operation of crankcase fill solenoid valve	If crankcase level is high: Close valve using control switch; Manually close valve if required.
Piping and flex coupling integrity	If leaks or obstructions are present. Isolate leaks or clear obstructions if possible; Notify OS/CRS.

c) CRANKCASE LUBE OIL LEVEL HIGH

Check	Action
Crankcase level	If normal: Attempt to clear alarm. If high: Proceed to next step.
Confirm solenoid makeup valve is closed	If open: Close valve using Control Switch; Manually close if required.
Crankcase level trend	Manually drain if required.

d) CRANKCASE LUBE OIL LEVEL LOW

Check	Action
Crankcase level	If normal: Attempt to clear alarm. If low: Proceed to next check.
Confirm Control Switch is on AUTO	If not: Determine reason for switch out of AUTO; Return switch to AUTO when possible; With Control Switch in AUTO, confirm solenoid valve is open; Manually open if required to maintain crankcase level.
Lube oil makeup system operable	If not: Gravity fill crankcase to clear alarm.

e) ROCKER ARM LUBE OIL PRESSURE LOW

Check	Action
Instrumentation valve lineup	Open high pressure switch isolation valve, if closed
Duplex L.O. filter	Swap and clean filter
Confirm motor-driven pump start	If prelube pump has not started, manually start to clear alarm
Pressure relief valve	Confirm PSV is not stuck open
System integrity	Isolate leaks if possible

f) LUBE OIL PRESSURE LOW PRE-TRIP

Check	Action
Operating pressure	If normal: Attempt to clear alarm. If low: Proceed to next check.
Strainer and filter dP	If high, refer to applicable response.
Piping integrity	If breaks or obstructions are found: Attempt to isolate leak or free obstruction; Notify OS/CRS
Valve lineup to instrumentation	Open valves if closed.
Pump operation	Examine pump for damage and air inleakage

g) LUBE OIL PRESSURE LOW SHUTDOWN

Check	Action
Operating pressure	If greater than 60 psi: Attempt to clear alarm. If below 60 psi: Confirm diesel has shutdown; Manually shutdown if required; Determine cause of low pressure.

Low Priority

a) LUBE OIL TEMPERATURE LOW

Check	Action
Lube oil temperature	If normal: Attempt to clear alarm. If low: Proceed to next check.
Operation of temperature control valve	If valve fails open, may cause low temperature under certain conditions

b) LUBE OIL KEEP WARM TEMPERATURE HIGH

Check	Action
Heater outlet temperature	If normal: Attempt to clear alarm. If high: Proceed to next check
Control switch positions	Heater and pump Control Switches should be in AUTO, if not: Determine reasons for switch position; Return to AUTO when possible
Pump operating properly Heater thermostat operating	If thermostat has failed, notify I&C and with pump running: Control temperature by cycling Control Switch to control heater If pump not running: Place Control Switch in OFF to prevent heater damage

c) LUBE OIL KEEP WARM TEMPERATURE LOW

Check	Action
Heater outlet temperature	If normal: Attempt to clear alarm If low: Proceed to next check
Control switch positions	Heater and pump Control Switches should be in AUTO, if not: Determine reason for switch position Return to AUTO when possible
Heater thermostat operation	If thermostat has failed, notify I&C
Operation of temperature control valve	Valve fails full open

d) ROCKER ARM LUBE OIL TANK LEVEL HIGH

Check	Action
Operation of tank level control valve	Confirm linkage and valve actuator are not bound
Tank overflow	If overflow occurs, manually control tank level

e) LUBE OIL STRAINER DIFFERENTIAL PRESSURE HIGH

Check	Action
Differential pressure indicator	If normal: Attempt to clear alarm
Lube oil pressure	Confirm adequate L.O. pressure is available and clean strainer when possible
	If Lube Oil Pressure low, Notify CRS

f) LUBE OIL FILTER DIFFERENTIAL PRESSURE HIGH

Check	Action
Differential pressure indicator	If normal: Attempt to clear alarm
	if high: Filter may be isolated and cleaned if keep warm system is shut down

g) CRANKCASE PRESSURE HIGH

Check	Action
Crankcase monometer	If normal: Attempt to clear alarm. If high: Proceed to next check.
Vacuum ejector piping and flex coupling integrity	Notify OS/CRS of any leaks or obstructions.

TABLE 9.5-28

CRANKCASE VACUUM, AIR INTAKE AND EXHAUST SYSTEMS'

INSTRUMENTS, CONTROLS, AND SENSORS (1)

Instrument No.	Function
KJ PSH-6602 A-D	Crankcase Pressure
KJ TI-6600 A-D	Intake Air Temperature
KJ TI-8269 A-D	Left Turbo Out
KJ TI-8270 A-D	Right Turbo Out
KJ TI-8271 A-D	Air Manifold Left
KJ TI-8272 A-D	Air Manifold Right
KJ TSH-6605 A1-D1	Combustion Air Temperature
KJ TSH-6605 A2-D2	Combustion Air Temperature
KJ TI-8585 A-D	Cylinder Exhaust Temperature
KJ PG-6603 A-D	Crankcase Vacuum

NOTES:

(1) This SDG instrumentation listed below will be calibrated on an 18 month schedule until RCM analysis, in accordance with NC.NA-AP.ZZ-0010(Q), on the calibration records and failure records is complete, at which time the frequency will be based on the analysis.

TABLE 9.5-29

SUMMARY OF OPERATOR ACTIONS TAKEN IN RESPONSE TO DIESEL ENGINE COMBUSTION AIR INTAKE AND EXHAUST SYSTEM ALARMS

High Priority

COMBUSTION AIR TEMPERATURE HIGH

Check	Action
Intercooler cooling water temperature pressure	If abnormal: Check piping for leaks and obstructions Ensure: Makeup water is available from jacket water expansion tank; Intercooler cooling pump is operable; SACS is available to the intercooler heat exchanger.

TABLE 9.5-30

Areas Associated with Safe Shutdown in the Event of Fire

Note: For illumination from 8-hour battery pack lighting either at equipment or for access through an area refer to Table 9.5-17 and Section 9.5.3.2.2.

Security Related Information
Table Withheld Under 10 CFR 2.390

Figure F9.5-1 intentionally deleted.

Refer to Plant Drawing M-5001 in DCRMS

Figure F9.5-2 intentionally deleted.

Refer to Plant Drawing M-5002 in DCRMS

Figure F9.5-3 intentionally deleted.

Refer to Plant Drawing M-5003 in DCRMS

Figure F9.5-4 intentionally deleted.

Refer to Plant Drawing M-5004 in DCRMS

Figure F9.5-5 intentionally deleted.

Refer to Plant Drawing M-5005 in DCRMS

Figure F9.5-6 intentionally deleted.

Refer to Plant Drawing M-5006 in DCRMS

Figure F9.5-7 intentionally deleted.

Refer to Plant Drawing M-5007 in DCRMS

Figure F9.5-8 intentionally deleted.

Refer to Plant Drawing M-5008 in DCRMS

Figure F9.5-9 intentionally deleted.

Refer to Plant Drawing M-5009 in DCRMS

Figure F9.5-10 intentionally deleted.

Refer to Plant Drawing M-5010 in DCRMS

Figure F9.5-11 intentionally deleted.

Refer to Plant Drawing M-5011 in DCRMS

Figure F9.5-12 intentionally deleted.

Refer to Plant Drawing M-5012 in DCRMS

Figure F9.5-12A intentionally deleted.

Refer to Plant Drawing M-5013 in DCRMS

Figure F9.5-13 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 1 in DCRMS

Figure F9.5-14 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 2 in DCRMS

Figure F9.5-15 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 3 in DCRMS

Figure F9.5-16 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 4 in DCRMS

Figure F9.5-17 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 5 in DCRMS

Figure F9.5-18 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 6 in DCRMS

Figure F9.5-19 intentionally deleted.

Refer to Plant Drawing M-22-0 SH 7 in DCRMS

Figure F9.5-20 intentionally deleted.

Refer to Plant Drawing E-1421-0 in DCRMS

Figure F9.5-21 SH 1-3 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0049 in DCRMS

Figure F9.5-21A SH 1-2 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0141 sheet 13 for sheet 1 in DCRMS
Refer to Vendor Technical Document PM018Q-0366 sheet 23 for sheet 2 in DCRMS

Figure F9.5-22 intentionally deleted.

Refer to Plant Drawing M-30-1 SH 1 in DCRMS

Figure F9.5-23 SH 1-2 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0052 for both sheets in DCRMS

Figure F9.5-24 SH 1-2 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0050 for both sheeets in DCRMS

Figure F9.5-25 intentionally deleted.

Refer to Plant Drawing M-30-1 in SH 2 DCRMS

Figure F9.5-26 SH 1-2 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0048 for both sheets in DCRMS

Figure F9.5-27 SH 1-2 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0056 for both sheets in DCRMS

Figure F9.5-28 intentionally deleted.

Refer to Plant Drawing M-30-1 SH 3 in DCRMS

Figure F9.5-29 SH 1-2 intentionally deleted.

Refer to Vendor Technical Document PM018Q-0047 for both sheets in DCRMS

FIGURE DELETED

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HOPE CREEK NUCLEAR GENERATING STATION

Updated FSAR Figure 9.5-30
Revision 8 September 25, 1996

FIGURE DELETED

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

Updated FSAR
Figure 9.5-31
Revision 8 September 25, 1996

Figure F9.5-32 intentionally deleted.

Refer to Plant Drawing M-15-1 in DCRMS

Figure F9.5-33 intentionally deleted.

Refer to Plant Drawing E-1475-1 SH 1 in DCRMS

Figure F9.5-34 intentionally deleted.

Refer to Plant Drawing E-1475-1 SH 2 in DCRMS

Figure F9.5-35 intentionally deleted.

Refer to Plant Drawing M-5101 in DCRMS

Figure F9.5-36 intentionally deleted.

Refer to Plant Drawing M-5102 in DCRMS

Figure F9.5-37 intentionally deleted.

Refer to Plant Drawing M-5103 in DCRMS

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Refer to Plant Drawing M-5104 in DCRMS

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Refer to Plant Drawing M-5106 in DCRMS

Figure F9.5-41 intentionally deleted.

Refer to Plant Drawing M-5107 in DCRMS

Figure F9.5-42 intentionally deleted.

Refer to Plant Drawing M-5108 in DCRMS

Figure F9.5-43 intentionally deleted.

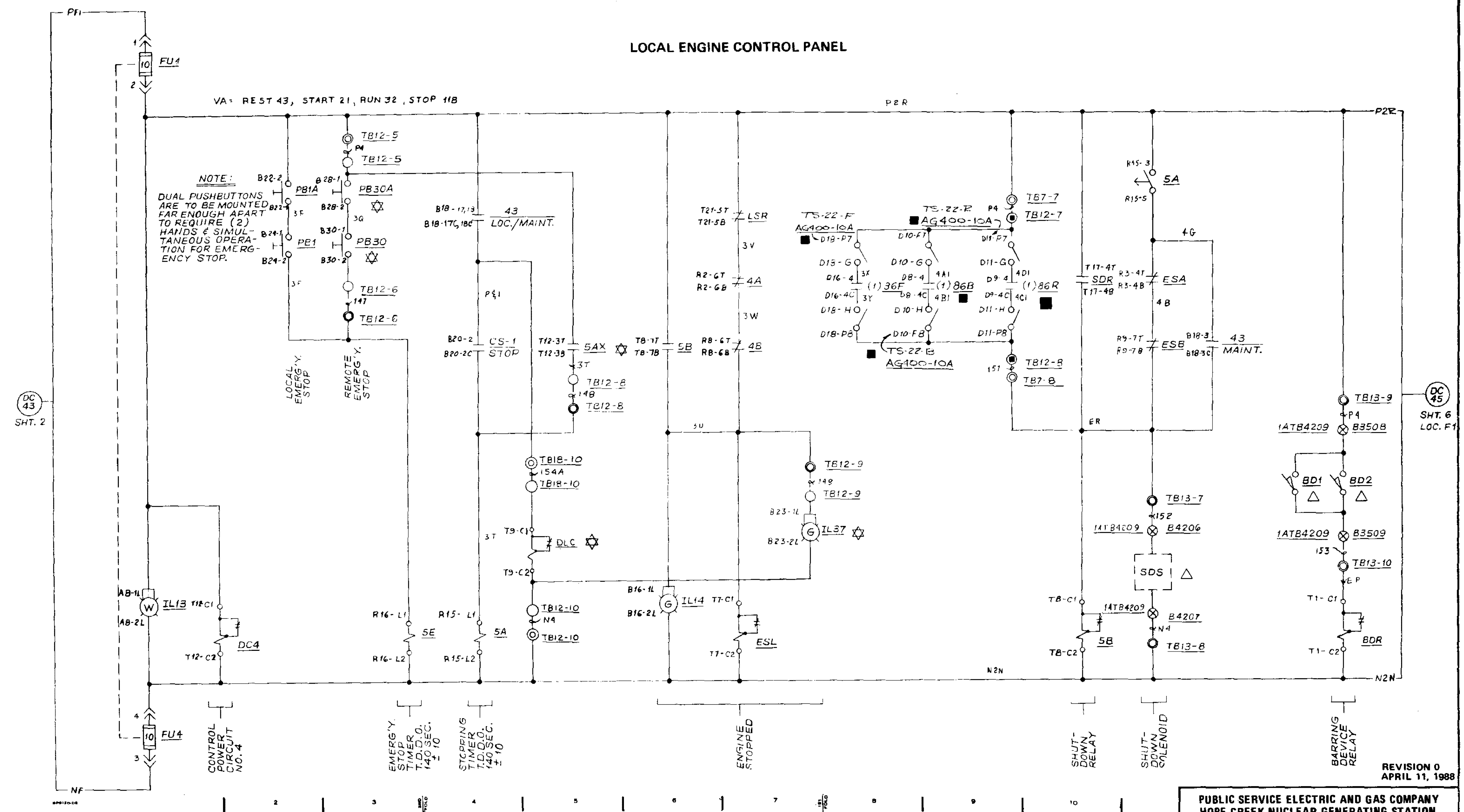
Refer to Plant Drawing M-5109 in DCRMS

Figure F9.5-44 intentionally deleted.

Refer to Plant Drawing M-5110 in DCRMS

Figure F9.5-45 intentionally deleted.

Refer to Plant Drawing M-5111 in DCRMS



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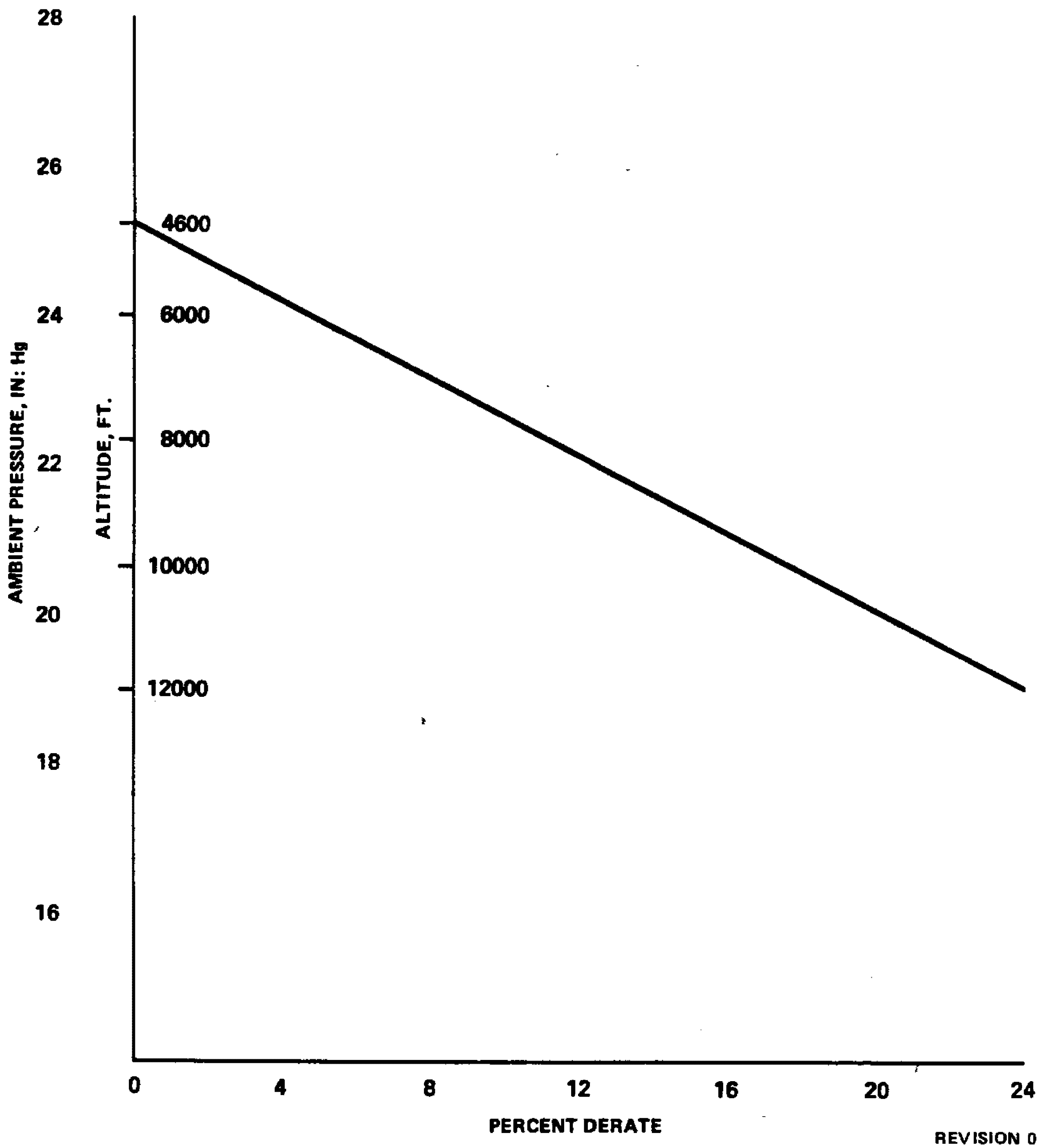
APRIL 11, 1988

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
HOPE CREEK NUCLEAR GENERATING STATION

ELECTRICAL SCHEMATIC
ENGINE CONTROL

UPDATED FSAR

FIGURE 9.5-46



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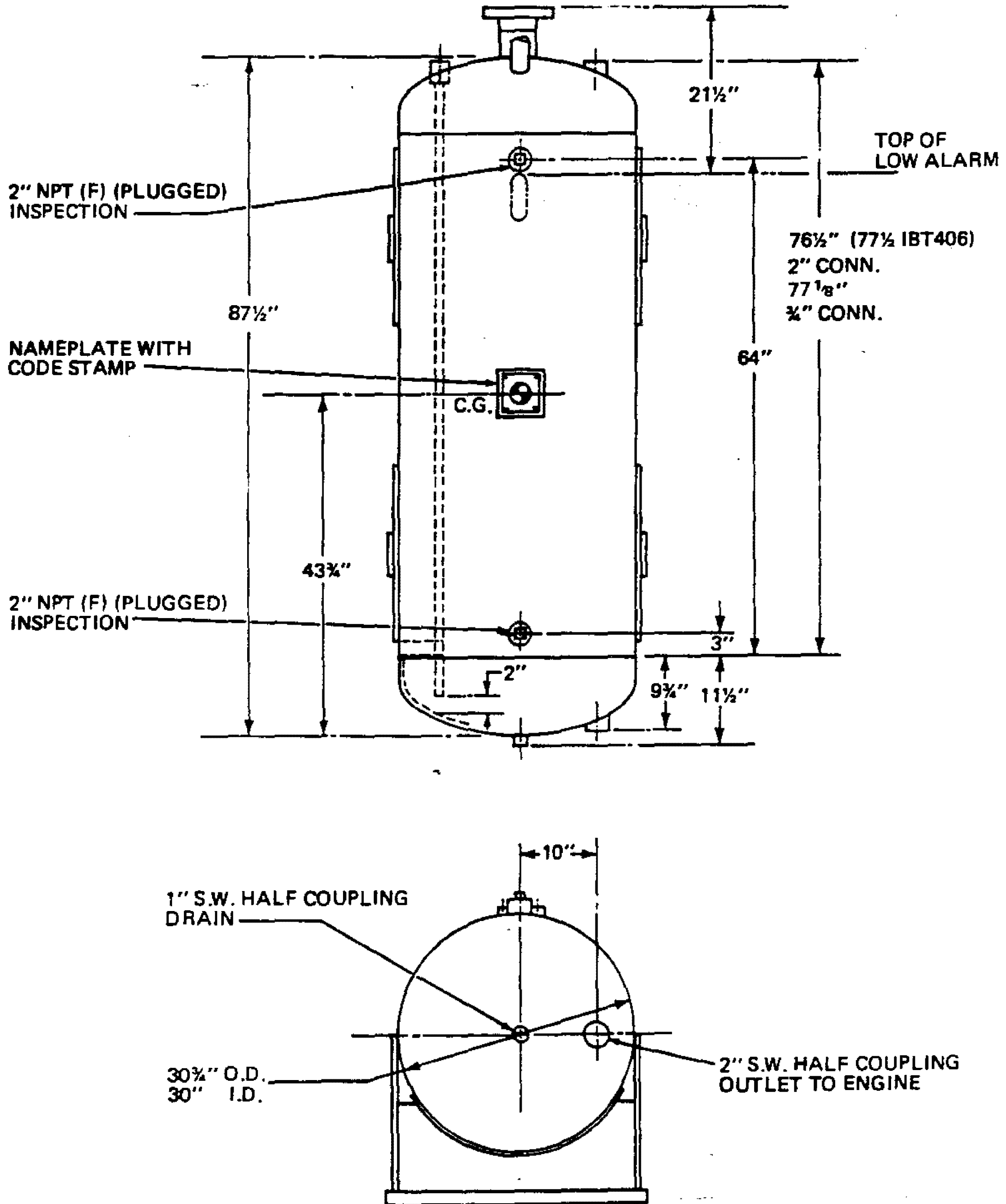
HOPE CREEK NUCLEAR GENERATING STATION

12 CYL. PC2 (4238KW AT 514 RPM)
AMBIENT PRESSURE vs
PERCENT DERATE

UPDATED FSAR

FIGURE 9.5-47



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PUBLIC SERVICE ELECTRIC AND GAS COMPANY HOPE CREEK NUCLEAR GENERATING STATION
STANDBY DIESEL GENERATOR LUBE OIL MAKE-UP TANK
UPDATED FSAR FIGURE 9.5-48