CHAPTER 9

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CHAPTER 9

AUXILIARY SYSTEMS

9.1 FUEL STORAGE AND HANDLING

9.1.1 New Fuel Storage

The new fuel storage area, located in the fuel building, is designed to provide a safe, effective means for dry storage of the new fuel assemblies.

9.1.1.1 Design Bases

The new fuel storage area is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the ability of structures housing the facility components to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 5, as it relates to shared structures, systems, and components important to safety being capable of performing required safety functions.

3. General Design Criterion 61, as it relates to the facility design for fuel storage.

4. General Design Criterion 62, as it relates to the prevention of criticality by physical systems or the process utilizing geometrically safe configurations.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of facility components.

6. The capability to store sufficient fuel for one refueling (one-third core) plus 17 spares, for a total of 70 assemblies, and maintain the fuel subcritical ($K_{eff} \leq 0.95$) when fully loaded and flooded with non-borated water. With fuel of the highest anticipated enrichment, assuming optimum moderation, the effective multiplication factor (K_{eff}) will not exceed 0.95.

9.1.1.2 Facilities Description

The new fuel storage area is shown on Figures 9.1-1 and 9.1-2. New fuel storage is provided for one-third core (53 fuel assemblies) plus 17 spare assemblies. New fuel assemblies are stored dry in a steel and concrete structure within the fuel building. The new fuel storage racks consist of a stainless steel support structure into which 70 stainless steel fuel guide assemblies are bolted in 14 parallel rows of five fuel guide assemblies each. Due to the design of the fuel guide supporting

structure the necessary minimum spacing between nearby fuel assemblies is ensured.

The spacing of the new fuel assemblies, located in the new fuel guide assemblies, is a minimum of 21 inches center-to-center. Fuel assemblies are loaded into the fuel guide assemblies through the top. Adequate guidance is provided in each fuel guide assembly by means of a flared lead-in opening to preclude damage to the fuel assemblies during insertion or withdrawal. The accumulation of liquid in the new fuel storage area is prevented by a 4-inch floor drain located in the area.

9.1.1.3 Safety Evaluation

The new fuel storage area is located in the Seismic Category I fuel building. Handling of new fuel is done by a separate 10-ton hoist on the motor-driven platform crane (Section 9.1.4).

New fuel assemblies are stored vertically, with a minimum center to center spacing of 21 inches. This will maintain the fuel in a subcritical condition with the effective multiplication factor, K_{eff} less than or equal to 0.95, for both the full density (water at 68°F and 1gm/cm^3) and low density (0.075 gm/cm^3) optimum moderation conditions.

The new fuel storage racks are designed to Seismic Category I requirements. A detailed analysis of the storage racks have been performed to verify the adequacy of the design to withstand the loadings encountered during normal operation, an operating basis earthquake (OBE), and the safe shutdown earthquake (SSE).

The motor-driven platform crane, which is used for transfer of fuel, is the only overhead crane which can pass over the new fuel.

Damage to the fuel assemblies and the new fuel racks by excessive uplift forces from the new fuel handling hoist are prevented by operating procedures and by a load cell attached to the crane. In addition, the new fuel storage area is protected from the effect of dropped heavy objects by interlocks on the fuel handling hoist, which limit the lifting capability of the crane to the weight of a fuel cell and its handling tool. Heavier loads will be handled by an administrative procedure, which will define the area over which these loads may be handled to prevent damage to the new fuel.

9.1.2 Spent Fuel Storage

The spent fuel storage area, located in the fuel building, is designed to provide a safe and effective means of storing spent fuel.

9.1.2.1 Design Bases

The spent fuel storage area is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to structures housing the facility and the facility itself being capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, as it relates to structures housing the facility and the facility itself being capable of withstanding the effects of environmental conditions, external missiles, internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks, such that safety functions will not be precluded.

3. General Design Criterion 5, as it relates to shared structures, systems, and components important to safety being capable of performing required safety functions.

4. General Design Criterion 61, as it relates to the facility design for fuel storage and handling of radioactive materials.

5. General Design Criterion 62, as it relates to the prevention of criticality by physical systems or processes utilizing geometrically safe configurations.

6. General Design Criterion 63, as it relates to monitoring systems provided to detect conditions that could result in the loss of decay heat removal capabilities, to detect excessive radiation levels, and to initiate appropriate safety actions.

7. The requirements of Regulatory Guides 1.13, 1.29, 1.115, and 1.117.

9.1.2.2 Facilities Description

The spent fuel storage area, shown on Figures 9.1-1 and 9.1-2, is divided into three areas separated by a stainless steel-lined concrete wall, with a removable gate provided between each area to allow movement of fuel elements between them. Each gate is equipped with an inflatable seal to prevent leakage from one area to another. The three areas are defined as the fuel cask

area, the spent fuel pool, and the fuel transfer canal. Each area is lined with stainless steel. The fuel cask area and the spent fuel pool are normally filled with borated demineralized water. The fuel transfer canal is normally drained but may be filled with borated demineralized water to support fuel movement or other activities.

The fuel cask area consists of two locations at different elevations, which allow for the safe movement of spent fuel into the shipping cask. The lower elevation provides a sufficient height of water above the fuel being transferred to allow for adequate shielding, while the upper elevation limits the potential spent fuel cask drop height and allows for preliminary decontamination using a floating spray ring.

The spent fuel pool houses the spent fuel storage racks. The spent fuel pool is sized to accommodate the storage of a minimum of one full core in the event the reactor must be emptied of fuel at any time during BVPS-2 life. This sizing requirement primarily relates to the ability to provide heat removal capability for such a full core offload. No specific event acknowledged in the licensing bases requires such a core offload to be performed, nor does any obligation exist to ensure storage locations for such a full core offload are present. The spent fuel pool contains 15 storage racks designed with Metamic neutron absorber material. Storage racks have a storage capability of no more than 1690 fuel elements assuming all cells are utilized.

The Metamic fuel storage racks consist of freestanding modules, made primarily from austenitic stainless steel containing honeycomb storage cells interconnected through longitudinal welds. A panel of Metamic metal matrix composite containing a high areal loading of the boron-10 (B-10) isotope provides neutron attenuation between adjacent storage cells. The baseplates on all fuel rack modules extend out beyond the rack module periphery wall such that the plate protrusions act to set a required minimum separation between the facing cells in adjacent rack modules. Each fuel rack module is supported by four or five pedestals, which are remotely adjustable. The rack module support pedestals length adjustment is primarily provided to accommodate minor level variations in the pool floor flatness. Thus, the racks are installed in a vertical position and the top of the racks are co-planar with each other. Some pedestals are supported by the sub-base beams remaining from the removed Boraflex spent fuel storage racks. Between the rack module pedestals and the pool floor liner is a bearing pad, which serves to diffuse the dead load of the loaded racks into the reinforced concrete structure of the pool slab. The bearing pads are part of the Metamic rack installation.

The Metamic fuel storage racks have storage cells that are regionalized for loading purposes into three distinct regions, with independent criteria defining each region:

Region 1 is designed to accommodate fresh fuel with a maximum initial enrichment up to 5.0 wt% U-235. Region 1 storage cells are located on the periphery of each rack (outer row only) and are therefore separated from other Region 1 cells in adjacent racks by the gap between the racks. Region 1 cells are additionally separated from other Region 1 cells within the same rack by Region 2 cells (including a Region 2 cell in the diagonal direction). Since Region 1 cells are qualified for the storage of fresh fuel, any fuel assembly (fresh or burned) meeting the maximum enrichment requirement may be stored in a Region 1 location.

Region 2 is designed to accommodate fuel with a maximum initial enrichment of up to 5.0 wt% U-235 and a high burnup defined according to the calculated Region 2 initial enrichment and burnup combination. Region 2 cells are located on the rack periphery (outer row) interspaced with (separating) Region 1 cells and are also located in the second row of cells (from the outside of the rack) separating the Region 1 cells from the Region 3 cells.

Region 3 is designed to accommodate fuel with a maximum initial enrichment of up to 5.0 wt% U-235 and a moderate burnup defined according to the calculated Region 3 initial enrichment and burnup combination. Region 3 cells are located on the interior of the rack and are prohibited from being located in the outer two rows of the rack.

A spent fuel pool boron concentration of 495 ppm and 1212 ppm is required to ensure a K_{eff} less than or equal to 0.95 for normal and for accident conditions, respectively.

A spent fuel pool boron dilution analysis concluded that the worst case boron dilution event would dilute the boron concentration from 2000 ppm to 495 ppm in 85 minutes. The worst case addition of water to the spent fuel pool would raise the water level causing a high level alarm in approximately 2.6 minutes initiating operator action to correct the situation. Therefore there is sufficient time to respond to the dilution event and significant boron dilution is unlikely.

The fuel transfer canal houses the fuel transfer system which provides for transfer of new and spent fuel elements between the fuel building and reactor containment during refueling. Spent fuel is transported between the fuel transfer canal, spent fuel pool, and the fuel cask area by the fuel building motor-driven platform crane.

This platform incorporates separate 10-ton hoists for new fuel and spent fuel. A complete description of fuel handling and utilization of the movable platform with hoists is provided in Sections 9.1.4 and 9.1.5. Handling of the spent fuel casks utilizes the spent fuel cask trolley and is described in Section 9.1.5.

Normal makeup water for the spent fuel pool is provided by the primary grade water system. Borated makeup water may be supplied from the refueling water storage tank (RWST) through the fuel pool cleanup system, as described in Section 9.1.3.

Boron concentration is maintained greater than or equal to 2,400 ppm and monitored by samples taken periodically.

Decay heat from fuel elements is removed by the fuel pool cooling system, as described in Section 9.1.3.

Ventilation in the fuel building is designed to maintain a negative pressure and is described in Section 9.4.2.

9.1.2.3 Safety Evaluation

In accordance with Regulatory Guide 1.13, the storage and handling of fuel in the fuel building is designed to protect the fuel, limit potential offsite exposures, and prevent loss of water from the fuel pool which may uncover the fuel.

The spent fuel pool, spent fuel pool liner, and all supporting structures are designed for SSE seismic loads as described in Sections 3.8.4 and 3.2.1.2. The BVPS-2 spent fuel pool structure and the spent fuel racks are classified, designed, and constructed as Seismic Category I items. The spent fuel pool liner and refueling cavity liner are classified, designed, and

constructed as Seismic Category II items. The effects of tornadoes, hurricanes, and floods are described in Sections 3.3.1, 3.3.2, and 3.4.1. The capability of these components and structures to withstand the effects of external missiles, pipe whip, and jet impingement forces are described in Sections 3.5.1.1, 3.6.1, and 3.6.2.

The spent fuel pool is designed such that the water level in the pool cannot be decreased below the top of the fuel stored in the spent fuel racks. The fuel transfer gates do not extend below the top of the spent fuel assemblies, and all piping and piping penetrations of the spent fuel pool terminate no lower than elevation 750 feet, 10 inches. A spent fuel pool water elevation of 750 feet, 10 inches provides suitable shielding for radiation protection.

The fuel pool is lined with stainless steel and is equipped with a leak chase system and tell-tale drain connections which drain to a tell-tale drain tank located in the fuel building.

In the event of a loss of fuel pool cooling and normal makeup water supply, a supply of water is provided from the Seismic Category I service water system, as described in Section 9.1.3.

Radiation levels are kept at a minimum (Chapter 12) and optical clarity is maintained by the spent fuel pool cleanup system, as described in Section 9.1.3.

The release of radioactive material is prevented by the design of the fuel building ventilation system which maintains a negative pressure on the building and by the supplementary leak collection, as described in Sections 9.4.2 and 6.5.1.

The ASME III portions of the fuel pool cooling system and the ASME III portions of other systems important to safety of the spent fuel stored in the spent fuel storage facility undergo periodic inservice inspection and testing, as described in Sections 3.9.6 and 6.6.

Spent fuel assemblies are stored vertically in high density storage racks with Metamic neutron absorber.

The Metamic racks contain a neutron absorbing material (boron carbide in an aluminum metal matrix) also in vented storage compartments with a minimum center-to-center spacing of 9.03 inches nominal. The Metamic spent fuel rack criticality analysis credits the Metamic neutron absorbing material and soluble boron to maintain the spent fuel in a subcritical condition. With a maximum spent fuel enrichment of 5.0 wt% U-235, the fuel pool filled with unborated water at 39.2°F, and the fuel stored in the analyzed storage configurations, the effective multiplication factor, K_{eff}, will be less than 1.0. With credit for 495 ppm soluble boron, K_{eff} will be less than or equal to 0.95.

For the Metamic racks, a boron concentration of 1212 ppm will ensure a K_{eff} of less than or equal to 0.95 in the event of the most limiting fuel handling accident, which is misloading a fresh fuel assembly in the outer row of the rack in a Region 2 location.

The high density spent fuel storage racks have been designed to meet the requirements for Seismic Category I structures. Detailed structural and seismic analyses of the storage racks have been performed to verify the adequacy of the design to withstand the loadings encountered during normal operation, OBE, and SSE.

As described in Sections 9.1.4 and 9.1.5, the moveable platform with hoists is the only crane operating over the spent fuel and is described in Section 9.1.4. The spent fuel cask trolley is described in Section 9.1.5, along with a description of the paths of travel and interlocks to preclude the dropping of heavy objects on stored spent fuel.

Cooling of spent fuel stored in the spent fuel storage racks is accomplished by the safety-related Seismic Category I fuel pool cooling system described in Section 9.1.3. The adequacy of natural circulation flow to cool the spent fuel assemblies was established by a thermal hydraulic analysis, which concluded that natural circulation in the spent fuel pool is adequate to prevent local boiling.

The design of the spent fuel racks is such that the necessary minimum spacing between nearby fuel assemblies is ensured.

Damage to the spent fuel assemblies and the spent fuel racks by excessive uplift forces exerted by the spent fuel hoist during fuel handling are prevented by the hoist's load cell.

All materials used in construction are compatible with the spent fuel pool environment. All materials are corrosion resistant stainless steel, with the exceptions of the neutron absorbing material, gate seals, and fuel pool lights, and will not contaminate the fuel assemblies or pool environment.

9.1.3 Spent Fuel Pool Cooling and Cleanup System

The fuel pool cooling and cleanup system, shown on Figure 9.1-4, removes decay heat generated by the spent fuel stored in the fuel pool and provides clarification and purification of water in the fuel pool, refueling cavity, and RWST. Table 9.1-1 lists the principal component design and performance characteristics.

9.1.3.1 Design Basis

The fuel pool cooling and cleanup system is designed to remove the heat generated by the stored spent fuel assemblies, to permit unrestricted access to the working area around the spent fuel storage pool, and to maintain the optical clarity of the water in the spent fuel storage pool and the refueling cavity. The system is designed for continuous service whenever spent fuel is stored in the pool.

Two fuel pool heat exchangers and two fuel pool cooling pumps are provided to remove the heat produced by the spent fuel stored in the fuel pool in the event the reactor is emptied of fuel at anytime during BVPS-2 life (Section 9.1.2). Standard Review Plan (SRP) 9.1.3 specifies maximum normal heat load conditions and maximum abnormal conditions to be used in evaluating cooling system performance. Cooling system design is sufficient to satisfy SRP performance criteria for these conditions (UFSAR Section 9.1.3.3). Purification facilities are provided to permit unrestricted access to required areas and to maintain optical clarity of the spent fuel pool and refueling cavity.

The design of all the components in the fuel pool cooling and cleanup system complies with the following codes:

1. Fuel pool heat exchangers - ASME III, Class 3
2. Fuel pool cooling pumps - ASME III, Class 3
3. Fuel pool cooling piping, valves, and fittings - ASME III, Class 3
4. Fuel pool filters and demineralizers - ASME VIII.
5. Fuel pool cleanup system piping, valves, and fittings - ANSI B31.1

The ASME Code Baseline Document identifies the specific ASME III edition/addenda for these components.

The fuel pool cooling and cleanup system is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to structures housing the system, and the system itself, being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, and hurricanes.

2. General Design Criterion 4, with respect to structures housing the system, and the system itself, being capable of withstanding the effects of external missiles.

3. General Design Criterion 5, as it relates to shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to include:

    a. The capability to transfer heat loads from safety-related structures, systems, and components to heat sinks under both normal operating and accident conditions,

    b. Suitable redundancy of components so that safety functions can be performed, assuming a single active failure of a component coincident with the loss of all offsite power, and

    c. The capability to isolate components, systems, or piping, if required, so that the system safety function will not be compromised.

    d. Calculation of heat loads in accordance with Branch Technical Position ASB 9-2.

5. General Design Criterion 45, as it relates to the design provisions to permit periodic inspection of safety-related components and equipment.

6. General Design Criterion 46, as it relates to design provisions to permit operational functional testing of safety-related systems or components to assure structural integrity and system leak tightness, operability, adequate performance of active system components, and the capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

7. General Design Criterion 61, as it relates to the system design for fuel storage and handling of radioactive materials, including the following elements:

    a. The capability of periodic testing of components important to safety,

    b. Provisions for containment,

    c. Provisions for decay heat removal,

    d. The capability to prevent reduction in fuel storage coolant inventory under accident conditions in

accordance with the guidelines of position C.6 of Regulatory Guide 1.13, and

e. The capability and capacity to remove corrosion products, radioactive materials, and impurities from the pool water, thus reducing occupational exposures to radiation.

8. General Design Criterion 63, as it relates to monitoring systems provided to detect conditions that could result in a loss of decay heat removal capability, to detect excessive radiation levels, and to initiate appropriate safety action.

9. Paragraph 20.1(c) of 10 CFR 20, as it relates to radiation doses being kept as low as is reasonably achievable in accordance with Regulatory Guide 8.8, Positions C.2F(2) and C.2F(3).

10. Regulatory Guide 1.13, as it relates to system design to prevent damage resulting from the SSE.

11. Regulatory Guide 1.26, as it relates to quality group classification of the system and its components.

12. Regulatory Guide 1.29, as it relates to the seismic design classification of system components.

9.1.3.2 System Description

The fuel building, the spent fuel pool, the fuel pool cooling portion of the spent fuel pool cooling and cleanup system, and all supporting structures are designed: for the SSE and OBE seismic loads described in Section 3.8.4; for the effects of tornadoes and hurricanes, as described in Sections 3.3.1 and 3.3.2; and to withstand the effects of external missiles, as described in Section 3.5.1.1. The cooling portions of the spent fuel pool cooling and cleanup system are designed to Seismic Category I requirements and are constructed to Quality Group C.

All components of the spent fuel pool cooling and cleanup system have minimum design pressures and temperatures of 74 psig and 200°F, respectively. All parts of equipment and piping in contact with borated fuel pool water are constructed of stainless steel.

The fuel pool water flows from the suction connection of the pool via either of the two fuel pool cooling pumps, through the tube side of either of the two fuel pool heat exchangers, and returns to the pool. The fuel pool heat exchangers are cooled by component cooling water (Section 9.2.2) flowing through the shell side.

The normal source of makeup water for the fuel pool to account for losses due to evaporation is from the primary grade water system (Section 9.2.8). To ensure an adequate supply of makeup water to the fuel pool under all conditions, an emergency supply from the service water pumps (Section 9.2.1) via the Seismic Category I service water system piping is provided. A backup supply of makeup can also be provided from the fire protection system (Section 9.5.1) which has hose racks available in the fuel building. The source of water is the Ohio River. Connection to the fuel pool can either be made by attaching to the temporary piping connections on the fuel pool heat exchanger inlets or running fire hoses directly into the pool. Boric acid is added manually, as required, to provide additional neutron absorbing capability.

The fuel pool cooling pumps are provided with cross-connecting piping such that either pump can be used with either or both heat exchangers. For additional safety, each fuel pool heat exchanger and fuel pool cooling pump can be isolated from the rest of the system for repairs. As an added measure of cooling assurance, temporary piping connections are provided in the inlet piping of the heat exchangers for connecting a temporary pump, which would take suction from the spent fuel pool via a temporary line.

The fuel pool cooling pump suction line penetrates the spent fuel pool in the spent fuel area. The discharge line penetrates the spent fuel pool in the spent fuel area and in the cask area, thus ensuring that an adequate supply of cooling water is available in both areas, and provides for the mixing of fuel pool water to produce a uniform temperature distribution under all conditions.

Two fuel pool cleanup pumps, in parallel, purify the spent fuel pool water. These pumps can be lined up to discharge from the spent fuel pool either through the fuel pool filters only (two filters are provided, each rated at 400 gpm flow) or through a single mixed bed fuel pool ion exchanger, and then through the filters, before returning to the spent fuel pool. Operation of the system is such that one pump is normally operating while the other pump is on standby. Local sample connections are provided for taking samples to determine the decontamination factor of the ion exchanger and efficiency of the filters.

Connections are provided from the RWST to allow for cleanup of the RWST and for fuel pool makeup, and from the fuel pool ion exchanger to the solid waste disposal system (Section 11.4) for resin discharge. The RWST connection is isolated by series automatic valves that receive a safety-injection signal. These valves provide a class break with the non-safety Fuel Pool Purification piping.

A connection from the residual heat removal (RHR) system (Section 5.4.7) is provided on the fuel pool purification lines inside the containment to permit circulation of RHR water in the refueling cavity as well as in the reactor vessel during refueling operations.

The activity levels in the spent fuel pool are determined by the analysis of samples taken periodically from the spent fuel pool. The allowable dose rates for personnel working in the fuel building are described in Section 11.3.

Ambient radioactivity concentrations in the access areas above the pool are monitored by radiation detection equipment, as described in Sections 11.5 and 12.3. The detector sample points are located in the inlet plenum of the exhaust ventilation duct. Ventilation in the fuel building is designed to maintain a negative pressure and is described in Section 9.4.2.

Fuel pool and refueling cavity skimmers keep the water surface of the spent fuel pool and refueling cavity free of floating dust and other material. The skimmer system is not in continuous use but is operated as needed to maintain the cleanliness of the spent fuel pool. Drains from the fuel building air-conditioning unit (Section 9.4.2) are directed to the air-conditioning unit drain tank (Figure 9.1-4) and its contents are subsequently pumped to the fuel pool.

9.1.3.3 Safety Evaluation

The spent fuel pool cooling and cleanup system consists of two cooling trains, each with a pump, a heat exchanger, and separate piping loops. The pumps are environmentally qualified, as described in Section 3.11, and are powered from the Class 1E emergency buses such that the pumps can be operated during all normal and emergency plant conditions.

The spent fuel pool cooling system is designed to remove the spent fuel heat load of a full core after 100 hours decay. Calculated fuel pool temperature assuming this heat load condition does not exceed 170°F, assuming failure of one cooling pump. The spent fuel pool cooling system also removes decay heat assuming a full core removed from the reactor and stored in the pool with 100 hours decay plus one-third core stored in the pool with 36 days decay and one-third core stored in the pool with 400 days decay. Calculated maximum pool temperature during this condition is 173°F assuming no concurrent failure. All analyses assume that all available storage spaces in the spent fuel pool are full. Administrative controls ensure acceptable fuel pool temperature by controlling offloading of fuel based on component cooling water temperature and decay time (refer to License Amendment No. 126 of the Unit 2 Technical Specifications).

Water level in the spent fuel pool cannot be lowered below elevation 750 feet, 10 inches, due to the design of the pool, as described in Section 9.1.2, and by the design of the piping, which does not allow any piping termination below this elevation. Tell-tale drains are provided to detect leakage from the pool in the event of a fuel pool liner failure. The fuel building is provided with a sump and sump pumps to collect leakage in the

building, as described in Section 9.3.3. An alarm will sound in the main control room if a low water level occurs in the fuel pool.

A Seismic Category I source of makeup water is provided from the service water system in the event that fuel pool cooling is rendered inoperable. To prevent contamination of the pool during normal operation, a spool piece with a spectacle flange is provided on the service water line in the valve pit. The blind face of the spectacle flange is normally installed in the flow path.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I & C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Standard 279-1971 requirements are satisfied, has been performed on the spent fuel pool cooling system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.1.3.4 Inspection and Testing Requirements

The fuel pool level and temperature instrumentation is tested and calibrated on a periodic basis. Operating and standby components are alternated periodically to verify operability of all equipment. Visual inspection of system components and instrumentation is

conducted periodically. Preoperational tests are performed as described in Chapter 14.

All safety class pumps and valves are in-service inspected as specified in Section 6.6. In addition, containment isolation valves are tested as specified in Section 6.2.4.

Balance of Plant Testing is performed periodically to assess operational readiness of the fuel pool cooling pumps over their service life.

9.1.3.5 Instrumentation Requirements

Control switches with indicating lights are provided in the main control room for the fuel pool cooling pumps. These pumps are operated manually.

Control switches with indicating lights are provided in the main control room for the fuel pool heat exchanger cooling water isolation valves. These valves are operated manually.

Control switches with indicating lights are provided in the main control room for the pool purification pumps. One pump is started manually and the second pump is placed in a standby mode to start on failure of the first pump.

Selector switches with indicating lights are provided in the main control room for the ion exchanger bypass valves. These valves are operated manually.

Level indicators are provided in the main control room for spent fuel pool level.

Temperature indicators are provided in the main control room for spent fuel pool temperature and refueling cavity water temperature.

Flow indication is provided in the main control room for fuel pool ion exchanger flow.

Annunciation is provided in the main control room for the following:

1. Fuel pool cooling pumps discharge pressure low,

2. Fuel pool cooling pumps auto trip,

3. Spent fuel pool temperature high,

4. Spent fuel pool level low,

5. Spent fuel pool level high,

6. Refueling cavity level low,

7. Refueling cavity level high,

8. Refueling cavity temperature high,

9. Pool purification filters differential pressure high,

10 Pool purification pumps thermal overload,

11. Pool purification pumps discharge pressure low,

12. Fuel pool ion exchanger inlet temperature high, and

13. Fuel pool ion exchanger differential pressure high.

These points are also monitored by the plant computer system.

Area radiation monitors are provided as described in Section 11.5.

9.1.4 Light Load Handling System

The light load handling system (LLHS), in conjunction with the new and spent fuel storage facilities (Sections 9.1.1 and 9.1.2) and the spent fuel pool cooling and cleanup system (Section 9.1.3), provide a safe and effective means of transporting and handling fuel from the time it reaches the station in an unirradiated condition until it is loaded into a spent fuel shipping cask after post-irridation cooling. The LLHS does not handle any loads heavier than a single fuel assembly. The handling of the spent fuel shipping cask and other heavy loads related to refueling operations are discussed in Section 9.1.5.

9.1.4.1 Design Bases

The following design bases apply to the LLHS:

1. Fuel handling devices are designed to avoid dropping or jamming of fuel assemblies during the fuel transfer operation.

2. Handling equipment is designed to avoid dropping of fuel handling devices and fuel assemblies during the fuel transfer operation.

3. Handling equipment used to raise and lower spent fuel assemblies have a limited maximum lift height so that the minimum required depth of water shielding is maintained over the fuel, as required by General Design Criterion (GDC) 61.

4. The fuel transfer system (FTS), where it penetrates the containment, has provisions to preserve the integrity of the containment pressure boundary.

5. Criticality during fuel handling operations is prevented by the geometrically safe configuration of the fuel assemblies and fuel handling equipment, as required by GDC 62.

6. Handling equipment will not fail in such a manner as to damage Seismic Category I equipment in the event of a SSE, as required by GDC 2, and Regulatory Guide 1.29.

7. The inertial loads imparted to the fuel assemblies or core components during handling operations are less than the loads which could cause damage.

8. Physical safety features are provided for personnel operating the handling equipment.

9. The BVPS-2 FTS and associated handling equipment are not shared among other nuclear power units, as it relates to GDC 5.

10. General Design Criterion 61, as it relates to the appropriate containment, confinement, and filtering systems, decay heat RHR system, and the prevention of significant reduction in the spent fuel pool inventory.

11. The equipment used in the LLHS is not classified as safety-related and is not required for safe shutdown of BVPS-2 nor used to mitigate the consequences of an accident.

9.1.4.2 System Description

The LLHS consists of the equipment needed for the refueling operation on the reactor core and for handling spent and new fuel in the fuel building. The LLHS is comprised of fuel handling equipment and a FTS. The areas associated with the fuel handling operations are the refueling cavity, the refueling canal, the spent fuel storage area, and the new fuel storage area.

9.1.4.2.1 Fuel Handling Description

New fuel assemblies received for core loading are removed one at a time from the shipping container and temporarily stored in both the new and spent fuel storage racks. All new fuel assemblies received after the initial fueling are stored in the new fuel storage racks located in the new fuel storage area, or in the spent fuel racks.

The fuel handling equipment is designed to handle the spent fuel assembly underwater from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site. Water provides an effective, economic, and transparent radiation shield, as well as a reliable cooling medium for removal of decay heat.

The associated fuel handling areas may generally be divided into three areas: the refueling cavity and refueling canal, which are flooded only during plant shutdown for refueling; the spent fuel pool, which is filled with water and is always accessible to operating personnel; and the new fuel storage area, designed for dry storage. The refueling canal in the reactor containment and the spent fuel pool in the fuel building are connected by a fuel transfer tube. This tube is fitted with a blind flange on the refueling canal end and a valve on the spent fuel pool end. The blind flange is kept in place except during refueling to ensure containment integrity. Fuel is transferred through the tube on an underwater transfer car.

Fuel is moved between the reactor vessel and the refueling canal by the manipulator crane. A rod cluster control (RCC) changing fixture is located on the refueling canal wall for transferring control elements from one fuel assembly to another. The fuel assembly then is placed in the fuel container, and the upender at either end of the fuel transfer tube is used to pivot the fuel container to the horizontal position. After the transfer car transfers the fuel assembly through the transfer tube, the upender at that end of the tube pivots the container to a vertical position so that the fuel assembly can be lifted out of the fuel container.

In the spent fuel pool, spent fuel assemblies are moved about by the motor-driven platform crane, which has two hoists rated at 10 tons each. When lifting spent fuel assemblies, the hoist uses a long-handled tool to ensure that sufficient radiation shielding is maintained.

A shorter tool (new fuel handling tool) is used to handle new fuel assemblies from the new fuel storage racks to the fuel elevator. The new fuel elevator is used to lower the assembly to a depth at which the hoist, using the long-handled tool, can place the new fuel assembly into or out of the fuel transfer container in the upending device. The new fuel elevator is used to lower the assembly to the bottom of the spent fuel pool to avoid immersing the hoist block and cable in the spent fuel pool water.

Decay heat, generated by the spent fuel assemblies in the spent fuel pool, is removed by the spent fuel pool cooling system. After a sufficient decay period, the spent fuel assemblies are removed from the spent fuel racks and loaded into spent fuel shipping casks for removal from the site.

9.1.4.2.2 Refueling Procedure

The refueling operation follows a detailed procedure which provides a safe, efficient refueling operation. Prior to initiating refueling operations, the reactor coolant system (RCS) is borated to the cold shutdown boron concentration and cooled down to the refueling shutdown conditions specified in the Technical Specifications. Criticality protection for refueling operations, including a requirement for daily checks

of boron concentration, is specified in the Technical Specifications (Chapter 16). The following significant points are assured by the refueling procedure:

1. The refueling water and the reactor coolant contain a minimum of 2,400 ppm boron. This concentration is sufficient to keep the core approximately 5 percent k/k subcritical during the refueling operations. It is also sufficient to maintain the core subcritical in the unlikely event that all of the RCCAs were removed from the core.

2. The water level in the refueling cavity keeps the radiation level within acceptable limits while fuel assemblies are being removed from and inserted into the core.

The refueling sequence is controlled by the Refueling Procedure. The sequence is based on the current Westinghouse fuel cycle loading plans, fuel handling specifications and the scheduled refueling operations.

The reactor fuel may be refueled in one of two ways. The core offload or the core shuffle. The core offload removes all of the fuel assemblies from the core, performs the insert changeouts, and then reloads the desired fuel assemblies into the core. The core shuffle, simultaneously offloads the spent fuel, performs fuel insert changeouts, and reloads the new fuel. These variations in the refueling sequence are necessary to support major maintenance on the reactor and reactor support systems, fuel handling, fuel insert changeouts and fuel inspection considerations, and to optimize the outage schedule.

Both the core shuffle and offload are performed with the equipment described as follows:

The manipulator crane transports fuel assemblies to and from the reactor, RCC change fixture and fuel transfer system upender. Fuel assemblies are lifted to a predetermined height sufficient to clear the reactor vessel and still leave sufficient water covering the fuel assembly. This limits any radiation hazard to the operating personnel. Limit switches are provided to ensure that the fuel assembly is in the fully up position before the manipulator crane can be moved.

The fuel transfer system transports fuel assemblies to and from the manipulator crane and motor-driven platform crane. The fuel assembly container of the fuel transfer car is pivoted to the vertical position by the upender. The manipulator crane is moved to line up the spent fuel assembly with the fuel assembly container. The manipulator crane loads the spent fuel assembly into the fuel assembly container of the transfer car. The container is pivoted to the horizontal position by the upender. The fuel transfer car with the fuel container is moved through the fuel transfer tube to the

fuel storage area. At the fuel storage area the fuel assembly container is pivoted to the vertical position. This sequence is reversed to transport fuel assemblies to containment.

The motor-driven platform crane transports the fuel assemblies to and from the fuel transfer system and spent fuel racks. The spent fuel assembly is unloaded from the container by the spent fuel handling tool attached to the motor-driven platform crane. The spent fuel assembly is placed in a spent fuel storage rack.

The motor-driven platform crane also transports new fuel assemblies to and from the new fuel storage racks, fuel transfer system, and the spent fuel storage racks. This is accomplished with the use of the new and spent fuel assembly handling tools and the new fuel elevator. New fuel assemblies are usually staged in the spent fuel pool prior to the core offload or core shuffle.

The motor-driven platform crane, with the appropriate handling tool is used to install and remove any of the fuel assembly inserts. This operation is performed either during the fuel shuffle or between the core offload and reload.

The RCC change fixture can be used to changeout RCCA inserts and inserts with RCCA type hubs. If the spent fuel assembly contains an RCC type unit, the fuel assembly may be placed in the RCC changing fixture by the manipulator crane. The RCC type insert is removed from the spent fuel assembly and put in a new fuel assembly or into another spent fuel assembly that had been previously placed in the changing fixture.

9.1.4.2.3 Component Description

9.1.4.2.3.1 Manipulator Crane

The manipulator crane (MC) is a rectilinear bridge and trolley system with a vertical mast extending down into the refueling cavity. The bridge spans the refueling cavity and runs on rails set into the edge of the refueling cavity. A computer and programmable logic controller (PLC) based control system is used to position the vertical mast over a fuel assembly in the core. A long tube with a pneumatic gripper on the end is lowered out of the mast to grip the fuel assembly. The gripper tube is long enough so that the upper end is still contained in the mast when the gripper end contacts the fuel. A hoist mounted on the trolley raises the gripper tube and fuel assembly into the mast tube. The fuel is transported while inside the mast tube.

All controls for the manipulator crane are mounted in a console on the trolley. The bridge and trolley are positioned by the computer and PLC control system. Bridge and trolley position is indicated on the control system monitor located on the MC console. The drives for the bridge, trolley, and hoist are servo types, that allow precise control of speed and position. The maximum speed for the bridge is 60 feet per minute (fpm) and for the trolley and hoist is 40 fpm. The auxiliary monorail hoist on the manipulator crane has hoisting speeds of approximately 3 fpm and 21 fpm.

Electrical interlocks and limit switches on the bridge and trolley drives prevent damage to the fuel assemblies. The hoist is also provided with redundant limit switches to prevent a fuel assembly from being raised above the safe shielding depth should the limit switch fail. In an emergency, the bridge, trolley, and hoist can be operated manually, using a handwheel on the motor shaft. The manipulator crane is equipped with an auxiliary hoist, which is rated at 1.5 tons.

9.1.4.2.3.2 Motor-Driven Platform Crane

The motor-driven platform crane is a gantry type, multiple girder, electric traveling crane with two top-running trolleys that run on parallel sets of bridge rails, and with a lower operating platform extending the span of the crane. The motor-driven platform crane operates over the spent fuel pool, the spent fuel cask loading area, fuel transfer canal, new fuel storage area, and the new fuel receiving area. The capacity of the gantry platform is 20 tons, with each trolley and hoist having a capacity of 10 tons.

The motor-driven platform crane is seismically designed, meets all requirements of Crane Manufacturers Association of America (CMAA)

Specification No. 70 for Class C moderate service, and meets all mandatory requirements of ANSI B30.2.0. Each crane motion utilizes a variable speed control, with a speed regulation of at least 10 to 1, to provide for gradual acceleration and deceleration. Each hoist has a load indicating and limiting system and is provided with upper and lower travel limit switches.

The motor-driven platform crane is equipped with two single pendant stations having controls and indicators for all motions of the gantry platform, trolley, and hoists. The pendants are suspended from each trolley unit. Interlocks are furnished to prevent platform and trolley movement while the hoists are being operated. An alarm bell is sounded to indicate if the load indicator exceeds its preset weight.

The hoist motors are provided with thermal detectors which trip the motor in the event of overheating. The trip will automatically reset itself upon motor cool-down.

One hoist is primarily used for handling new fuel and the other is for spent fuel. The west trolley is designated as the new fuel hoist. It utilizes the new fuel assembly handling tool to lift and transfer new fuel from the new fuel shipping container to the new fuel storage racks, and then from these storage racks to the fuel elevator. The east trolley is designated as the spent fuel hoist. The spent fuel hoist is dual rated for 10 and 2 tons. The dual rating is dependent upon which hook is installed. A two ton clevis type hook is used for handling fuel assemblies and the various refueling tools and is normally installed on the hoist. A ten ton hook is used to handle loads greater than two tons and is normally stored. The spent fuel hoist utilizes the spent fuel assembly handling tool to lift and transfer spent fuel from the fuel transfer system in the fuel transfer canal to the spent fuel storage racks, and then from these storage racks to the spent fuel shipping cask. This hoist unit can also transfer new fuel from the fuel elevator to the upended transfer car utilizing the same spent fuel assembly handling tool.

The high hook interlock elevations of the platform hoists are such that with the spent fuel assembly handling tool attached, a spent fuel element cannot be raised above a safe shielding depth.

9.1.4.2.3.3 Fuel Elevator

The fuel elevator includes an electric winch located at the edge of the fuel pool and a fuel assembly carriage located in the fuel pool. The carriage runs on tracks which extend vertically along the wall of the fuel pool. New fuel is loaded into the elevator at the raised position. The fuel is then lowered to the bottom of the pool and is removed using the spent fuel hoist and the spent fuel assembly handling tool. The design capacity of the elevator which is

2,600 pounds. The design capacity of the fuel assembly carriage is 2,000 pounds (125 percent of assembly weight). The maximum hoisting and lowering speed of the elevator carriage is 10 fpm. The fuel elevator carriage and tracks are designed to withstand full SSE seismic loads.

9.1.4.2.3.4 Fuel Transfer System

The FTS (Figure 9.1-6) includes an electric motor-driven winch cable drive, an underwater transfer car that runs on tracks extending from the refueling canal through the transfer tube and into the spent fuel pool, and an operator-actuated upender at each end of the transfer tube. The fuel container in the refueling canal receives a fuel assembly in the vertical position from the manipulator crane. The fuel container is then lowered to a horizontal position for passage through the transfer tube. After passing through the tube, the fuel container is raised to a vertical position for removal of the fuel assembly by the spent fuel handling tool suspended from the east hoist mounted on the motor-driven platform crane in the spent fuel pool. The motor-driven platform crane then moves to a storage position and places the spent fuel assembly in the spent fuel storage racks.

During reactor operation, the transfer car is stored on the reactor side of the transfer tube. A blind flange is bolted on the refueling canal end of the transfer tube to seal the reactor containment. The terminus of the tube outside the containment is closed by a gate valve.

9.1.4.2.3.5 Rod Cluster Control Changing Fixture

The RCC changing fixture is supplied for periodic RCC element inspections and for transfer of RCC elements from one fuel assembly to another. The major subassemblies which comprise the changing fixture are the frame and track structure, the carriage, the guide tube, the gripper, and the drive mechanism. The carriage is a moveable container supported by the frame and track structure. The tracks provide a guide for the four flanged carriage wheels and allows horizontal movement of the carriage during changing operation. The positioning stops on both the carriage and frame locates each of the three carriage compartments directly below the guide tube. Two of these compartments are designed to hold individual fuel assemblies while the third is made to support a single RCC element. Situated above the carriage and mounted on the refueling canal wall is the guide tube. The guide tube provides for the guidance and proper orientation of the gripper and RCC element as they are being raised and lowered. The gripper is a pneumatically-actuated mechanism responsible for engaging the RCC element. It has two flexure fingers which can be inserted into the top of the RCC element when air pressure is applied to the gripper piston. Normally, the fingers are locked in a radially extended position. Mounted on the operating deck is the drive mechanism assembly which consists of the manual carriage drive mechanism, the revolving stop operating handle, the

pneumatic selector valve for actuating the gripper piston, and the electric hoist for elevation control of the gripper.

9.1.4.2.3.6 Spent Fuel Assembly Handling Tool

The spent fuel assembly handling tool is used to handle new and spent fuel assemblies in the spent fuel pool. It is a manually-actuated tool, suspended from the motor-driven platform crane, that uses four cam-actuated latching fingers to grip the underside of the fuel assembly top nozzle. The operating handle to actuate the fingers is located at the top of the tool. When the fingers are latched, a pin is inserted into the operating handle to prevent the fingers from being accidentally unlatched during fuel handling operations.

9.1.4.2.3.7 New Fuel Assembly Handling Tool

The new fuel assembly handling tool is used to lift and transfer fuel assemblies from the new fuel shipping containers to the new fuel storage racks and to transfer fuel assemblies from the new fuel storage racks to the fuel elevator. It is a manually-actuated tool, suspended from the motor-driven platform crane, that uses four cam-actuated latching fingers to grip the underside of the fuel assembly top nozzle. The operating handles to actuate the fingers are located on the side of the tool. When the fingers are latched, the safety screw on the handle post is turned in to prevent the accidental unlatching of the fingers.

9.1.4.2.3.8 Reactor Vessel Stud Tensioner

The stud tensioners are employed to secure the head closure joint at every refueling. The stud tensioner is a hydraulically-operated device that uses oil as the working fluid. The device permits preloading and unloading of the reactor vessel closure studs at cold shutdown conditions. Stud tensioners minimize the time required for the tensioning or unloading operation. The studs are tensioned to their operational load in two steps to prevent high stresses in the flange region and unequal loadings in the studs.

9.1.4.2.3.9 RCC (Portable) Change Tool

The rod cluster control (RCC) change tool is a device used to remove an RCC from one fuel assembly and transfer it to another in the spent fuel pit. During use, this tool is supported from the spent fuel pit bridge hoist and is designed to operate from the bridge walkway.

The RCC change tool consists of three basic assemblies. The first is the guide tube. Guide plates in the lower end of the tube provide guidance for the gripper and the RCC. The upper portion of the guide tube has guides that orient and align the gripper assembly as the RCC is removed from the fuel assembly.

Second, above the guide tube is the support tube that gives the proper length to the tool and provides support for the gripper actuator and protection for the lift cable. The gripper actuator consists of a pneumatic system that provides for the engagement and disengagement of the latch mechanism to the RCC spider. A limit switch will indicate the engage or disengage position for the gripper actuator as an additional safety feature.

Third, the drive mechanism consists of an electric-powered winch and an enclosure with controls for gripper actuation and winch operation. Limit switches prevent winch over-travel in either direction, and an overload switch protects the system during RCC lifting operations. Lamps on the enclosure face display the status of all switches.

The bottom of the tool is equipped with locating pins to orient the tool with respect to the fuel assembly nozzle.

The RCC tool is lowered onto a fuel assembly in the spent fuel racks. The gripper is then inserted into the RCC hub and activated to engage. The gripper and RCC are withdrawn from the fuel assembly and into a guide structure in the lower portion of the tool.

Once the RCC is fully withdrawn from the fuel, the tool is raised to permit movement to another fuel assembly. The tool is then lowered into the top nozzle of the other fuel assembly, the RCC is inserted into the fuel, and the gripper mechanism is disengaged.

9.1.4.2.4 Applicable Design Codes

The design codes and standards used for the fuel handling system (FHS) are given in Section 9.1.4.3 and in Table 3.2-1.

9.1.4.3 Safety Evaluation

9.1.4.3.1 Safe Handling

9.1.4.3.1.1 Design Criteria for the Fuel Handling System

The primary design requirement of the manipulator crane, fuel elevator, and motor-driven platform crane is reliability and safety. A conservative design approach is used for all load bearing parts. Where possible, components are used that have a proven record of reliable service. Throughout the design, consideration is given to the fact that the cranes and hoists will spend long idle periods stored in an atmosphere of 105°F and high humidity. The design and fabrication of the manipulator crane is in accordance with the CMAA Specification No. 70 for Class Al service, and Class C for the motor-driven platform crane.

Seismic considerations are discussed in Section 9.1.4.3.2.

All components critical to the operation of the cranes and parts which could fall into the reactor are positively restrained from loosening. Fasteners above water that cannot be lock-wired or tack welded are coated with a locking compound.

9.1.4.3.1.2 Industrial Codes and Standards Used

Manipulator crane and motor-driven platform crane: applicable sections of CMAA Specification No. 70.

Structural: manipulator crane: AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. Motor-Driven Platform Crane: ANSI 30.2, 7th Edition.

Electrical: manipulator crane: applicable standards and requirements of the National Electric Code (NFPA 70 1975) and NEMA Standards MGI and ICS are used in the design, installation, and manufacturing of all electrical equipment; motor-driven platform crane: NEC Article 670, NEMA MG1, and NEMA IS1.1 1977.

Materials: manipulator crane: main load supporting materials are procured with certified chemical and physical properties.

Safety: manipulator crane: Occupational Safety and Health Act (OSHA) Standards 29 CFR 1910 and 29 CFR 1926, including load testing requirements, the requirements of ANSI N18.2, Regulatory Guide 1.29, 10 CFR 50, Appendix A, and GDC 61 and 62; Motor-driven Platform Crane: OSHA Standard 29 CFR 1910 and CFR 1926.

9.1.4.3.1.3 Manipulator Crane

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

1. Electrical interlocks

    a. Bridge, trolley, and hoist drives are interlocked, to prevent operation of any drive beyond their dimensional limits, by dual axis encoders and can therefore withstand a single failure.

    b. Bridge and trolley drive operation is interlocked to the hoist position to limit motion when fuel or mast is extended beyond the stationary mast. The interlock is redundant to the dual encoder system and can therefore withstand a single failure.

    c. A gripper interlock is supplied which prevents the opening of a solenoid valve in the air line to the gripper except when a zero suspended weight is indicated by a load cell. As a backup, the gripper design prevents the ability to disengage the gripper from the load due to mechanical advantage of the air cylinder to the gripper motion while loaded. This interlock is redundant and can withstand a single failure.

    d. Overload protection and maximum overload protection by two independent controls prevents upward hoist motion when load exceeds the load setpoints. This interlock is redundant and can withstand a single failure.

    e. Gripper position is monitored by two limit switches, that require positive indication of gripper position to allow up motion. The interlock consists of two circuits, one to verify position and the other to verify both switches do not indicate simultaneously to monitor for switch failure. The system can withstand single failure by the combination of the two circuits.

2. Bridge and trolley hold-down devices

    Both manipulator crane bridge and trolley are horizontally restrained on the rails by two pairs of guide rollers, one pair at each wheel location on one truck only. The rollers are attached to the bridge truck and contact the vertical faces on either side of the rail to prevent horizontal movement. Vertical restraint is accomplished by anti-rotation bars located at each of the four wheels for both the bridge and trolley. The anti-rotation bars are bolted

to the trucks and extend under the rail flange. Both horizontal and vertical restraints are adequately designed to withstand the forces and overturning moments resulting from the SSE.

3. Design load

   The design load for structural components supporting the fuel assembly is the dead weight of the mast (approximately 1,000 pounds) plus three times the fuel assembly weight (approximately 4,800 pounds).

4. Main hoist braking system

   The main hoists are equipped with two independent braking systems. A solenoid-release, spring-set, electric brake is mounted on the motor shaft. This brake operates in the normal manner to release upon application of current to the motor and to set when current is interrupted. The second brake is a mechanically-actuated load brake internal to the hoist gear box that sets if the load starts to overload the hoist. It is necessary to apply torque from the motor to raise or lower the load. In raising, this motor cams the brake open. In lowering, the motor slips the brake, allowing the load to lower. This brake actuates upon loss of torque from the motor for any reason and is not dependent on any electrical circuits. Both brakes are rated at 150 percent of the hoist design load.

5. Fuel assembly support system

   The main hoist system is supplied with redundant paths of load support such that failure of any one component will not result in free fall of the fuel assembly. Two wire ropes are anchored to the winch drum and carried to a load equalizing mechanism on the top of the gripper tube. The working load of fuel assembly plus gripper is approximately 3,000 pounds. The gripper itself has four fingers gripping the fuel, any two of which will support the fuel assembly weight. The gripper mechanism contains a spring-actuated mechanical lock which prevents the gripper from opening unless the gripper is under a compressive load. During each refueling outage and prior to removing fuel, the gripper and hoist system is routinely load-tested to 125 percent of the maximum setting on the secondary hoist load limit.

9.1.4.3.1.4 Motor-Driven Platform Crane

The motor-driven platform crane design includes the following provisions to ensure safe handling of fuel assemblies:

1. Electrical interlocks

   a. Bridge, trolley, and hoist interlocks are furnished to prevent platform and trolley movement while hooks are being operated.

   b. An interlock is provided to prevent lifting the fuel transfer system upender if the platform crane is nearby.

   c. Each hoist load indicating device has an adjustable interlock which will stop hoist motion and sound an alarm if the preset weight is exceeded. The set point is based upon the weight of a single fuel assembly.

   d. The platform and trolleys are interlocked to provide a signal to the crane operator whenever the crane travels over the upender area.

2. Seismic requirements

   The crane bridge and trolleys are provided with suitable restraints so that they do not leave their rails during an SSE.

3. Hoist braking system

   Each hoist has a control brake compatible with the motor controller and two load holding brakes. The load holding brakes consist of two independent, spring-set, electrically released brakes.

9.1.4.3.1.5 Fuel Transfer System

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

1. Transfer car permissive switch

   A transfer car permissive switch allows an operator on either the spent fuel pit side or containment side to control the car movement if conditions visible to the operator warrant such control. Transfer car operation is possible only when both upenders are in the down position, as indicated by the proximity switches. The load system and upender frame up proximity switch are the backups for the transfer car upender interlock. Assuming the fuel container is in the upright position in the containment and the upender interlock circuit fails in the permissive condition, neither operator can operate the car because of the permissive switch and mechanical interlock. The interlock can withstand a single failure. Also, a communications system has been provided so that the transfer car operator in the fuel building can talk directly to the transfer car operator during the fuel handling process.

2. Upender: transfer car position

   A proximity switch interlock allows upender operation only when the transfer car is at the respective end of its travel. This interlock can withstand a single failure since the control system determines the transfer car position.

3. Transfer car: valve open

   An interlock on the transfer tube valve permits transfer car operation only when the transfer tube valve position switch indicates the valve is fully open.

4. Transfer car: upender

   The transfer car upender interlock is primarily designed to protect the equipment from overload and possible damage if an attempt is made to move the car when the fuel container is in the vertical position. This interlock can withstand a single failure since the control system determines the upender position.

5. Upender: manipulator crane

   The refueling canal upender is interlocked with the manipulator crane. Whenever the transfer car is located in the refueling canal, the upender cannot be operated unless the manipulator crane mast is in the full retracted position or the manipulator crane is over the core or the gripper is released and inside the core.

6. Upender: motor-driven platform crane

   The upender is interlocked with the motor-driven platform crane. The upender cannot be operated when the motor-driven platform crane is nearby.

9.1.4.3.1.6 Fuel Handling Tools and Equipment

All fuel handling tools and equipment handled over an open reactor vessel are designed to prevent inadvertent decoupling from machine hooks (for example, lifting rigs are pinned to the machine hook and safety latches are provided on hooks supporting tools).

Tools required for handling internal reactor components are designed with fail safe features that prevent disengagement of the component in the event of operating mechanism malfunction. These safety features apply to the following tools:

1. Control rod drive shaft unlatching tool

   The air cylinders actuating the gripper mechanism are equipped with backup springs which close the gripper in the event of loss of air to the cylinder. Air-operated valves are equipped with safety locking rings to prevent inadvertent actuation.

2. Spent fuel handling tool

   When the fingers are latched, a pin is inserted into the operating handle and prevents inadvertent actuation. The tool weighs approximately 400 pounds and is pre-operationally tested at 125 percent of the weight of one fuel assembly (1,600 pounds).

3. New fuel assembly handling tool

   When the fingers are latched, a safety screw is engaged to prevent inadvertent actuations. The tool weighs approximately 100 pounds and is pre-operationally tested at 125 percent of the weight of one fuel assembly (1,600 pounds).

9.1.4.3.2 Seismic Considerations

The safety classifications for all fuel handling and storage equipment are listed in Table 3.2-1. These safety classes provide criteria for the seismic design of the various components. Class 1 and Class 2 equipment is designed to withstand the forces of the OBE and SSE. For normal conditions plus OBE loadings, the resulting stresses are limited to the allowable working stresses, as defined in ASME Section III, Appendix XVII, Subarticle XVII-2200, 1971 up to and including Winter 1972 addenda, for normal and upset conditions. For normal conditions plus SSE loadings, the stresses are limited to within the allowable values given by ASME III, Subarticle XVII-2110, for those critical parts which are required to maintain the capability of the equipment to perform its safety function. Permanent deformation is allowed for the loading combination, which includes the SSE to the extent that there is no loss of safety function.

The Class 3 fuel handling and storage equipment satisfies the Class 1 and Class 2 criteria given previously for the SSE. Consideration is given to the OBE only insofar as failure of the Class 3 equipment might adversely affect Class 1 or 2 equipment.

For non-nuclear safety (NNS) class equipment, design for the SSE is included if its failure might adversely affect a Safety Class 1, 2, or 3 component. Design for the OBE is included if failure of the NNS class component might adversely affect a Safety Class 1 or 2 component.

9.1.4.3.3 Containment Pressure Boundary Integrity

The fuel transfer tube, which connects the refueling canal (inside the reactor containment) and the fuel storage area (in the fuel building), is closed on the refueling canal side by a blind flange at all times, except during refueling operations. Two seals are located around the periphery of the blind flange with leak-check provisions between them.

9.1.4.3.4 Radiation Shielding

During all phases of spent fuel transfer, the gamma dose rate to operating personnel due to a raised fuel assembly is less than 15 mRem/hr in accordance with the radiation zone designation on Figure 12.3-16. The three fuel handling devices used to lift spent fuel assemblies are the manipulator crane, the motor-driven platform crane and the new fuel elevator during top nozzle reconstitution. The manipulator crane contains positive stops which prevent the top of a fuel assembly from being raised to within a minimum of 93 inches of the water level in the refueling cavity during refueling operations. The hoist on the motor-driven platform crane moves spent fuel assemblies with a long-handled tool. Hoist travel limit switches and tool length limit the maximum lift of a fuel assembly to within a minimum of 100 inches of the water level in the fuel storage area during refueling operations. The new fuel elevator may handle partially spent fuel assemblies during top nozzle reconstitution. The hoist will have travel limits set at 108 inches (9.0 ft.) below the water level and physical stops placed at 102 inches. In addition, an area radiation monitor is mounted on the manipulator crane and will alarm on excessive radiation levels. Fuel handling accidents and the radiological consequences are discussed in Sections 15.7.4 and 15.7.5.

9.1.4.4 Tests and Inspections

9.1.4.4.1 Fuel Handling System

9.1.4.4.1.1 Manipulator Crane, New Fuel Elevator, and Rod Cluster Control Change Fixture

1. The minimum acceptable tests at the shop include the following:

    a. Hoists and cables are load-tested at 125 percent of the rated load.

    b. The equipment is assembled and checked for proper functional and running operation.

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

    a. Visually inspect for loose or foreign parts and remove any dirt or grease.

b. Lubricate wheels and exposed gears with proper lubricant.

c. Inspect hoist cables for worn or broken strands.

d. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.4.4.1.2 Motor-Driven Platform Crane

1. The minimum acceptable tests at the shop include the following:

   a. Routine motor tests are required for all motors.

   b. Each hook is load-tested to 125 percent of its design rating.

   c. Magnetic particle examination of each hook is performed before and after hook load test, using the procedure as described in ASTM A275.

   d. Hoisting cables are required to have a segment of the cable pull-tested to the breaking strength.

   e. Hoist gears, pinions, shafts, and assemblies are 100 percent magnetic particle-tested using the procedure as described in ASTM 138, Magnetic Particle Examination.

   f. The equipment is assembled, completely wired, and tested for proper operation of each hoist drive, all interlocks, indicators, limit switches, alarms, trolley tracking, and all crane functions.

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

   a. Perform load and running tests at 125 percent of the rated capacity of each hoist.

   b. Visually inspect for loose or foreign parts and remove any dirt or grease.

   c. Lubricate wheels and exposed gears with proper lubricant.

   d. Inspect hoist cables for worn or broken strands.

e. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.4.4.1.3 New and Spent Fuel Assemblies Handling Tools

1. The minimum acceptable tests at the shop include the following:

   a. The tools are load-tested to 125 percent of the rated load.

   b. The tools are assembled and checked for proper functional operation.

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

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

   b. Check the tools for proper functional operation.

9.1.4.4.1.4 Fuel Transfer System

1. The minimum acceptable test at the shop includes the following:

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

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

   a. Visually inspect for loose or foreign parts and remove any dirt or grease.

   b. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.4.4.1.5 Reactor Vessel Stud Tensioner

1. The minimum acceptable test at the shop includes the following:

The tensioner is assembled and checked for proper functional and running operation.

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

   a. Visually inspect for loose or foreign parts and remove any dirt or grease.

   b. Inspect hydraulic lines for wear or damage.

   c. Check the hydraulic unit for proper pressurization and for leaks occurring at operating pressure.

9.1.4.5 Instrumentation Requirements

The control systems for the manipulator crane, motor-driven platform crane, and fuel transfer system are discussed in Section 9.1.4.2.3. A discussion of additional electrical controls, such as the interlocks and main hoist braking system for the FHS, are discussed in Section 9.1.4.3.1.

9.1.5 Overhead Heavy Load Handling Systems

The overhead heavy load handling systems (OHLHS) consist of several crane and monorail systems located throughout the plant. They are used to handle loads heavier than a fuel assembly and its associated handling tool during the refueling process or during equipment maintenance operations. Table 9.1-2 is a list of OHLHS that operate over the reactor, the spent fuel pool, or in the vicinity of piping and equipment required for safe shutdown of the plant. Table 9.1-3 lists the remaining cranes and monorails in BVPS-2 which are excluded from detailed study because they do not operate over safety-related equipment or equipment required for safe shutdown of the BVPS-2. A two-part report has been submitted to the USNRC concerning NUREG-0612 (USNRC 1980). (Refer to Section 1.6 for specific reference). Design requirements of the excluded cranes and monorails are similar to the handling systems listed in Table 9.1-2.

The Beaver Valley position on the seven (7) guidelines of NUREG-0612 section 5.1.1 on "Control of Heavy Loads" is summarized as follows:

1. Guideline 1 Requirement for Safe Load Paths: Beaver Valley has an administrative procedure that defines requirements for use and control of Safe Load Path drawings. This administrative procedure contains most of the approved Safe Load Path drawings but also allows these drawings to be contained in other approved site procedures subject to the review and revision requirements of this administrative procedure. This procedure specifies that all NUREG-0612 heavy load lifts are to be performed using approved heavy load Safe Load Path drawings. This procedure also specifies that issue of new Safe Load Path drawings and changes to existing drawings are to

be performed per the site approved 10 CFR 50.59 change process and specifies additional NUREG-0612 requirements that must be considered in making changes to safe load path drawings.

2. Guideline 2 requirement for Load Handling Procedures: Beaver Valley has an administrative procedure that defines requirements for performance of NUREG-0612 heavy load lifts. This procedure includes a checklist that must be used for performance of all NUREG-0612 heavy load lifts that ensures the requirements of Guideline 2 are met.

3. Guideline 3 on Crane Operator Training: Beaver Valley requires all Crane Operators to be trained and qualified and the training program ensures that these personnel are trained and qualified to the requirements of ANSI/ASME B30.2 and other applicable crane standards.

4. Guideline 4 on Special Lifting Devices: The design of the Beaver Valley Unit 1 Special Lifting Devices have been evaluated and determined to be in compliance with the requirements of Guideline 4. In order to ensure continued compliance, the procedures for use of these devices requires performance of a visual examination by qualified personnel of critical welds and parts prior to the initial use each refueling outage. In addition, NDE of all major load carrying welds is performed each ten year in-service inspection interval.

5. Guideline 5 for Slings and Lifting Devices Not Specially Designed: The Beaver Valley administrative procedure for Heavy Loads and the administrative procedure for the Beaver Valley Rigging and Lifting Program both require that all other rigging equipment be designed, inspected and maintained to the applicable ANSI/ASME standards including ANSI/ASME B30.9 “Slings”. In addition, the Beaver Valley administrative procedure for heavy loads requires that all slings to be used on NUREG-0612 heavy load lifts be rated for at least twice the normal required capacity to account for the potential effects of dynamic loading. This method has been determined to be conservative for accounting for the sum of both the static and dynamic loading based on the potential acceleration from the maximum crane speed of all the site cranes capable of handling NUREG-0612 heavy loads.

6. Guideline 6 on Crane Inspection, Testing and Maintenance: The Beaver Valley administrative procedure has a checklist required to be used for performance of all NUREG-0612 Heavy Load Lifts which includes steps to verify completion of the crane periodic inspection (within previous 12 months or prior to use) and the daily "prior to use" visual inspection. In addition, periodic inspection procedures have been generated and scheduled to ensure completion of the required periodic inspections to the requirements of the applicable ANSI/ASME standards including ANSI/ASME B30.2.

7. Guideline 7 on Crane Design: All Beaver Valley cranes that handle NUREG-0612 heavy loads have been evaluated and determined to meet the requirements of Guideline 7 on crane design.

Beaver Valley followed the Nuclear Energy Institute Document, NEI 08-05, "Industry Initiative on Control of Heavy Loads, Section on Load Drop Analyses" concerning the evaluation of reactor vessel head heavy load lifts. In response to this initiative a postulated reactor vessel closure head drop analysis was performed. For the load drop scenario, it is postulated that the closure head assembly falls and impacts flat and concentrically with the reactor vessel flange.

Using a dynamic finite element model a closure head assembly drop and impact with the reactor vessel flange was simulated. The responses of the reactor vessel, reactor vessel support components and main loop piping were evaluated. The stresses and strains caused by the impact were evaluated to demonstrate acceptability based on maintaining the structural integrity of the critical components such that core cooling was not compromised and the core remains covered.

The analysis qualified the postulated drop of the closure head assembly 34 feet through air onto the reactor vessel flange. The analysis followed the methodology and assumptions for conducting reactor vessel head drop analyses as provided in NEI 08-05 and endorsed by NRC Regulatory Issue Summary (RIS) 2008-28, "Endorsement of Nuclear Energy Institute Guidance for Reactor Vessel Head Heavy Load Lifts."

The acceptance criteria used for the coolant retaining components, reactor vessel, piping and elbows, is taken from Appendix F, Section F-1341.2 of the ASME Code. The acceptance criteria for reactor vessel support steel were from NEI 08-05 guidance. The acceptance criteria for the concrete support bearing strength in the concrete under the reactor vessel supports was based on NEI 08-05 and ACI 349-97, Section 10.15. The acceptance criteria used from NEI 08-05 is consistent with the criteria endorsed in RIS 2008-28.

The analysis showed that the reactor vessel, main loop piping and the steel and concrete support structure for the reactor vessel are capable of meeting the acceptance criteria under a 34 foot drop of the reactor vessel closure head assembly, through air, onto the reactor vessel flange.

9.1.5.1 Design Bases

The following design bases apply to the OHLHS:

1. Heavy load-lifting devices are designed to avoid the dropping of their loads during the lifting operation.

2. Handling equipment is designed to avoid the dropping of fuel handling devices and lifting rigs during the lifting operation.

3. The spent fuel cask trolley, used to move the spent fuel shipping casks in and out of the fuel and decontamination building, has a limited maximum lift height so that the shipping cask is never lifted higher than the maximum height from which the cask can be dropped and still maintain its integrity.

4. All components and parts of the cranes and monorails which could fall into the reactor cavity or spent fuel pool are positively restrained from loosening.

5. Handling equipment and overhead rails that are located above safety-related systems or equipment required for safe shutdown of BVPS-2 are Seismic Category II, to the extent that they will not fail in such a manner as to damage Seismic Category I equipment in the event of a SSE.

6. Physical safety features are provided for personnel operating the handling equipment.

7. Movement and positioning of crane hooks in the fuel building is restricted to prevent damage to certain pieces of safety-related equipment.

8. Movement of the polar crane work platform is restricted to prevent damage to equipment attached to the containment dome.

9. The OHLHS conforms to the requirements of GDC 4, 5, and 61. The requirements of GDC 2 are satisfied for those cranes and monorails that operate over safety-related systems or equipment.

9.1.5.2 System Description

The OHLHS consists of the equipment needed for the lifting and movement of any loads heavier than a fuel assembly and its associated handling tool over the reactor core, spent fuel pool, or equipment required for safe shutdown of the plant. These movements could be made either during the refueling/fuel handling process or during plant maintenance operations. The equipment consists of the cranes and monorails listed in Table 9.1-2. Table 9.1-4 lists the loads carried by each piece of equipment. The structures associated with OHLHS are the containment building, fuel and decontamination building, auxiliary building, cable vault area, and the intake structure.

9.1.5.2.1 Heavy Load Handling by the Motor-Driven Platform with Hoists

All loads handled by the motor-driven platform with hoists, with respect to the fuel handling operations, are considered light loads and are covered in Section 9.1.4. However, this crane is also used for maintenance operations in the fuel building where the loads

lifted are classified as heavy loads. An interlock, as described in Section 9.1.5.5.2.3, must be overridden for the crane to perform these lifts. Generally, these components can be lifted from their installed locations at the west end of the fuel building and moved to the entrance way at the north side of the building as required. Components installed at the east end of the fuel building can be moved to the spent fuel cask pool area and removed from the building by the spent fuel cask trolley hoists. Table 9.1-4 lists heavy loads lifted by this crane.

9.1.5.2.2 Heavy Load Handling by the Spent Fuel Cask Trolley

The spent fuel cask trolley is an overhead crane provided for the primary purpose of handling the spent fuel shipping casks from the time they arrive at the site until they are loaded with spent fuel and are removed from the site. The travel of the trolley extends north outside the decontamination building and above the railroad tracks. The shipping cask is transported to the site via truck or railcar, where it is attached to the crane hook while still on the transport vehicle, upended and transported to the washdown area in the decontamination building. The cask is then transported to the fuel building where it is lowered into the cask laydown area to receive spent fuel assemblies. A handling tool is provided so that the cask may be lowered to the bottom step of the loading area within the cask laydown area without submerging the main hoist hook. After the cask is loaded with spent fuel assemblies, the trolley is used to transfer the cask out to the transport vehicle for removal from the site. Table 9.1-4 lists the heavy loads lifted by this crane.

9.1.5.2.3 Heavy Loads Handled by the Polar Crane

The polar crane is used for most heavy load lifts performed in the reactor containment building, as described in Section 9.1.5.2.3.1. The polar crane is used for several major lifts during construction, for lifting various pieces of equipment as required for maintenance, and for the movement of equipment required for the refueling operation.

The Polar Crane 2CRN-201 large hooks are to be administratively controlled per procedures to ensure there are no credible failure modes that will cause the polar crane bottom block and hooks to be dropped. The polar crane large hook and block assemblies are identified as NUREG-0612 Heavy Loads in Table 9.1-4. The administrative control governs allowable use of the large hoists and control of large hoist motor breakers.

9.1.5.2.3.1 Heavy Load Lifts Performed by the Polar Crane During Construction

During construction, the polar crane will be required to make several major lifts - 3 steam generators of 396 tons each, 1 reactor vessel of 390 tons, and one neutron shield tank of 198 tons. Vendor-supplied lifting devices are used for these lifts.

9.1.5.2.3.2 Heavy Load Lifts Performed by the Polar Crane During Maintenance Operations

The polar crane is also available for various maintenance operations required to service equipment in the containment building. The polar crane has the capacity to lift and transport for maintenance the reactor coolant pump (RCP) motor, the control rod drive mechanism (CRDM) ventilation fans, the residual heat removal (RHR) heat exchangers and pumps, the regenerative heat exchanger, and the reactor coolant system (RCS) loop isolation valves. Table 9.1-4 lists heavy loads lifted by the polar crane.

9.1.5.2.3.3 Heavy Load Lifts Performed by the Polar Crane During Plant Outage for Refueling

The refueling operation follows a detailed procedure that provides for a safe, efficient refueling process. A typical description of the overhead heavy load handling components' movements during refueling is given as follows. Handling of light loads during the refueling process is discussed in Section 9.1.4.

Load lifts made by the polar crane that are required in order to dismantle the reactor prior to refueling are listed as follows. The equipment is removed either from the reactor cavity area or the reactor head storage area, and then stored at various locations throughout the containment building. Some pieces of equipment may be moved several times during the refueling process.

The following is a list of crane movements inside containment:

1. Remove CRDM horizontal ventilation ducts with supports (3) to storage.

2. Remove reactor head lifting rig spreader assembly from storage to temporary location on CRDM missile shield.

3. Remove reactor head stud carriers (6) and stud rack bases (3) to temporary storage.

4. Move reactor head lifting rig spreader assembly to temporary storage position within the load handling path.

5. Secure and remove CRDM missile shield to storage (includes 3 sections).

6. Remove CRDM vertical ventilation ducts with supports (3) to storage.

7. Remove CRDM missile shield and support structure with electrical tray intact to storage.

8. Remove all reactor head insulation to storage.

9. Remove the internal lifting rig assembly from the upper internals storage stand to temporary storage location.

10. Deleted

11. Lower the stud tensioners and all other necessary tools and equipment required to unbolt and remove the reactor vessel head.

12. After the reactor vessel head studs have been loaded into the stud carriers, remove the carriers to storage on the operating floor.

13. Remove the southwest rail and platform grating from above the reactor head storage area to temporary storage.

14. The reactor vessel head is lifted slightly to check for levelness. If the closure head is not level, the head is set back on the vessel and the head lifting device sling assembly is adjusted. This procedure is repeated until the head is level when lifted. While monitoring the load cell the reactor head is lifted enough to verify that the P/L RCC element drive shafts are locked out and the F/L RCC CRDS are clear of the thermal sleeves. The reactor closure head may then be lifted out of the refueling cavity to the reactor head storage stand at el 692 ft-11 in.

15. Replace the southwest section of the manipulator crane rail and platform grating in position using the polar crane.

16. The CRDM shafts are disconnected, and with the upper internals, are removed from the vessel using the internals lifting rig assembly to a storage stand in the refueling cavity.

17. Should the lower internals need to be removed from the reactor, all of the fuel assemblies must be removed from the reactor, as described in Section 9.1.4. Then the internals lifting rig assembly is used to lift the lower internals and place them on a storage stand in the refueling cavity.

Reactor assembly following refueling is essentially achieved by reversing the sequence of operations described above.

9.1.5.2.4 Heavy Load Handling by Various Monorail Systems Throughout Beaver Valley Power Station - Unit 2

The monorail systems listed in Table 9.1-2 are identified as carrying heavy loads in the vicinity of piping and equipment required for safe shutdown of BVPS-2. In all cases, the loads are lifted by the monorail and transported to a lay-down area where maintenance can be performed on the particular piece of equipment. If required, the monorail system can lift the equipment so that a cart can be positioned under the load to transport the load to other plant locations. Table 9.1-4 lists the heavy loads lifted by these monorails.

9.1.5.2.5 Heavy Load Handling by the Screenwell Crane

The screenwell crane is an overhead bridge crane provided by BVPS-1 for maintenance operations in the intake structure, which is used by both BVPS-1 and BVPS-2. The crane is able to service the entire area of the intake structure and transfer any equipment to a lay-down area for maintenance. The BVPS-2 service water pumps are located in this building and are lifted by this crane. Heavy loads lifted by this crane are listed in Table 9.1-4.

9.1.5.2.6 Heavy Load Handling by the Permanent Auxiliary Crane

The auxiliary crane is located inside Containment on the Operating Floor at El. 767'-10'' between Steam Generator SG21A and the equipment hatch. The auxiliary crane does not perform any safety-related functions. During Modes 1-4, the auxiliary crane will be de-energized outside Containment and will remain in its stored configuration. During Modes 5, 6 and the defueled condition, the auxiliary crane is identified in Table 9.1-4 as performing a variety of load handling activities inside containment to support various refueling/maintenance activities. The auxiliary crane may carry various heavy loads in the vicinity of piping and equipment required for safe shutdown of BVPS-2. Station heavy loads administrative controls apply during any heavy load lift using the auxiliary crane.

The auxiliary crane is also administratively controlled per procedure to ensure that no loads (this precludes the crane hook or boom even if empty) are lifted over the reactor vessel when the reactor head is removed and fuel is in the vessel. This prevents any credible auxiliary crane failures that could cause a load to be dropped on the fuel.

9.1.5.3 Overhead Heavy Load Handling Equipment

9.1.5.3.1 Polar Crane

The polar crane is an overhead bridge, multiple girder, electric traveling crane with two top-running trolleys moving on a parallel set of bridge rails, and with a lower maintenance platform attached to the side of one of the bridge rails. The polar crane operates over the entire containment building, which includes the reactor

vessel and refueling cavity, the three steam generator cubicles, and the el 767 ft 10 in operating floor. The capacity of the bridge is 334 tons, with each trolley and hoist having a capacity of 167 tons. An auxiliary hoist having a capacity of 15 tons is located on Trolley No. 1.

The polar crane is seismically designed and meets all requirements of CMAA Specification No. 70 for Class A1, moderate service, and meets all mandatory requirements of ANSI B30.2-1967. The bridge and trolley motions have infinitely variable speed controls, with a speed regulation of 10 to 1 to provide for gradual acceleration and deceleration. Each hoist has five speed-set points to allow for raising and lowering of loads at preselected speeds, and is provided with upper and lower travel limit switches.

The polar crane is equipped with a telescoping work platform located on top of Trolley No. 2 to provide access to the containment spray header nozzles. A pendant station having controls for movement of the work platform, trolley, and main bridge is provided to allow for control of the crane motion from this location.

Electrical interlocks are provided as described in Section 9.1.5.5.2.1.

Each hoist is provided with two sets of brakes that each provide 150 percent of their respective motor full load torque. The bridge brakes have a torque rating of at least 100 percent of the rated full load torque of the bridge motors. The trolley motors have brakes rated at 100 percent of the full rated motor torque.

The main hoists are used primarily during plant outages for refueling or maintenance purposes. The hoists use two special lifting devices to lift the reactor head and the internals. These lifting rigs attach to one of the polar crane hooks for use. For other lifts, field-supplied rigging is used for lifting the loads. The auxiliary hoist is used for various maintenance lifts and lifts made during the refueling procedure to move tools and equipment (Section 9.1.4).

9.1.5.3.2 Spent Fuel Cask Trolley

The spent fuel cask trolley is an overhead type, multiple girder, electric traveling crane with a main trolley and auxiliary bridge on parallel sets of bridge rails, with a lower operating cab connected to the crane. The spent fuel cask trolley operates in the east end of the fuel building and in the decontamination building, which includes the spent fuel cask loading area and the cask washdown area. The capacity of the trolley is 125 tons, with a 30 ton auxiliary bridge.

The spent fuel cask trolley meets all requirements of CMAA Specification No. 70 for Class A1 standby service, all mandatory requirements of ANSI B30.2-1976, and Regulatory Guide 1.13. Each

crane motion utilizes five steps of variable speed control to provide for the required control when moving loads. With the exception of the auxiliary trolley motion which is controlled by a two-speed, dual wound motor, each crane motion is provided with a separate inching motor for continuous inching speeds. The main trolley inching speed and auxiliary trolley slow speed are identical. Each hoist has a load-indicating and limiting system and is provided with upper and lower travel limit switches, which prevent the cask from being lifted higher than 30 feet at any time during its travel.

All inching motor circuits are interlocked such that the inching motors cannot be operated unless the main hoist, auxiliary hoist, and main trolley are essentially at rest.

The hoist motors are provided with thermal detectors which trip the motor in the event of overheating. The trip will automatically reset itself upon motor cooldown.

The primary use of the main hoist and trolley is to upend and transfer the spent fuel shipping cask, that weighs approximately 100 tons, from the rail car into the fuel building for loading, and then returning the cask to a rail car for shipment from the site. The auxiliary hoist and trolley are used primarily for various small load lifts that may be required in the decontamination and fuel building areas.

9.1.5.3.3 Motor-Driven Platform Crane

The motor-driven platform crane is a gantry type, multiple girder, electric traveling crane with two top moving trolleys moving on parallel sets of bridge rails, and with a lower operating platform crane extending the span of the crane. The motor-driven platform crane operates over the spent fuel pool or pit, which includes the spent fuel cask loading area and fuel transfer canal, over the new and spent fuel storage areas, and over the new fuel receiving area. The capacity of the gantry platform is 20 tons, with each trolley and hoist having a capacity of 10 tons. The Licensing Requirements Manual contains limits for the maximum weight of any load which can be carried over the spent fuel pool.

The motor-driven platform crane is seismically designed, and meets all requirements of CMAA Specification No. 70 for Class C moderate service and ANSI B30.2-1976. Each trolley motion utilizes a variable speed control with a speed regulation of at least 10 to 1 to provide for a gradual acceleration and deceleration. Each hoist has a load indicating and limiting system and is provided with upper and lower travel limit switches.

The motor-driven platform crane is equipped with two single pendant stations having controls and indicators for all motions of the gantry platform, trolleys, and hoists. The pendants are suspended from each trolley unit.

Interlocks are furnished to prevent platform and trolley movement while the hooks are being operated. If the load indicator exceeds its preset weight, an interlock stops the hoist and sounds an alarm to alert the operator. The hoist motors are provided with thermal detectors which trip the motor in the event of overheating. The trip will automatically reset itself upon motor cooldown.

One hoist is primarily used for handling new fuel and the other for spent fuel. Section 9.1.4 describes the lifts made by these hoists during the fuel transfer operation.

9.1.5.3.4 Monorail Systems

The monorail systems listed in Table 9.1-2 are all manual or electric trolley and hoist drives. The monorails operate over specific plant areas or over equipment that requires maintenance. A list of the heavy loads lifted by the monorails is included in Table 9.1-4.

All monorail systems included in Table 9.1-2 are designed to comply with the Monorail Manufacturers Association (MMA) No. 61, Specifications for Underhung Cranes and Monorail Systems. In addition, all mandatory requirements of ANSI B30.11-1973 and ANSI B30.16-1973 are met by the design of the monorails.

The electrified monorail systems have maximum hoisting speeds based on the hoist rated load. Each hoist has a load limiting device to prevent hoist overload, and is provided with upper and lower travel limit switches.

The electrified monorail systems are provided with a single pushbutton pendant station having controls and indicators for all motions of the hoist and trolley. The pushbutton pendants are suspended from the tractor unit. Each chain hoist has a limiting device such that when an overload situation occurs, the chain wheel will revolve, but without further raising of the load.

Each monorail that is located over safety-related equipment is equipped with mechanical rail stops to ensure that the trolley is not stored over the safety-related equipment during operation.

9.1.5.3.5 Screenwell Crane

The screenwell crane, provided by BVPS-1, is an electric, overhead bridge type, traveling crane with a top running trolley. It is located in the intake structure and services the traveling screen areas, the raw water pumps, river water pumps, and the BVPS-2 service water pumps.

The screenwell crane meets all requirements of ANSI B30.2-1967, Overhead and Gantry Cranes, and Electric Overhead Crane Institute (EOCI) No. 61, Specification for Electric Overhead Traveling Cranes for Class A Standby Service.

The hoist motors are provided with thermal detectors which trip the motor in the event of overheating. Manual restart protection is provided on all motors.

9.1.5.3.6 Reactor Vessel Head Lifting Device

The reactor vessel head lifting device consists of a welded and bolted structural steel frame with suitable rigging to enable the polar crane operator to lift the head and store it during refueling operations. The lifting device is permanently attached to the reactor vessel head.

9.1.5.3.7 Reactor Internals Lifting Device

The reactor internals lifting device is a structural frame suspended from the polar crane. The frame is lowered onto the guide tube support plate of the internals, and is mechanically connected to the support plate by three breech lock type connectors. Bushings on the frame engage guide studs in the vessel flange to provide guidance during removal and replacement of the internals package.

9.1.5.3.8 Auxiliary Crane

The auxiliary crane is classified as an articulating boom crane, and consists of the crane itself, a support structure, utility pedestal and lateral support brace. The auxiliary crane is located inside the crane wall between steam generator SG21A and the equipment hatch. The crane operates using an electric-powered hydraulic system, and has an articulating and telescoping boom with a maximum horizontal reach of approximately 72 feet. The boom configuration consists of the column and lift cylinder, main boom, and a telescoping extension boom with nine extensions. The crane capacity ranges from approximately 50,000 lbs. at 10 ft. to approximately 5,000 lbs. at 72 ft. for lifts with the crane boom.

In addition, the auxiliary crane is equipped with a 4.5 ton winch with fully automatic brake, overload protection, anti-two-block damage prevention features, and an anti-over-spooling device. The auxiliary crane is controlled using a radio remote control equipped with an emergency stop button, removable-key lock, speed range switch and a display which indicates the load and provides an audible warning above 90% of crane capacity.

The auxiliary crane is qualified and supported Seismic Category II so as not to adversely affect safety-related, Seismic Category I components during a seismic event. The crane is secured and de-energized during plant operation.

9.1.5.4 Applicable Design Codes

The design codes and standards used for the OHLHS are given in Section 9.1.5.5.

9.1.5.5 Safety Evaluation

9.1.5.5.1 Safe Handling

9.1.5.5.1.1 Design and Operating Criteria for the Overhead Heavy Load Handling System

1. The primary design requirement of the polar crane, motor-driven platform crane, spent fuel cask trolley, screenwell crane, and the monorail hoists is safety and reliability. A conservative design approach is used for all load bearing parts. Where possible, components are used that have a proven record of reliable service. Throughout the design, consideration is given to the fact that the cranes and hoists spend long idle periods stored in an atmosphere of high temperature and humidity. The design and fabrication of the polar crane and spent fuel cask trolley is in accordance with the CMAA Specification No. 70 for Class A1 service, and Class C service for the motor-driven platform crane. The BVPS-1 screenwell crane was designed to EOCI No. 61 Specification for Class A standby service. The monorail hoists are designed to MMA Specification 61.

   The two special lifting devices at BVPS-2 are the reactor head lifting device and the internals lifting rig assembly. These devices are provided by the NSSS supplier and were designed to the American Institute of Steel Construction (AISC) specifications applicable at the time of their design. These specifications require that lifting devices be capable of lifting two times the weight of their designated loads without exceeding the yield strength of the material in the devices.

Administrative procedures for the handling of heavy loads will include the general guidelines and evaluation requirements of NUREG-0612 (USNRC 1980). In addition, load handling operational procedures will be written as necessary to ensure compliance with NUREG-0612 (USNRC 1980). The safe load paths originally described by Woolever, 1981, will be used as the load handling paths and any deviation from these operational procedures will require an approved procedural change. Operator training, qualification, and conduct will be in compliance with the requirements of ANSI B30.2-1976. Crane inspection, testing, and maintenance procedures will comply with ANSI B30.2-1976, Chapter 2-2, as clarified by NUREG-0612. Should any deviation from this standard be required, they will be equivalent to the requirements of ANSI B30.2-1976.

9.1.5.5.1.2 Industrial Codes and Standards Used

1. Polar crane, spent fuel cask trolley, and motor-driven platform crane: applicable sections of the CMAA Specification No. 70; screenwell crane: EOCI Specification No. 61; monorail systems: MMA Specification No. 61. Spent fuel cask trolley: ANSI B30.2-1976; polar crane: ANSI B30.2-1967; motor-driven platform crane: ANSI B30.2-1976; screenwell crane: ANSI B30.2-1967; spent fuel cask trolley: Regulatory Guide 1.13; auxiliary crane: ASME B30.22.

2. Electrical: motor-driven platform crane: applicable standards and requirements of NEC-1975 and National Electrical Manufacturers Association (NEMA) MG1; polar crane: applicable standards and requirements of NEC-1971 and NEMA MG-1-1972; spent fuel cask trolley: applicable standards and requirements of NEMA MG1-1972 Revision 7 March 1977, NFPA 70-1975, and NEMA ICS-1970; monorail systems: NEMA MG-1-1969, NEMA ICS-1970, NEMA IS1.1-1977; auxiliary crane: NEC, NEMA MG2.

3. Safety: monorail systems: applicable OSHA requirements; polar crane: OSHA Standard 29 CFR and 10 CFR 50 Appendix B; Spent fuel cask trolley: applicable OSHA requirements; motor-driven platform crane: applicable OSHA requirements; screenwell crane: applicable OSHA requirements; auxiliary crane: OSHA Standard 29 CFR.

9.1.5.5.2 Component Description

9.1.5.5.2.1 Polar Crane

The polar crane design includes the following provisions to ensure safe handling of heavy loads:

1. Electrical interlocks

   a. Interlocks are furnished such that when the work platform is in a raised position, it is impossible for the platform operator to bring the platform or its handrails into contact with either the containment dome or spray nozzles by either traversing the trolley or by raising the platform.

   b. Interlocks are provided to permit crane operation from only one location, the cab, or work platform.

   c. Interlocks are provided to prevent operation of the crane's normal cab control when the platform is raised above its fully retracted position.

2. Seismic requirements

   The polar crane bridge and trolley are provided with suitable restraints so that they do not leave their rails during SSE, thus meeting Seismic Category II design criteria. Also, no part of the crane shall become detached and fall during an SSE.

3. Main hoist braking system

   Eddy current control brakes are provided for hoisting and lowering motions. Each of the hoists are also provided with independent shoe-type brakes that are automatically applied to the motor shaft when the motor is de-energized. Additionally, each of the hoists is provided with a backup shoe brake with a delayed action to prevent simultaneous application of shoe-type brakes at once. Both sets of these shoe-brakes are rated at 150 percent of the motor full load torque.

9.1.5.5.2.2 Spent Fuel Cask Trolley

The spent fuel cask trolley design include the following provisions to ensure safe handling of spent fuel shipping casks:

1. Electrical interlocks

   a. Track-type limit switch interlocks are provided for the rolling steel doors and main trolley runway to prevent the spent fuel cask trolley from passing through the doorway unless the door is in the fully open position.

   b. Interlocks are provided to limit the maximum raised height of the rail or truck spent fuel cask to 30 feet or less.

c. Each hoist is provided with an overload cutoff which senses the load on the hoist and stops the hoisting motion if the preset weight is exceeded. The preset weight is determined in accordance with administrative procedure.

2. Seismic requirements

The trolley system is provided with suitable restraints so that it does not leave the rails during an SSE, thus meeting Seismic Category II design criterion. Also, the trolley

system is designed so that no part of the trolley system can become detached and fall during an SSE.

3. Main hoist braking system

   Eddy current control is provided for the hoisting and lowering motions. Each of the hoists is also provided with independent shoe-type brakes that are automatically applied to the motor shaft when the motor is de-energized. Additionally, each of the hoists is provided with a backup shoe brake with a delayed action to prevent simultaneous application of both shoe-type brakes at once. Both sets of these shoe brakes are rated at 150 percent of the motor full load torque.

9.1.5.5.2.3 Motor-Driven Platform Crane

The motor-driven platform crane design includes the following provisions to ensure safe handling of fuel assemblies:

1. Electrical interlocks

   a. Interlocks are furnished to prevent platform and bridge trolley movement while hooks are being operated.

   b. An interlock is provided to prevent lifting the fuel transfer system upender if the platform crane is nearby.

   c. Each hoist load indicating device has an adjustable interlock which will stop hoist motion and sound an alarm if the preset weight is exceeded.

   d. The platform and trolleys are interlocked to provide a signal to the crane operator whenever the crane travels over the upender area.

2. Seismic requirements

   The crane bridge and trolleys are provided with suitable restraints so that they do not leave their rails during an SSE, thus meeting Seismic Category II design criteria. No part of the crane will become detached and fall during an earthquake. In addition, the crane is designed so that a fuel element does not lower in an uncontrolled manner during or as the result of an earthquake.

3. Hoist braking system

   Each hoist has a control brake compatible with the motor controller and two load holding brakes. The load holding brakes consist of two independent spring-set, electrically released brakes. Each holding brake has the capacity to stop 150 percent of the full load motor torque at any speed up to 200 percent of the rated speed.

4. Trolley braking system

   The trolley motors are equipped with disc type brakes capable of sustaining 50 percent of the rated full load torque of the motors. A loss of electrical power automatically applies the trolley brakes to the motor shafts.

9.1.5.5.2.4 Monorail Systems

The monorail systems listed in Table 9.1-2 have several design features to ensure safe handling of heavy loads.

1. Load limiting switches are included to prevent an overload on the hoisting mechanism.

2. Upper and lower travel limit switches are provided to restrict the raising and lowering of loads to predetermined safe levels.

3. The hoisting ropes and cables and all other load carrying parts such as the track, fittings, hangers, and load chains are designed so that the maximum applied load does not exceed 20 percent of the ultimate strength of the material.

4. The track for all patented track monorail systems have a specially rolled lower carrying flange meeting the requirements of the MMA Specification No. 61.

5. Each electric hoist is provided with an independent disc or shoe-type motor holding brake which is automatically applied when the motor is de-energized. This brake has a rated braking torque of 150 percent of the motor full load torque. A load control mechanical load break is also provided for each hoist. This brake is capable of holding 125 percent of the rated load and is externally adjustable.

6. Rail stops will be used to hold trolleys in a safe location while not in use.

9.1.5.5.2.5 Screenwell Crane

The screenwell crane design includes the following provisions to ensure safe handling of heavy loads.

1. Electrical Interlocks

   Limit switches are provided to limit the travel of the hoists in both the upward and downward direction.

2. Hoist braking systems:

   Each hoist motor is provided with a spring-set, electrically-released disc brake with a rated braking torque of 150 percent of the motor full load torque. A mechanical or electric brake is also included to prevent excessive acceleration and to limit the speed when lowering.

9.1.5.5.2.6 Auxiliary Crane

The auxiliary crane design includes the following provisions to ensure safe handling of heavy loads:

1. Electrical interlocks and controls

   a. Overload Protection System - this system prevents crane operator inputs that would overload the crane

   b. Load indication on the crane controller in 10% increments above 60% to 100% of capacity, with audible alarm at 90% and audible and visual alarms at 100%

   c. All crane movements stop on loss of electric power, loss of hydraulic pressure, or loss of remote control signal

   d. The crane controller is equipped with an emergency cut-off button

   e. The hoist is provided with an anti-over-spooling device

2. Seismic Requirements

   The auxiliary crane and its support structure are qualified and installed Seismic Category II. The auxiliary crane is de-energized and secured on its support structure during plant operation.

3. Hoist braking system

   The hoist utilizes a hydraulic released spring-pressure multiple-disc brake system.

9.1.5.6 Tests and Inspections

9.1.5.6.1 Polar Crane

1. The following include shop testing of the crane:

   a. Using the crane controls and cab master switches, all drives are operated electrically and mechanically through all no-load speed ranges.

   b. A no-load shop performance test on all motors.

   c. All hooks are load-tested at 125 percent of their design load rating.

2. During maintenance, the following items are checked.

   a. Visually inspect for loose or foreign parts and remove any dirt or grease.

   b. Lubricate wheel and exposed gears with proper lubricant.

   c. Inspect hoist cables for worn or broken strands.

   d. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.5.6.2 Spent Fuel Cask Trolley

1. The following include shop testing of the trolley:

   a. Routine motor tests on all motors.

   b. A test to show proper operation of all hoist drives by rotation of the hoist drums through the required no-load speed ranges.

   c. Verify proper operation of the main trolley drive by rotation of the main trolley drive wheels through the required no-load speed range.

d. Tests to verify proper auxiliary trolley tracking, bridge electrification, and auxiliary trolley drive operation.

e. The main and auxiliary hooks are load-tested at 125 percent of its design rating.

2. During maintenance, the following items are checked.

   a. Visually inspect for loose or foreign parts and remove any dirt or grease.

   b. Lubricate wheels and exposed gears with proper lubricant.

   c. Inspect hoist cables for worn or broken strands.

   d. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.5.6.3 Motor-Driven Platform Crane

1. The following include shop testing of the crane:

   a. Routine motor tests for all motors.

   b. Each hook is load-tested to 125 percent of its design rating.

   c. Magnetic particle examination of each hook before and after hook load-testing.

   d. Hoisting cables are required to have a segment of the cable pull-tested to the breaking strength.

   e. Hoist gears, pinions, shafts, and assemblies are 100-percent magnetic particle tested.

   f. The equipment is assembled, completely wired and tested for proper operation of each hoist drive, all interlocks, indicators, limit switches, alarms, trolley tracking, and all crane functions.

2. During maintenance, the following items are checked.

   a. Visually inspect for loose or foreign parts and remove any dirt or grease.

b. Lubricate wheels and exposed gears with proper lubricant.

c. Inspect hoist cables for worn or broken strands.

d. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.5.6.4 Head Lifting Rig and Internals Lifting Rig

1. The minimum acceptable test at the shop includes the following:

   a. Load test to 125 percent of the rated load.

   b. Inspect assembly to ensure proper component fit up.

2. During maintenance, the following items are checked.

   a. Visually inspect for loose or foreign parts or damaged surfaces and remove any dirt or grease.

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

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

9.1.5.6.5 Screenwell Crane

1. The following include shop and field testing of the crane:

   a. No-load running test of all crane motions.

   b. Loaded running test of all crane motions.

2. After erection, the crane will, be completely lubricated in accordance with the manufacturers instructions.

9.1.5.6.6 Monorail Systems

1. The following include shop testing of the monorails:

   a. Routine motor tests on all motors.

   b. All hooks magnetic particle tested.

   c. Each hoist hook load tested to 125 percent of its rated load.

2. During maintenance, the following items are checked.

   a. Each monorail system is completely lubricated with the proper lubricant.

   b. Inspect all cables for worn or broken strands.

   c. Visually inspect all limit switches and limit switch actuators for any sign of damaged or broken parts.

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

9.1.5.6.7 Auxiliary Crane

1. The following include shop testing of the crane:

   a. Using the crane controls, all drives are operated through all no-load speed ranges.

   b. Routine motor tests.

   c. Inspect assembly to ensure proper component fit up.

2. During maintenance, the following items are checked:

   a. Visually inspect for loose or foreign parts and remove any foreign material.

   b. Inspect all switches and actuators for any sign of damaged or broken parts.

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

9.1.5.7 Instrumentation Requirements

The interlock system for the polar crane, spent fuel cask trolley, and motor-driven platform crane are discussed in Section 9.1.5.5.2.

9.1.5.8 Reference for Section 9.1

U.S. Nuclear Regulatory Commission 1980. Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36. NUREG-0612.

E. J. Woolever, Duquesne Light Co., letter to D. G. Eisenhut, "Generic Letter 81-07, Control of Heavy Loads," dated September 21, 1981.

BVPS-2 SER, Appendix F, "Control of Heavy Loads at Nuclear Power Plants, BVPS-2," March 1985.

U.S. Nuclear Regulatory Commission - Safety Evaluation related to Amendment Nos. 247 and 126 for Facility Operating License Nos. DPR-66 and NPF-73, dated January 29, 2002.

50FR05548, ‘‘Criteria and Procedures for Determining the Adequacy of Available Spent Nuclear Fuel Storage Capacity,’’ dated February 11, 1985.

Holtec Report HI-2084175, Revision 8, ‘‘Licensing Report for Beaver Valley Unit 2 Rerack,’’ as submitted to the NRC in support of License Amendment 173, Unit 2 Fuel Storage Pool Rerack.

U.S. Nuclear Regulatory Commission - Safety Evaluation related to Amendment No. 173 Regarding the Spent Fuel Pool Rerack for Facility Operating License No. NPF-73, dated April 29, 2011.

Tables for Section 9.1

TABLE 9.1-1

FUEL POOL COOLING AND CLEANUP SYSTEM
principal components, design
AND PERFORMANCE PARAMETERS

Component	Design/Performance Parameters
Fuel Pool Cooling Pumps (2FNC*P21A & B)	
Quantity	2
Rated flow (gpm) (each)	750
Total head (ft)	72
Net positive suction head required at rated flow (feet)	8
Fuel Pool Heat Exchangers (2FNC*E21A & B)	
Quantity	2
Operating flow, tube side (gpm) (each)	750
Operating flow, shell side (gpm) (each)	1,100
Design temperature (°F)	200
Operating temperature in, tube side (°F)	140
Operating temperature out, tube side (°F)	109.6
Operating temperature in, shell side (°F)	100
Operating temperature out, shell side (°F)	120.7
Total duty (Btu/hr) (each)	11.4×10^6
Fuel Pool Purification Pumps (2FNC-P24A & B)	
Quantity	2
Rated flow (gpm) (each)	400
Total head (ft)	143
Net positive suction head required (ft)	6.5
Fuel Pool Filters (2FNC-FLT21A & B)	
Quantity	2
Design temperature (°F)	250
Operating temperature (°F)	140 - 200
Design pressure (psig)	150
Operating pressure (psig)	85
Design flow (gpm) (each)	450
Design differential pressure (psig)	25
Size range (microns absolute)	25

TABLE 9.1-1 (Cont.)

Component	Design/Performance Parameters
Fuel Pool Ion Exchanger (2FNC-IOE21)	
Quantity	1
Design pressure (psig)	150
Operating pressure (psig)	65
Design temperature (°F)	200
Operating temperature (°F)	140

TABLE 9.1-2

APPLICABLE OVERHEAD LOAD HANDLING SYSTEMS

Equipment No.	Identification	Location
2CRN-201	Polar crane	Reactor containment
2MHR-CRN207	Residual heat removal pump monorail	Reactor containment
2CRN-203	Auxiliary crane	Reactor containment
2MHF-CRN215	Spent fuel cask trolley	Fuel and decontamination building
2MHF-CRN227	Moveable platform w/hoists	Fuel building
2MHK-CRN250	Cable vault area monorail	Cable vault area
2MHP-CRN209A,B	Primary component cooling heat exchangers monorails	Auxiliary building
2MHP-CRN210	Pipe chase slab removal monorail	Auxiliary building
2MHP-CRN220A,B,C	Chemical and volume control pump removal monorails	Auxiliary building
2MHP-CRN221A,B	Primary component cooling heat exchangers monorails	Auxiliary building
2MHP-CRN223	Auxiliary building miscellaneous filter/ demineralizer monorail	Auxiliary building
2MHP-CRN234	Primary component cooling pump monorail	Auxiliary building
2MHP-CRN235	Sweep gas system monorail	Auxiliary building
CR-17	Screenwell crane	Intake structure

TABLE 9.1-3

OVERHEAD LOAD HANDLING SYSTEMS THAT DO NOT OPERATE OVER SAFETY-RELATED EQUIPMENT OR EQUIPMENT REQUIRED FOR SAFE SHUTDOWN

Equipment No.	Identification	Location
2FNR-CRN205-1	CRDM drive assembly monorail (Refueling Cavity manipulator crane - auxiliary monorail hoist)	Reactor containment
2MHK-CRN240	Radwaste bride crane	Condensate polishing building
2MHK-CRN241	Demineralizer filter monorail	Condensate polishing building
2CR-35	Stop log monorail system	Alternate intake structure
2MHK-CRN232	Cooling tower pump house crane	Cooling tower pump house
2MHK-CRN208	Solid waste handling crane	Waste handling building
2MHT-TR202-1	Turbine room crane	Turbine building
2MHT-CRN239A,B	Condenser water box cover removal hoist	Turbine building
2MHT-CRN242	CCS heat exchanger removal hoist	Turbine building
2MHP-CRN222	Waste gas charcoal bed tank monorail	Auxiliary building
2MHP-CRN237	Waste gas surge tank monorail	Auxiliary building
2MHP-CRN225	Charcoal delay bed, degasifier monorail	Auxiliary building
2MHP-CRN238A,B	Access slab monorails	Auxiliary building
2MHZ-CRN243	Electrical equipment and installation monorail	Service building

TABLE 9.1-4

LOADS CARRIED BY EACH PIECE OF EQUIPMENT

Crane Mark No.	Capacity (tons)	Heavy Load Identification	Load Weight (tons)	Lifting Device
2CRN*201	Bridge-334 Trolley No. 1-167/15 Trolley No. 2-167	Reactor vessel head & attachments (including temporary reactor vessel head shielding used during refueling)	134.5	Vessel head lifting device
		Reactor vessel internals (upper)	40	Internals lifting rig assembly
		Reactor vessel internals (lower)	130	Internals lifting rig assembly
		Reactor coolant pump-motor	40	
		Reactor coolant system loop isolation valve	15	
		Reactor head lifting rig spreader assembly	3.5	
		Removable slabs	7.5	
		CRDM missile shield (3 sections) (total weight) and CRDM support structure*	42	
		Ventilation fans	1.0	
		Stud carriers (full)	3.6	
		Removable rail & beam	1.15	
		Removable platform north & south	3.0	
		Containment Air Recirculation Fan (Fan and motor)	3.0	

*Lifted together to stored location

TABLE 9.1-4 (Cont.)

Crane Mark No.	Capacity (tons)	Heavy Load Identification	Load Weight (tons)	Lifting Device
		Internals lifting rig assembly	10.5	
		Irradiation specimen cask	3.5	
		Residual heat removal heat exchanger	9.4	
		Residual heat removal pump	3.9	
		Regenerative heat exchanger	3.5	
		Polar cranes - bottom block & hook	5.4 (NOTE 1)	
		Reactor vessel lead shielding boxes	1.5 (ea)	
		Steam generator snubbers	2.2 (ea)	
2CRN-203	NOTE 2	NOTE 3		
2MHR-CRN207	5	Residual heat removal pump	3.9	
2MHF-CRN215	125/30	Spent fuel shipping cask	100	
		Fuel repair and fuel inspection boxes	1.5	
		Spent fuel shipping cask trolley - bottom block and hook	3.25	
2MHF-CRN227	10/10*	New fuel shipping container (upended only)	3.0	
		Fuel pool heat exchangers	16.5	
*Spent Fuel Hoist has a capacity of 2 tons when Clevis hook is installed.		Failed fuel assembly storage can	1.5	
		Refueling canal weir gate	1.8	
		Cask pool weir gate	1.5	
2MHK-CRN250	5	Removable slabs	2.3	
		Rod drive motor generators	3.8	
2MHP-CRN209A,B	10/10	Primary component cooling water heat exchangers (two monorails together)	17.5	
2MHP-CRN210	5	Removable slabs	4.5	
		Non-regenerative heat exchanger	4.25	
2MHP-CRN220A,B,C	5/5/5	Charging pumps-pump	3.75	

TABLE 9.1-4 (Cont.)

Crane Mark No.	Capacity (tons)	Heavy Load Identification	Load Weight (tons)	Lifting Device
		Charging pumps-motor	1.95	
2MHP-CRN221A,B	10/10	Primary component cooling water heat exchangers (two monorails together)	17.5	
2MHP-CRN223	10	Removable slabs	9.75	
		Cesium removal ion exchangers	0.95	
		Mixed bed demineralizers	0.95	
		Deborating demineralizers	1.4	
		Spent filter shipping cask	7.75	
2MHP-CRN234	2	Primary component cooling water pumps	1.0	
		Primary Component cooling water motor	1.7	
2MHP-CRN235	3	Removable slabs	2.8	
CR-17	15	River water pumps	6.5	
		River water motors	2.7	
		Raw water pumps	9.3	
		Raw water motors	3.8	
		Electric fire pump	3.0	
		Electric fire pump-motor	2.0	
		Diesel fire pump	3.0	
		Diesel engine	1.9	
		Hydro-pneumatic tank	1.2	
		Removable covers (largest)	4.3	
		BVPS-2 service water pumps	11.8 (dry)	
		BVPS-2 service water pump motors	3.4	

TABLE 9.1-4 (Cont.)

Crane Mark No.	Capacity (tons)	Heavy Load Identification	Load Weight (tons)	Lifting Device
		Traveling water screens (heaviest section)	10.4	
		Stop logs	10	
		Corrosion Inhibitor Chemical Storage Tank (empty)	2.1	
		Dispersant Chemical Storage Tank (empty)	2.1	

NOTE 1: For the Polar Crane 2CRN-201 large bottom block and hooks, NUREG-0612 heavy load control requirements are met by administrative controls per procedures to ensure there are no credible failure modes that will cause the polar crane large bottom block and hooks to be dropped. The administrative control governs allowable use of the large hoists and control of large hoist motor breakers.

NOTE 2: The auxiliary crane 2CRN-203 capacity ranges from approximately 2.5 tons at 72 ft. to approximately 25 tons at 10 ft.

NOTE 3: The auxiliary crane 2CRN-203 is used to handle a variety of heavy loads within the crane’s capacity and in accordance with the heavy loads program.

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FIGURE 9.1-1
ARRANGEMENT- FUEL & DECONTAMINATION BUILDING
BEAVER VALLEY POWER STATION-UNIT 2
UPDATED FINAL SAFETY ANALYSIS REPORT

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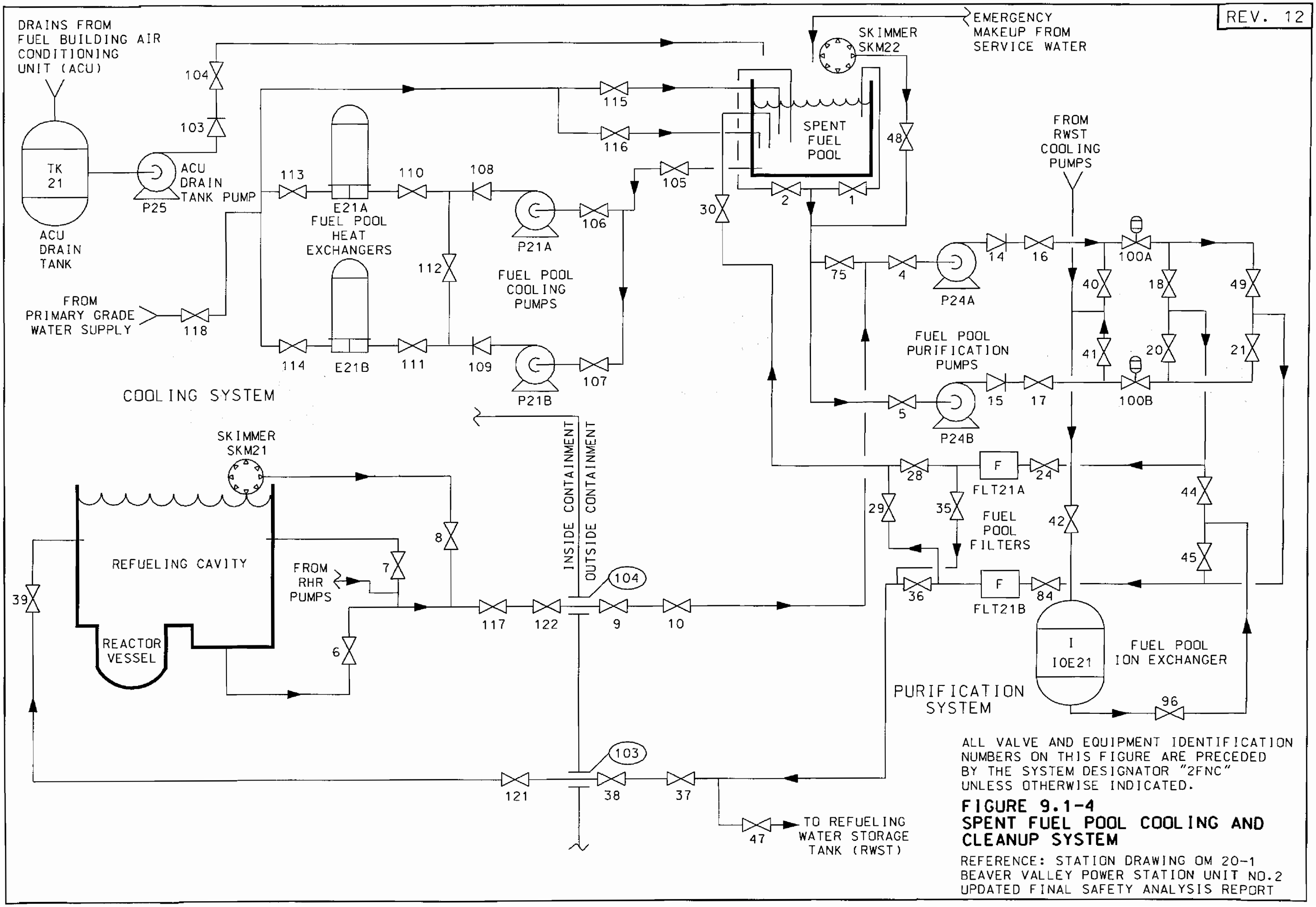
FIGURE 9.1-2
ARRANGEMENT-FUEL &
DECONTAMINATION BUILDING
BEAVER VALLEY POWER STATION-UNIT 2
FINAL SAFETY ANALYSIS REPORT



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2FNC" UNLESS OTHERWISE INDICATED.

FIGURE 9.1-4
SPENT FUEL POOL COOLING AND CLEANUP SYSTEM

REFERENCE: STATION DRAWING OM 20-1
BEAVER VALLEY POWER STATION UNIT NO.2
UPDATED FINAL SAFETY ANALYSIS REPORT

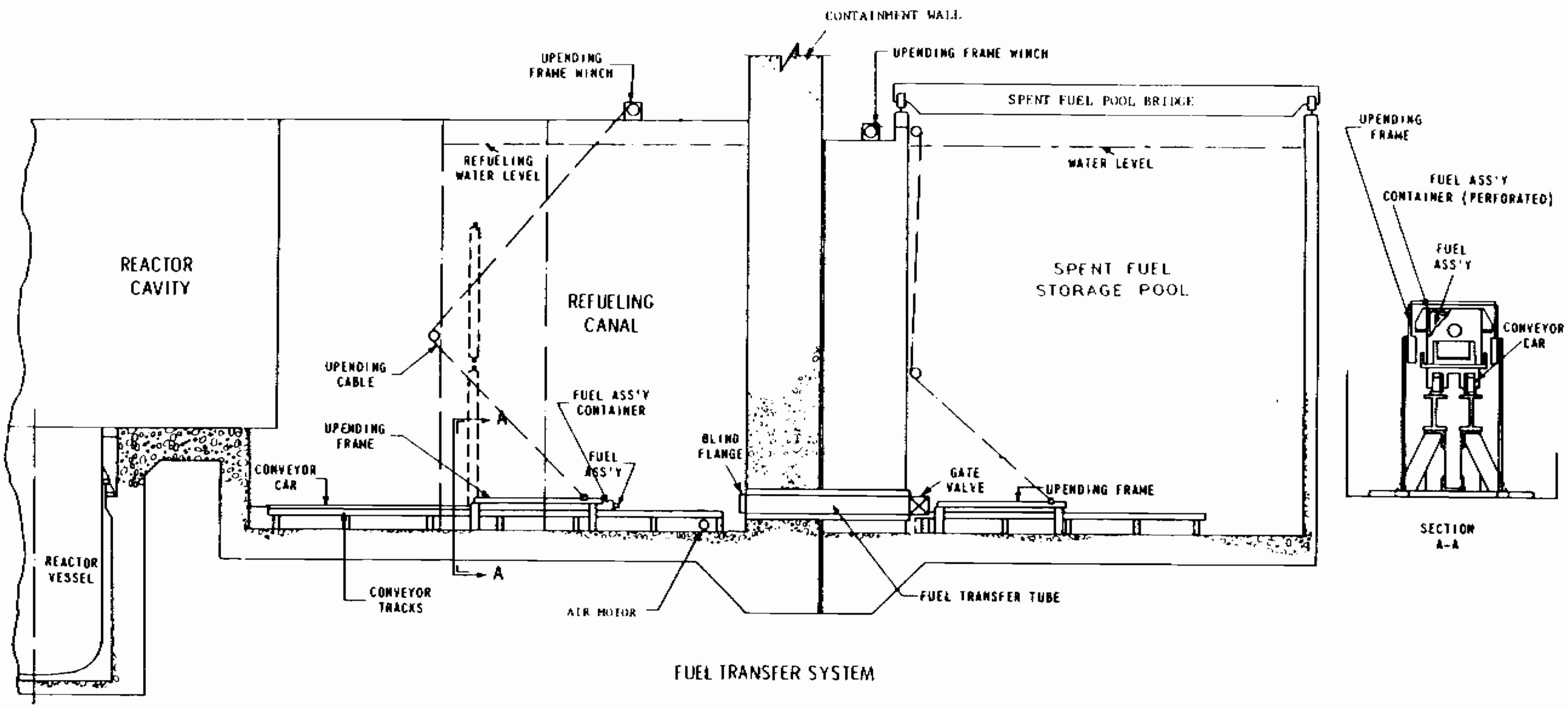


FIGURE 9.1-6
FUEL TRANSFER SYSTEM
BEAVER VALLEY POWER STATION-UNIT 2
FINAL SAFETY ANALYSIS REPORT

9.2 WATER SYSTEMS

9.2.1 Station Service Water System

9.2.1.1 Main Service Water System

The station service water system includes both the service water system (SWS) (Section 9.2.1.1) and the standby service water system (SSWS) (Section 9.2.1.2).

The SWS is a safety-related system which provides cooling water to remove heat from the power plant auxiliary systems during all modes of operation. The SWS is shown on Figure 9.2-1. Table 9.2-1 lists the component design data for this system.

9.2.1.1.1 Design Bases

The SWS is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to structures housing the system, and the system itself being capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system, and the system itself being capable of withstanding the effects of external and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to the capability of shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to assure:

    a. The capability to transfer heat loads from safety-related structures, systems, and components to a heat sink during both normal operating and accident conditions,

    b. Component redundancy so that the safety function can be performed assuming a single active failure coincident with the loss of offsite power (LOOP), and

    c. The capability to isolate components, subsystems, or piping, if required, so that the system safety function will not be compromised.

5. General Design Criterion 45, as it relates to design provisions made to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as it relates to design provisions made to permit operational functional testing of safety-related systems and components to assure:

   a. Structural integrity and system leaktightness,

   b. Operability and adequate performance of active system components, and

   c. Capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

7. Regulatory Guide 1.26, as it relates to the quality group classification of systems and components.

8. Regulatory Guide 1.29, as it relates to the seismic design classification of system components.

9. Regulatory Guide 1.102, as it relates to the flood protection of system components.

10. Regulatory Guide 1.117, as it relates to the tornado design classification of system components.

11. The system shall provide water during normal operation and shutdown conditions at the flow rates and temperatures required to remove the component heat loads, and to maintain the primary component cooling water (CCW) below 100°F during all normal conditions and below 120°F during cooldown or transient conditions.

12. The SWS is designed to handle all required heat loads at a maximum river water temperature of 89°F at either extremes of low river water level (el 648 ft-7 in) or the probable maximum flood (PMF) (el 730 ft) (Section 2.4).

9.2.1.1.2 System Description

The SWS is shown on Figure 9.2-1. Component design data for the SWS is given in Table 9.2-1. Three SWS pumps are provided with the system. Two out of three SWS pumps are required for normal plant operation. During this mode of operation, each pump is considered to be a 50-percent capacity pump. Only one SWS pump is required for safe shutdown. During this mode of operation, each pump is considered to be a 100-percent capacity pump.

Three SWS pumps supply service water to the two 30-inch SWS headers. Each pump is capable of delivering approximately 15,000 gpm. The SWS is designed with two pumps operating concurrently to supply the quantity of water needed for the essential cooling requirements for all operating conditions. The minimum flow of service water required for safe shutdown is shown in Table 9.2 2.

The SWS pumps are ac motor-driven vertical wet pit-type units. They are mounted above, and take suction from, three separate sections of the intake structure. The pump motors are in cubicles which are protected from flooding to the PMF level. The intakes of the pumps (el 640 ft-7 in) are located sufficiently below the low river water level (el 648 ft-7 in) to provide the required pump submergence. One pump motor is powered from one of the two emergency 4,160 V switchgear buses, a second pump motor is powered from the other bus, and the third, which is not normally connected to either of the buses, can be manually connected to either.

The three SWS pumps share the intake structure with the river water and raw water pumps of Beaver Valley Power Station - Unit 1 (BVPS-1). Each SWS pump is located in a separate bay of the intake structure.

Seal water for cooling, lubricating, and sealing of the service water pumps can be provided by either the non-safety related BVPS-1 filtered water system or by the discharge of the service water pumps via self-cleaning strainers located in the intake structure. BVPS-1 filtered water is normally isolated and service water pumps are cooled by the discharge of the service water pumps via self-cleaning strainers.

The pumps discharge into two 30-inch headers which transport service water from the intake structure to the service water valve pit. These headers are buried and separated.

Each of these headers supplies a redundant valve pit section. Branches from the main headers supply water to the equipment listed in Table 9.2-2 via buried supply lines. Portions of the headers and supply lines within the intake structure and buried lines from the intake structure to the valve pit were installed during the BVPS-1 construction effort and under BVPS-1 procedures and specifications. Table 9.2-2 indicates what equipment is supplied during various modes of unit operation. Also, a single, 30-inch header from the SSWS (Section 9.2.1.2) provides a backup source of water to either service water header.

During normal operation, the service water is discharged to: 1) the main circulating water lines downstream of the main condenser and travels from there to the cooling tower, and 2) the emergency outfall structure (EOS). The service water provides the necessary makeup for the main circulating system. This makeup is required to compensate for drift and evaporation in the cooling tower and maintain circulating water concentration. Since the service water flow exceeds the makeup requirements, the excess is discharged into the blowdown line downstream of the cooling tower basin.

(Section 9.2.1.1.2) The SWS provides a continuous supply of cooling water to the following components during normal unit operation:

1. At least two primary CCW heat exchangers (Section 9.2.2).

2. At least one secondary CCW heat exchanger (Section 9.2.7).

3. At least two charging pump lube oil coolers (Section 9.3.4).

4. One control room air-conditioning refrigerant condenser (Section 9.4.1).

5. Two centrifugal water chiller condensers (Section 9.2.2.2).

6. One or two safeguards area air-conditioning units (Section 9.4.11).

7. Two sets of motor control center (MCC) cooling coils (Section 9.4.3).

During unit cooldown, the normal heat load on the primary CCW heat exchangers is not present as cooling of most of the components is not required. Primary CCW is then used to remove the cooldown heat loads, including the residual heat from the reactor through the use of the residual heat removal (RHR) heat exchangers (Section 9.4.7).

In the event of a design basis accident (DBA), initiating a containment isolation phase B (CIB) signal, the SWS is designed to supply sufficient cooling water to safely shutdown the unit, assuming any single active component failure coincident with a LOOP. As a minimum, cooling water would be supplied to the following components:

1. At least two recirculation spray coolers for cooling the water sprayed into the containment (Section 6.5.2).

2. At least one charging pump lube oil cooler (Section 9.3.4).

3. One control room air-conditioning refrigerant condenser or one control room air-conditioning unit (Section 9.4.1).

4. At least one emergency diesel generator cooling system heat exchanger (Section 9.5.5).

5. At least one set of MCC cooling coils (Section 9.4.3).

6. At least one safeguards area air-conditioning unit (Section 9.4.11).

On a CIB signal, motor operated valves (MOVs), located in the valve pit, divert flow from the primary CCW heat exchangers, secondary CCW heat exchangers, and chillers to the four recirculation spray coolers. Service water will continue to be supplied to the other safety-related equipment, listed previously. The motor operated inlet valves to the emergency diesel generator cooling system heat exchangers are opened on a safety injection signal, since the signal also starts the emergency diesel generators. The safety injection signal is initiated prior to a CIB signal.

On a LOOP, service water is supplied to emergency diesel generator cooling system heat exchangers through MOVs that open automatically when the diesel generators are started. The secondary CCW heat exchangers and the chillers are not required after a LOOP and will be automatically isolated, if necessary, on low pressure in both service water headers, to maintain the required flow to the other equipment.

The SWS is also designed to perform the following functions as required:

1. Provide an emergency source of makeup water to the fuel pool (Section 9.1.3).

2. Provide an emergency source of water to the steam generator auxiliary feed pumps (Section 10.4.9).

3. Provide fill water for the building service drains seal tank (Figure 9.4-1).

Each recirculation spray cooler has an MOV at both its inlet and outlet, so that it can be remotely isolated from the main header and the other recirculation spray coolers. The system is engineered and designed so that all components, pumps, and heat exchangers can be individually isolated, thus providing for continued operation during equipment repair and maintenance.

The SWS piping and components are Safety Class 3 and Seismic Category I from the intake structure to the service water valve pits. The redundant service water lines from the service water valve pit to the safety-related components are also Safety Class 3 and Seismic Category I, and tornado- and missile-protected. The supply lines to the chilled water unit condensers and secondary CCW heat exchangers are not seismically designed, with the exception of lines located within Seismic Category I structures. The majority of the normal flow from the primary CCW heat exchangers is discharged to the main circulating water system. This normal discharge path is not seismically designed. An auxiliary discharge path from the primary CCW heat exchangers is through two redundant Safety Class 3, 24-inch discharge lines to the two main 30-inch redundant discharge lines to the river via the EOS. The EOS is Seismic Category I and tornado- and missile-protected. A portion of the primary CCW heat exchanger discharge flow is normally directed through this auxiliary path.

Isolation between the Safety Class 3 and the nonsafety-related portions of the system is provided by double, motor operated isolation valves. These valves close on a containment isolation phase A (CIA) signal. In the event of a failure of the nonsafety-related portion of the system, one valve from each header will close on a system low pressure signal.

The operation of the various valves following a DBA or a LOOP is summarized in Table 9.2-3.

Service water is supplied to the centrifugal water chiller condensers via two condenser water booster pumps (Section 9.2.2.2). These pumps, in conjunction with a temperature control valve, provide the capability to recirculate the cooling water to maintain a minimum temperature into the centrifugal water chiller condensers.

One header of the SWS can supply water to the suction of the steam generator auxiliary feed pumps (Section 10.4.7) and to the spent fuel pool (Section 9.1.3). This header can also be connected to the discharge of Beaver Valley Power Station - Unit 1 (BVPS-1) engine-driven fire pump. In the long term, the locked closed valve separating the flow paths to the recirculation spray coolers can be opened to supply water to the auxiliary feed pumps from the other header.

An SWS backup, B Train, is provided to the containment recirculation cooling coils (Section 9.2.2.2).

Chemical protection for the materials of the SWS is provided in the following ways:

1. The Service Water System receives normal treatment to prevent marine growth and/or corrosion via a continuous dispersant/corrosion inhibitor feed.

2. The Emergency Diesel Generator heat exchangers are normally in standby and flowed monthly with treated Service Water during surveillance testing.

   In addition to normal treatment, biodegradable chemicals can be added to the emergency diesel generator coolers for wet layup from a chemical addition tank (CAT) to prevent undue corrosion during long term shutdown.

3. Additional injection points are provided for use in controlling corrosion macro invertebrate growth and to aid in the control of silt deposition in the SWS lines and components.

4. Water samples are taken periodically for chemical analyses to ensure that service water chemistry stays within required specifications.

A high flow rate through the heat exchangers minimizes the possibility of pitting occurring in the stainless steel tubes due to deposition of silt.

The minimum flow requirements for the various components following a DBA, and for other modes of operation of the SWS, are given in Table 9.2-2.

9.2.1.1.3 Safety Evaluation

The safety-related portion of the SWS is designated Safety Class 3, Seismic Category I, with pressure-retaining components designed to ASME III, Class 3, requirements.

The SWS is designed to permit individual isolation of all pumps, heat exchangers, and piping for maintenance.

The minimum flow requirements for safe shutdown following a DBA are given in (Table 9.2-2). For this condition, the system performance is calculated on the basis of a technical specification low river level of el 654 ft and a maximum service water temperature of 89°F.

The Service Water System bounding design criteria which has been determined for an extreme low river water level is:

1. A design basis accident occurs at Beaver Valley Power Station Unit No. 2 with the Ohio River at elevation of 654 ft mean sea level at the Intake Structure with an extremely low river water flow rate of 800 cfs.

2. A coincident shutdown of Beaver Valley Power Station Unit No. 1 from full power operation.

3. Ohio River water temperature of 89°F.

4. A single failure in either a) an onsite system or b) in an offsite manmade structure. The limiting design basis offsite single failure is the loss of one lock or tainter gate in the downstream New Cumberland Dam. This is a passive failure as defined in Section 3.1.1 which culminates in an extreme low river water level of 648.6 ft mean sea level in a time frame as shown in Appendix 2.4B.

The cooling requirements to satisfy the above scenario bounds the cooling requirements for the postulated scenario which involves the failure of one tainter gate in the downstream dam, a subsequent normal shutdown of both units prior to reaching 650 ft river level, and a single failure in an onsite system.

A maximum solid blockage limit of 22 inches of silt has been established for each Intake Structure bay to ensure that sufficient ultimate heat sink cooling water remains available given the above design basis criteria for extreme low river water level. Silt, in this application, is defined as any obstruction which completely blocks flow from the Ohio River to the pump suction in an Intake Structure bay. This silt limit also requires that flow taken out of a single Intake Structure bay by station pumps be limited to a maximum of 7500 gpm whenever the Ohio River Water level is less than 650 ft mean sea level to ensure sufficient water level remains in the bay for pump NPSH/submergence requirements. 7500 gpm is sufficient to meet Beaver Valley Power Station Unit No. 2 post-DBA cooling requirements in the long term. There is no limit for flow out of an Intake Structure bay with river water level greater than 650 ft mean sea level.

The SWS is designed with adequate redundancy throughout to meet the single failure criterion, either active or passive. During normal BVPS-2 operation, two pumps supply all service water required. Service water pump 2SWS*P21A is connected to emergency bus 2AE while pump 2SWS*P21B is connected to emergency bus 2DF. Service water pump 2SWS*P21C may be operated from either emergency bus. To prevent a tie between these redundant emergency buses, a two key interlock is provided (Section 8.3.1). These pumps supply the safety-related portion of the system through two redundant trains. The nonsafety-related portion of the system is supplied by a single header, isolated from each of the Safety Class 3 trains by motor-operated isolation valves.

Only one of the three SWS pumps is needed to provide the cooling for the minimum number of components required for safe shutdown following a DBA. These components are listed in Table 9.2-2. Use of one pump is based on the required heat removal duty of the recirculation spray coolers following a DBA, as discussed in Chapter 6. Assuming a coincident LOOP, the required start-up time for the SWS pumps is well within the sequential loading capability of the emergency diesel generators, as discussed in Chapter 8. In addition to the redundant SWS pumps, the SSWS is provided to meet an additional design basis event (Section 9.2.1.2).

Failure of SWS piping is considered unlikely for the following reasons:

1. All safety-related SWS piping is tornado-protected either by being buried or by being located in Seismic Category I buildings.

2. All safety-related SWS piping is designed to meet Safety Class 3 and Seismic Category I requirements and is protected from pipe break effects as described in Section 3.6.

All piping and equipment movements due to thermal or seismic effects have been analyzed for safety-related items in accordance with Section 3.9B.3. The piping and equipment is designed to ensure that no undue forces are exerted on piping or equipment nozzles.

Because the seismic movements of the intake structure and other buildings may differ from the seismic movements of the earth in which the pipe is buried, the most critical points are where the pipes pass into the structures. If required, the pipes are provided with sleeves or enclosures which extend a short distance out from the structures. The enclosures decouple the pipe from the soil and permit the pipe to accommodate differential movements between the soil and the structures. Flexible joints are used within the enclosures, as necessary, to limit piping stresses and to reduce the required length of the enclosure. The radial clearance between pipe and enclosure is ample to accommodate both settlement and seismic motion. Analysis of postulated cracks in piping systems is discussed in Section 3.6.

The SWS has been analyzed to verify that the system functions properly in the entire range of river water level from the technical specification low water level in the Ohio River (654 ft) to the PMF level (730 feet). All BVPS-2 equipment with a safety-related function has been located in structures of suitable design to prevent any flooding resulting from the PMF level, including the SWS pumps located in the intake structure.

Radiation monitors in the service water outlets from the recirculation spray coolers and the primary CCW heat exchangers detect leakage of radioactive material to the environment (Section 11.5). Both the shell and tube side of these heat exchangers can be manually isolated to stop leakage to the environment.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls and electrical portions meet the single

failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Standard 279-1971 requirements are satisfied, has been performed on the SWS system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.2.1.1.4 Inspection and Testing Requirements

The SWS will be tested in accordance with the ASME OM Code and inspected in accordance with ASME Section XI.

The major portion of the SWS is in continual use and requires no periodic testing.

The SWS sides of the recirculation spray coolers are tested on a nominal 18 month frequency to verify an acceptable flow rate of service water through the coolers as specified in Table 9.2-2. The SWS (tube) sides of the recirculation spray coolers can be flow tested in pairs.

The output of one SWS pump can be diverted, by suitable valve operation, to the recirculation spray coolers through one of the 30-inch service water lines, the other line being used to supply the primary and secondary CCW heat exchangers. The emergency diesel generators cooling system heat exchangers can also be flow tested by operation of the appropriate valves.

Preoperational tests are performed as described in Section 14.2.12. The equipment is accessible for inservice inspections.

The MOVs in the lines to and from the recirculation spray coolers are tested periodically to ensure satisfactory operation. They are normally set in the safe open position with the header valves in the 24-inch service water lines closed.

The recirculation spray cooler header valves are checked during unit start-up and periodically to verify their proper position with the valves in the lines to the primary CCW heat exchangers.

In-service inspection will be done on the SWS pumps by measuring the specific pump operating parameters. These measurements will be compared to established reference values, as required by ASME Section XI. The motors are equipped with a vibration monitoring cabinet and can be monitored or scanned continuously via the vibration monitoring system. The in-service inspection of the remainder of the system will be performed in accordance with ASME Section XI.

9.2.1.1.5 Instrumentation Requirements

Control switches with indicating lights are provided in the main control room for the service water pumps. These pumps may be started manually or automatically from a safety injection signal or a diesel loading sequence signal. During normal operation, two pumps will supply all service water required for all unit operating conditions.

The two modes of operation which are available, manual and automatic, may be initiated from either the control room or the emergency shutdown panel (ESP). A pushbutton is provided on the ESP which will transfer control to the ESP from the main control room. A manual reset at the relay is used to transfer control back to the main control room.

A control switch with indicating lights is provided on the alternate shutdown panel (ASP) for a service water pump. This pump is operated manually. A pushbutton on the ASP will transfer control from the ESP or from the main control room to the ASP. A manual reset at the relay will transfer control from the ASP back to the ESP or to the main control room.

Control switches with indicating lights are provided in the main control room for the service water pump discharge valves. These valves may be operated manually or automatically when their respective service water pump is running.

A control switch with indicating lights is provided on the ASP for a service water pump discharge valve. This valve is operated manually. A pushbutton is provided on the ASP which will transfer control from the main control room to the ASP. A manual reset at the relay will transfer control back to the main control room.

Control switches with indicating lights are provided in the main control room for the secondary CCW heat exchangers service water isolation valves. These valves are operated manually. The valves may be closed manually, or automatically by a CIA signal or low header pressure in the system.

A selector switch with indicating lights is provided in the main control room for the containment air recirculation cooling coils chilled water return valve. This valve is operated manually.

Selector switches with indicating lights are provided locally for the SWS chemical addition pumps. These pumps are operated manually.

Control switches with indicating lights are provided in the main control room for the containment air recirculation cooler service water supply isolation valve and primary CCW heat exchanger service water inlet valves. These valves may be opened when a CIB signal is not present and may be closed manually or automatically by the CIB signal being present.

Control switches with indicating lights are provided in the main control room for the recirculation spray cooler service water header valves. These valves may be opened manually or automatically when they receive a CIB signal and may be closed manually when the CIB signal is not present.

Control switches with indicating lights are provided in the main control room for the four diesel generator heat exchanger service water

header valves. Two of these valves are operated automatically from an emergency diesel generator start signal or a safety injection signal. These valves may also be opened manually. The valves may be closed manually when there are no auto open signals. The other two valves are operated only manually from the main control room.

A control switch with indicating lights is provided on the ASP for a diesel generator heat exchanger service water header valve. This valve is operated manually. A pushbutton is provided on the ASP which will transfer control from the main control room to the ASP. A manual reset at the relay will transfer control from the ASP back to the main control room.

Control switches with indicating lights are provided for the air-conditioning condenser service water header valves at the MCC. An extra set of indicating lights is provided for these valves in the main control room. These header valves are normally locked in the open position at their respective MCCs with power secured.

Control switches are provided locally with local indicating lights for the seal water injection strainer backwash motors. These motors may be operated manually or automatically. While in the automatic mode, the motors receive a start signal from a low seal water header pressure signal. These motors are started automatically by a safety injection signal.

Indicating lights are provided in the main control room for the service water to seal water header isolation valves. These valves operate automatically when their respective service water pump is racked in on its bus.

A clarified water pressure control valve to the seal water header is modulated to maintain clarified water pressure at set point.

Control switches with indicating lights are provided in the main control room for the clarified water to seal water header isolation valves. These valves close automatically from a safety injection signal or a seal water header pressure low signal.

Control switches with indicating lights are provided on the building service control panel for the main control room refrigerant condenser recirculation pumps. These pumps may be started manually, or automatically when the service water temperature is low and the corresponding cooling unit is in operation. The pumps may be stopped manually, or automatically when the service water temperature is not low and the corresponding cooling unit is in operation.

The main control room cooling coil return temperature is controlled by throttling manual valves.

Ammeters are provided on the main board in the main control room, one each for the two service water pumps and two for the third pump.

Pressure indicators are provided in the main control room, one each for the two service water pump discharge headers.

Annunciation is provided in the main control room for service water pumps auto start/stop, control of service water pumps at the ESP, control at the ASP, and service water header pressure low. An alarm is also provided for SWS trouble, which consists of seal water header pressure low for each service water pump, seal water injection strainer differential pressure high for each strainer, seal water injection strainer backwash motor auto start, and seal water injection strainer motor thermal overload for each strainer. These alarms are also monitored by the BVPS-2 computer system. Annunciation is also provided in the main control room for chlorination system local panel trouble.

Computer inputs not associated with annunciation system are provided for SWS pumps start/stop, SWS valve pit area header A pressure, SWS valve pit area header B pressure, SWS pumps upper bearing temperatures, and SWS pumps thrust bearing temperatures.

9.2.1.2 Standby Service Water System

In response to the new design basis event presented in U.S. Atomic Energy Commission (USAEC) Regulatory Staff Position 22 (BVPS-2 preliminary safety analysis report (PSAR), Q2.18, July 20, 1973), the SSWS conveys water from the alternate intake structure to provide heat sink requirements when the Seismic Category I intake structure is disabled by the postulated event (BVPS-2 PSAR, USAEC Question No. 2.18, Amendment 8, July 1973, Amendment 12, December 1973, and Amendment 13, February 1974). In accordance with Regulatory Guide 1.27, the SSWS is capable, as a minimum, of providing its design function during site-related historic events.

9.2.1.2.1 Design Bases

The SSWS is designed in accordance with the following criteria:

1. Historic earthquake - 0.03 g (surface motion).
2. Redundant pumps and motor-operated valves are provided to accommodate a single active failure.
3. Flood protected to el 705 feet (standard project flood).
4. Minimum site river level capability to el 654 feet.
5. No tornado protection.
6. Located to preclude damage from gasoline barge impact/explosion which may disable the Seismic Category I intake structure.
7. Regulatory Guide 1.27, as it relates to the redundant supplies of service water heat sink.
8. Capability is provided for onsite essential power for essential equipment.
9. A DBA is not considered coincident with requirements for the SSWS.
10. Electrical and control requirements to meet IEEE Standards 279-1971 and 308-1974 for essential equipment.
11. Piping and valves meet Power Piping Code ANSI B31.1.0 and pumps are designed to applicable ANSI and Hydraulic Institute Standards.

The SSWS is designed to accommodate unit shutdown from 100-percent reactor power and subsequent cooldown of the reactor coolant system (RCS) to less than 200°F (cold shutdown requirements), after the postulated loss of the Seismic Category I intake structure.

The SSWS is designed to duplicate the cooldown cooling capacity of the SWS specified in Section 9.2.1.1.

9.2.1.2.2 System Description

The SSWS consists of two 100-percent capacity pumps discharging to a 30-inch line and connected to the redundant 30-inch Seismic Category I service water supply lines via MOVs located in the Seismic Category I valve pit. From the point of connection to the service water lines, the cooling water flows to the systems and equipment described in Section 9.2.1.1.

The two 100-percent capacity pumps and two MOVs are provided to accommodate the single active failure criterion requirement for the system. The check valves in the Seismic Category I service water lines, located in the valve pit, will isolate the SSWS from the disabled intake structure during the design basis event. This feature maintains the integrity of the SWS to continue unit shutdown cooling water requirements when supplied from the SSWS.

The SSWS pumps share the auxiliary intake structure with the auxiliary river water pumps of BVPS-1, but are located in a separate bay.

The SSWS is capable of operating during LOOP from redundant emergency 4,160 V switchgear buses.

Seal water for the SSWS pumps is normally provided from the discharge of the SSWS pumps via self-cleaning and Y-type strainers located in the auxiliary intake structure. These self-cleaning strainers also provide a backup supply of seal water to BVPS-1 auxiliary river water pumps and supply wash water to both BVPS-1 and BVPS-2 traveling water screens. An automatic backup supply of seal water is provided from the discharge of the SSWS pumps via a Y-type strainer.

The SSWS pumps are provided with an automatic start capability. Although this feature is not required for the design basis event, it is provided to prevent inadvertent plant trip on loss of a running service water pump. Given a low pressure signal in either SWS header, provided there is no loss of power signal present, its associated SSWS pump will be activated and the MOV connecting the SSWS to the affected SWS header will open. The SSWS pumps can also be manually started on the emergency buses after a loss of power signal if the diesel loading sequence is completed and the associated SWS pump on the bus is not running. The postulated barge impact explosion design basis event would result in an immediate loss of pressure and flow to both redundant service water supply lines, which would result in auto start of both SSWS pumps and opening of both header MOVs. If an automatic start did not occur, the SSWS pumps can be manually started.

9.2.1.2.3 Safety Evaluation

The postulated gasoline barge impact with the intake structure and coincident explosion disabling the SWS is a low probability event and is outside those typically postulated by the NRC for reactor sites. Nonetheless, the SSWS provides defense in depth in assuring shutdown cooling capability. The requirement to operate the SSWS is not coincident with a postulated Design Basis Accident, but is coincident with the postulated gasoline barge impact event. The SSWS is a non-safety system provided with redundant pumps and valves to accommodate a single active failure.

The SSWS is designed to provide cooling water to shut down the unit from 100-percent power and to subsequently cool down the RCS to less than 200°F for as long as necessary after the postulated loss of the Category I intake structure due to the specified design basis event. A DBA is not considered coincident with requirements for the SSWS.

Redundancy of the SSWS pump and MOVs permit acceptance of a single active failure without impairing designed cooling water requirements. Furthermore, low pressure alarms and pressure indicators in the service water lines at the primary CCW heat exchanger, as well as pump motor current (amperes), and the primary plant cooling system temperatures provide the operator with information to evaluate the performance of the SSWS and the SWS. The SSWS pumps are also capable of operation during LOOP, as power requirements can be provided from the redundant essential buses when the SWS pumps are unavailable. The Licensing Requirements Manual establishes the functionality requirements for the SSWS.

9.2.1.2.4 Inspection and Testing Requirements

The SSWS from the alternate intake structure to the connection to the SWS in the valve pit will be tested periodically during unit operation, shutdown, or refueling periods.

During normal unit operation, cooling water is supplied to the valve pit by two SWS pumps via two 30-inch service water supply headers from the intake structure. The SSWS can be tested by operating each SSWS pump through a recirculating line provided in the alternate intake structure. Also, the SSWS may be tested by supplying the SWS with one SSWS pump in place of an SWS pump. The performance of the SSWS can be evaluated by monitoring SSWS and SWS header pressure, SSWS pump motor current (amperes), and temperatures of systems cooled by the SWS.

The system is hydrostatically tested prior to acceptance and all active components are accessible for periodic visual inspection during unit operation. Preoperational tests are performed as described in Section 14.2.12.

9.2.1.2.5 Instrumentation Requirements

Control switches with indicating lights are provided for the SSWS pumps on the main control board. The SSWS will be put into operation automatically upon a loss of pressure in the SWS valve pit area header provided there is no loss of power.

Seal water injection valves are provided with indicating lights on the main control board. These valves are interlocked with the SSWS pumps. When their respective pump starts, the valve will open and when the pump stops, the valve will close.

Control switches with indicating lights are provided for the SSWS pump discharge valves in the main control room. These valves are interlocked with their respective SSWS pump.

Selector switches with indicating lights are provided locally for the wash water booster pump. An extra set of indicating lights are provided on the main control board for the pump. This pump is interlocked with the SSWS pumps high discharge pressure to start on this signal.

Selector switches with indicating lights are provided locally for the traveling water screen. An extra set of indicating lights are provided on the main control board for the water screen. This water screen is interlocked with the wash water booster pump running.

Selector switches with indicating lights are provided locally for the self-cleaning strainer. This strainer is interlocked with the SSWS pumps high discharge pressure to start on this signal.

Ammeters are provided on the main control board in the main control room for each of the SSWS pumps. A pressure indicator is provided on the main control board in the main control room for discharge pressure of the SSWS pumps. Annunciation is provided in the main control room for any standby service water pump auto start/stop and alternate intake structure local panel trouble. These are also monitored by the BVPS-2 computer system. Annunciation is provided locally for the standby service water pumps bearing temperature high. These annunciators are monitored by the BVPS-2 computer system. Annunciation is also provided locally for the SSWS pumps seal water pressure low, SSWS pumps discharge header pressure low, SSWS self-cleaning strainer differential pressure high, and SSWS alternate intake structure temperature high/low. These annunciators, however, are not monitored by the BVPS-2 computer system.

9.2.2 Cooling Systems for Reactor Auxiliaries

The cooling systems for the reactor auxiliaries consist of the primary CCW system (Section 9.2.2.1), the chilled water system (Section 9.2.2.2), and the neutron shield tank cooling water system (Section 9.2.2.3). These systems are used individually and in combination with each other to provide cooling water for heat removal from various reactor plant components.

9.2.2.1 Primary Component Cooling Water System

The primary CCW system provides an intermediate cooling loop for removing heat from reactor plant auxiliary systems and transferring it to the SWS (Section 9.2.1). The primary CCW system is shown on Figure 9.2-10. Table 9.2-4 lists the required flows for the various equipment cooled by this system. Table 9.2-5 lists subsystem component design data.

9.2.2.1.1 Design Bases

The primary CCW system is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, as it relates to structures housing the piping and the piping itself being capable of withstanding the effects of or being protected against externally and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to assure:

   a. The capability to transfer heat loads from safety-related structures, systems, and components to a heat sink under both normal operating and accident conditions,

   b. Component redundancy so that the system can operate assuming a single active component failure coincident with the LOOP, and

   c. The capability to isolate components, systems, or piping so that system safety function will not be compromised.

   d. The cooling water supply to the reactor coolant pump (RCP) seals meets the recommendations of NUREG-0737, Item II.K.3.25 (USNRC 1980).

5. General Design Criterion 45, as it relates to design provisions made to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as it relates to design provisions made to permit operational functional testing of safety-related systems and components to ensure:

   a. Structural integrity and system leak tightness,

b. Operability and adequate performance of active system components, and

c. Capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

7. Regulatory Guide 1.26, as it relates to the quality group classification of systems and components.

8. Regulatory Guide 1.29, as it relates to the seismic design classification of system components.

9. Regulatory Guide 1.46, as it relates to pipe whip inside the containment.

10. Branch Technical Position ASB 3-1, as it relates to breaks in high and moderate energy piping systems outside containment.

11. The system shall supply sufficient cooling water at 106°F maximum during normal operations and at 120°F maximum during initial shutdown and initial accident conditions using service water as the cooling medium.

12. The flow paths can be physically separated and isolated from each other by operator action following a passive failure.

13. The portions of the svstem required for cold shutdown or to provide cooling for spent fuel are designated Safety Class 3.

9.2.2.1.2 System Description

The primary CCW system consists of a Safety Class 3 portion which supplies cooling water to Safety Class 3 components, and a non-nuclear safety (NNS) class portion which supplies cooling water to NNS class components. The NNS class portion is isolated automatically on a containment isolation Phase A (CIA) signal or low surge tank level.

The CCW pumps, heat exchangers, and surge tanks are located in the auxiliary building. Components cooled by the system are located in the containment, fuel building, auxiliary building, waste handling building, and main steam valve area (Table 9.2-4).

The primary CCW heat exchangers, pumps, and component cooling surge tanks are Seismic Category I. The pump motors and electrical equipment are environmentally qualified for normal, abnormal, and accident operation as described in Section 3.11. The valves and

interconnecting piping between the previously mentioned components are Seismic Category I. The RHR heat exchangers, RHR pump seal coolers, fuel pool heat exchangers, the valves and interconnecting piping between the aforementioned components are Seismic Category I. The component cooling piping connecting these components with the CCW pumps and heat exchangers is Seismic Category I.

The largest primary CCW heat load occurs during Beaver Valley Power Station Unit 2 (BVPS-2) cooldown when the RHR system (Section 5.4.7) is initially placed in operation. The three CCW heat exchangers and three CCW pumps must be in operation to achieve the minimum cooldown time. A slower but acceptable cooldown rate can be maintained with a minimum of one CCW heat exchanger and one CCW pump. The cooldown rate is discussed in Section 5.4.7.

During normal operation, two primary CCW pumps and two primary CCW water heat exchangers can transfer the design heat loads from all components served, simultaneously with the service water temperature at its maximum. During most operating conditions, only one pump will be required.

Each cooling water outlet line from a component contains a valve for controlling flow. The valve is either a manually-operated valve of the globe, butterfly, or ball type, or an automatic type that is positioned by pressure or temperature control signals originating in the cooled systems. Plate type restrictive orifices in the supply or discharge piping of some of the equipment also act to control the flow to the component.

A chemical addition tank is connected to the discharge piping of the CCW pumps. To add chemicals to the system, the tank is isolated, drained down, and filled with the necessary chemicals. The isolation valves are then opened, and the discharge pressure of the pump will force water into the tank and inject the mixture into the system at the pump suctions via the surge tank.

Sampling is performed at the sampling station in the auxiliary building. Several local sample points are also provided.

9.2.2.1.3 Safety Evaluation

The primary CCW system is not required in the short term to mitigate the consequences of accidents (Chapter 15). The effects of a loss of cooling water on fuel pool cooling are discussed in Section 9.1.3. The CCW must be supplied to the RHR heat exchangers in the long term to bring BVPS-2 to a cold shutdown condition.

During normal operation, cross-ties between redundant flow paths are open. Valves are provided to allow isolation of redundant flow paths and the NNS class portions of the system, if required, ensuring that at least one primary CCW pump and heat exchanger can supply cooling to one RHR heat exchanger in the long term.

Low flow, low pressure, high temperature, or high radioactivity level alarms alert the operator to malfunctions. If the malfunction causing low flow, low pressure, or high temperature is not corrected, components and systems served by the primary CCW system may be inadequately cooled. The affected components and systems can be protected either automatically or through operator action (Section 9.2.2.1.5).

One of three 100-percent capacity pumps supplies the system with sufficient cooling water during normal BVPS-2 operation. The CCW pump 2CCP*P21A is connected to emergency bus 2AE while pump 2CCP*P21B is connected to emergency bus 2DF. Pump 2CCP*P21C may be operated from either emergency bus. To prevent a tie between these redundant emergency buses, a two-key interlock is provided (Section 8.3.1). Redundancy in the system ensures performance of the cooling function in the event of a single failure.

For normal plant operation, the primary CCW water system can maintain the CCW supply temperature below 106°F when the service water temperature is less than 89°F.

During plant cooldown operation, due to the initially high reactor coolant system temperature and the sensible and decay heat load imposed by the reactor coolant system via the RHR heat exchangers, the component cooling temperature is permitted to rise to 120 degrees F. This maximum temperature is controlled by regulating the reactor coolant flow through the RHR heat exchangers during the early stages of cooldown. As the cooldown progresses, the reactor coolant temperature drops, the sensible and decay heat loads decrease, and the component cooling temperature returns to normal levels.

The principal method of leak detection for loss of water from the primary CCW system is by the records of addition of water to the system to maintain the water level in the surge tanks. Temperature, level, and flow indicators in the main control room may be used to detect leakage at certain system points. Elsewhere, leaks can be located by manual inspection or by isolation.

Welded construction is used extensively throughout the system to minimize the possibility of leakage from pipes, valves, and fittings.

In the unlikely event of a header rupture, the cooling capacity of the system may be lost until the break can be isolated and the levels in the surge tanks are restored. The operator will be alerted to a major loss of CCW by annunciation in the main control room on low surge tank level. Following a loss of water, at least one flow path can be returned to service to supply cooling water to the RHR system within 36 hours.

In the event of a loss of CCW to the RCPs, indication will be provided in the main control room from flow transmitters on the outlet of each CCW line from the pumps. Low flow to the upper bearing coolers, lower bearing coolers, or the stator air coolers will actuate a common trouble alarm in the main control room. The operators can initiate manual protection of BVPS-2 within 10 minutes to prevent damage to the RCPs if the CCW flow is not restored to the bearing oil coolers within this time.

Inleakage to the system can be detected from records of the discharge of water to maintain the level in the surge tanks.

A radiation monitor (Section 11.5) is provided at the inlet to the primary CCW heat exchangers. The primary CCW system is not normally expected to contain radioactive water. Small amounts of leakage resulting in contamination could result from the leakage in a heat exchanger in the CVCS, RHR system, or sampling system, or from a leak in the thermal barrier of a RCP. Provisions are made, however, to preclude the possible spread of radioactive contamination in the event that a primary CCW leak should occur. These precautions

include isolation of each heat exchanger by manual shutoff of the inlet and outlet CCW valves.

Air-operated trip valves are installed in the outlet cooling water lines from the RCPs' thermal barriers. A check valve is installed in each inlet cooling water line to the thermal barriers. In the event that a leak occurs in the thermal barrier cooling coil, a high pressure or flow alarm annunciates in the main control room, and the high pressure reactor coolant is safely contained by automatic closure of the isolation valve. Any leakage and water samples from these heat exchangers is treated as radioactive and returned to the liquid waste disposal system (Section 11.2.4) via the auxiliary building sump pumps.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I&C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Standard 279-1971 requirements are satisfied, has been performed on the primary CCW system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

The containment isolation valve arrangement and signals which cause valve closure for the primary CCW system are described in Section 6.2.4, and are tested as described in Section 6.2.6.

9.2.2.1.4 Inspection and Testing Requirements

The primary CCW system is inspected in accordance with applicable ASME III requirements during construction to ensure proper installation. All components are inspected prior to installation to ensure that they comply with their ASME design specification. All safety class pumps and valves undergo inservice testing, as specified in Section 3.9.6. Preoperational tests are performed as described in Section 14.2.12.

9.2.2.1.5 Instrumentation Requirements

Control switches with indicating lights are provided in the main control room and at the ESP for the primary CCW pumps. Transfer from the main board to the ESP is effected by means of a pushbutton at the ESP. Transfer back to the main board is effected by means of a local manual reset at relay. Normal operation consists of one pump operating, with the second pump available for an automatic backup. The third pump during normal operation is arranged for manual standby. During periods of normal operation which require two operating pumps, the third pump is available for automatic backup. These pumps are automatically stopped on a containment isolation phase B (CIB) signal.

One primary CCW pump is provided with a control switch with indicating lights on the alternate shutdown panel (ASP) for manual

control. Transfer from the main board or the ESP to the ASP is effected by means of a pushbutton at the ASP. Transfer back to the main board or the ESP from the ASP is effected by means of a local manual reset at relay.

Control switches with indicating lights are provided in the main control room for the primary CCW header isolation valves. These valves close automatically on a CIB signal.

The primary CCW pumps have their discharge pressure indicated in the main control room.

Each pump differential pressure control valve is operated automatically or manually to maintain minimum flow requirements. The primary CCW heat exchanger outlet temperature is maintained by independent heat exchanger bypass temperature control valves. These temperature control valves permit primary CCW to bypass the heat exchangers. A differential pressure control valve in series with each heat exchanger can be operated manually or automatically to maintain a constant pressure drop across the temperature control valves.

Hand/automatic control stations are provided in the main control room for the operation of the differential pressure control valves and the temperature control valves.

Hand/automatic control stations are also provided in the main control room for the primary CCW system surge tank level control valves. These valves modulate to admit water to their respective surge tanks.

The levels of the CCW surge tanks are controlled at their centerlines. Each is sufficient to accommodate minor system surges and thermal swell. Makeup from the demineralized water system or primary grade water system is admitted to each tank through individual air-operated valves controlled automatically or by the control room operator. A local station is provided for the manual operation of the letdown of the levels in the surge tanks.

Ammeters are provided in the main control room for each of the CCW pumps.

Main control room indication is provided for CCW heat exchangers discharge temperatures, CCW pumps differential pressures, and CCW supply header flow. The CCW surge tanks also have level indication in the main control room.

Annunciation is provided in the main control room for primary CCW pump auto-start/auto-stop; primary CCW system trouble, which consists of CCW header pressure low, CCW surge tank level high or low, and CCW heat exchanger discharge temperature high; radiation level high; control at ESP alarm for the cooling water pumps; and control at ASP for the cooling water pump. These are also monitored by the BVPS-2 computer system. The CCW pumps' discharge pressure is monitored by the BVPS-2 computer.

9.2.2.2 Chilled Water System

The chilled water system is nonsafety-related and is designated as non-nuclear safety (NNS) class. This system provides chilled water to the following cooling coils and equipment:

1. Refueling water storage tank (RWST) coolers.

2. Cooling coils of the reactor containment air recirculation unit.

3. Containment test skid air compressor after coolers and water jackets.

4. Gaseous waste system coolers, waste gas system air ejector vent cooler, and sweep gas chiller.

5. Turbine plant sampling system.

6. Air conditioning units of the following areas:

    a. Auxiliary building,

    b. Pipe tunnel,

    c. Fuel building,

    d. Control building,

    e. Cable vault and rod control areas,

    f. Condensate polishing building,

    g. Waste handling building,

    h. Charcoal delay bed cubicles, and

    i. Main steam valve house cooling coils

7. Post-accident sampling system.

8. Hot water heating system pumps.

9.2.2.2.1 Design Bases

The design bases for the chilled water system are as follows:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of the chilled water system is shared.

3. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

4. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components.

5. The chilled water system is designed for the full cooling capacity requirement of the previously listed building areas and components during normal plant operation. It is based on an outside design air temperature of 90°F and chilled water being supplied to all cooling coils and equipment at a temperature of 45°F.

6. That service water at a maximum temperature of 89°F is used as a heat sink.

7. The chilled water system piping is designed to meet the requirements of ANSI B31.1.

9.2.2.2.2 System Description

The chilled water system is shown on Figure 9.2-1 and the principal components and design parameters are given in Table 9.2-6.

The system consists of three 50-percent capacity centrifugal chiller units and circulating pumps, two expansion tanks, an air separator, and related distribution chilled water piping. Condenser cooling water is provided from the SWS as described in Section 9.2.1. The chilled water system is a recirculated closed loop system where any variation in water volume, due to temperature changes and component cycling effect, is accommodated by expansion tanks. The expansion tanks are connected to the suction side of the pumps.

System makeup is provided from the demineralized water system (Section 9.2.3). The three chilled water pumps discharge to a common discharge header and take suction from a common return header. A chiller unit cannot be started unless there is water flow in the system. Chilled water flows from the chiller units to a common header which supplies chilled water at 45°F to system components and approximately 40°F, if required, at the end of refueling during the RWST cooldown.

9.2.2.2.3 Safety Evaluation

The chilled water system is nonsafety-related. Failure of this system will not affect the safe shutdown of the plant.

Safety-related service water or the supplementary leak collection and release system provide cooling for the safety-related areas requiring space cooling after a CIB signal, as described in Sections 9.4.1.1 and 9.4.12.2.

9.2.2.2.4 Inspection and Testing Requirements

The chilled water system piping and equipment is inspected and operated following initial installation to ensure the components are installed properly. Specific tests of the system following initial operation checkout are described in Section 14.2.12.

The chilled water system is in continuous operation, thus periodic testing is not required. Chillers and pumps are alternated in service periodically. Components are accessible for routine visual observation during normal operation.

Preliminary tests are performed as described in Section 14.2.12.

9.2.2.2.5 Instrumentation Requirements

Control switches with indicating lights are provided for the chilled water pumps and condenser water booster pumps at the local water chiller control panel.

Selector switches with indicating lights are provided for the water chillers at the local water chiller control panel. Indicating lights are also provided at this panel for the chilled water pump discharge valves. The valves will open when the chilled water pumps start and close when the chilled water pumps stop.

A chilled water system pressure differential valve is provided and will be modulated by chilled water supply and return header pressure.

A condenser water temperature control valve is provided and will be modulated by booster pump discharge header temperature to return the chiller condenser discharge to the booster pump suction.

A condenser water pressure control valve is provided and will be modulated by the booster pump suction/discharge header differential pressure. This allows the chiller condenser discharge to circulate the water discharge line to maintain a constant pressure differential across the condenser water booster pumps.

Chiller lube oil pumps are provided and will start when the water chiller is running and stop when the water chiller is stopped.

A lube oil sump heater is provided and will be energized on a low lube oil temperature and will be de-energized on a normal lube oil temperature.

A cooling water inlet valve to the lube oil cooler is provided and will open when the water chiller is running and will close when the water chiller is stopped.

Compressor inlet guide vanes are provided and will be modulated by chilled water temperature and by the chiller motor current. The vanes will be opened when the water chiller is running and will close when the water chiller is stopped.

A hot gas bypass valve is provided and will be opened when the chilled water return temperature is low and will close when the chilled water return temperature is normal.

The chilled water pumps, condenser water booster pumps, and the water chillers are manually started. The water chillers start when there is sufficient chilled water flow in the system.

Temperature indication is provided in the main control room for chilled water return header temperature.

Annunciation is provided in the main control room for water chiller circulating/booster pump auto trip and water chiller control panel trouble, which has the following inputs: expansion tank level high, expansion tank level low. Local panel status lights are provided with the following inputs to the water chiller control panel trouble annunciator: chilled water outlet temperature low, lube oil pressure low, chilled water flow low, condenser water flow low, chiller motor electrical protection trip, condenser pressure high, refrigerant temperature low, bearing temperature high, impeller displacement excessive, and compressor discharge gas temperature high. The annunciators are also monitored by the BVPS-2 computer system.

A local control panel is also provided for the water chillers. Pushbuttons, switches, thermostats, and status lights are provided for chiller operation.

9.2.2.3 Neutron Shield Tank Cooling Water System

The neutron shield tank cooling water system is a closed loop system consisting of a natural convection cooler and associated piping connecting the neutron shield tank (Section 5.4.14). The neutron shield tank cooling water system is safety-related and Seismic Category I.

9.2.2.3.1 Design Basis

The neutron shield tank cooling water system is designed to circulate and cool the water in the neutron shield tank, which is heated by neutron, gamma, and thermal radiation. When filled, the neutron shield tank provides additional neutron absorption and a thermal barrier for protection of the surrounding concrete.

The neutron shield tank cooling water system is designed in accordance with the following criteria:

1. Regulatory Guide 1.26, as it relates to the quality group classification of systems and components.

2. General Design Criterion 2 and Regulatory Guide 1.29, as they relate to the seismic design and seismic classification of system components.

3. General Design Criteria 45 and 46, as they relate to the testing and inspection of this system.

4. The piping of the system, except as noted in Item 6 as follows, is designed to ASME III standards. The design data of the major components of the neutron shield tank cooling water system are given in Table 9.2-7.

5. The corrosion control tank and associated piping are Quality Assurance Category II, ASME VIII, 1971 Edition, including all addenda to Winter, 1972, and ANSI B31.1, 1967 Edition, including all addenda through June 30, 1972, respectively.

9.2.2.3.2 System Description

The system is comprised of a neutron shield tank cooler, a neutron shield surge tank, a corrosion control tank, and the necessary piping and valves. The entire system is housed in the containment building.

The neutron shield tank cooling water system is designed as a thermo-siphon system. The heated water in the neutron shield tank rises due to natural circulation to the top of the tank and flows via interconnecting piping to the neutron shield tank cooler. The heated neutron shield tank water is cooled as it circulates down through the neutron shield tank cooler by primary CCW passing in counterflow through the shell side of the cooler. One full-duty neutron shield tank cooler is provided to perform the required cooling. A surge tank accommodates thermal expansion in the neutron shield system and a corrosion control tank is used for the addition of corrosion inhibitors by manual operation.

9.2.2.3.3 Safety Evaluation

Operation of the neutron shield tank water cooling system is not required for unit cooldown or for safe shutdown of BVPS-2.

A malfunction of the neutron shield tank cooling water system is improbable. The neutron shield tank cooling water system has no moving parts, so that a malfunction can occur only by loss of water due to leakage, loss of natural convection circulation, or low heat

transfer caused by fouling. Clogging of the system is unlikely due to the cleanliness level of the supply water from the primary CCW system. Since the neutron shield tank cooling system operates at a low system pressure, a pipe break is also unlikely. Should a pipe break occur, makeup water would be supplied to the system following a low water level indication from the surge tank water level transducer.

As a result of a loss of water from the neutron shield tank, neutron shielding would be decreased if water was not made up. This would be indicated by a low expansion tank level alarm or shield water temperature indication; however, no hazardous conditions would result. Operation of the neutron shield tank water cooling system is not required for unit cooldown or for safe shutdown of BVPS-2.

Although the neutron shield tank cooling water system is a safety-related system, it contains no electrically controlled components whose failure would affect the safety of BVPS-2. For that reason, no failure modes and effects analysis was performed on the instrumentation and controls and electrical portions of this system.

9.2.2.3.4 Inspection and Testing Requirements

The neutron shield tank cooling water system is inspected in accordance with the applicable code requirements during construction. Inservice inspection of the system is inappropriate because the system contains no moving parts, has adequate instrumentation to remotely verify correct operation, and is inaccessible during unit operation. Preoperational tests are performed as described in Section 14.2.12.

9.2.2.3.5 Instrumentation Requirements

A selector switch with indicating lights is provided in the main control room for the neutron shield tank cooling water makeup valve. This valve is operated manually. The primary CCW system provides water to the neutron shield tank cooling water system for filling and makeup.

A control switch with indicating lights is provided in the main control room for the neutron shield tank cooler cooling water supply valve. This valve is operated manually.

A temperature indicator is provided in the main control room for the neutron shield tank outlet temperature.

A level indicator is provided in the main control room for the neutron shield expansion tank level.

Annunciation is provided in the main control room for neutron shield expansion tank level low and temperature high. Each condition is monitored by the BVPS-2 computer system.

The BVPS-2 computer monitors the neutron shield tank outlet temperature, neutron shield tank cooler outlet temperature, and neutron shield tank cooler cooling water outlet temperature.

9.2.3 Demineralized Water Makeup System

The demineralized water makeup system is a nonsafety-related system that supplies water to the reactor plant and turbine plant systems listed below for makeup to tanks, sample sink flushing, and other miscellaneous requirements during all modes of operation. Demineralized water for the BVPS-2 makeup system is supplied from the BVPS-1 water treatment system. All water treatment is performed by the BVPS-1 water supply and treatment system described in the BVPS-1 FSAR, Section 9.11.

9.2.3.1 Design Bases

The demineralized makeup water system is designed in accordance with the following criteria:

1. The BVPS-2 shares the BVPS-1 demineralized water treatment system.

2. Each plant unit has a demineralized water storage tank with a nominal volume of 600,000 gallons, for a total shared capacity of 1.2 million gallons. Of the 600,000 gallons per tank, approximately 584,000 gallons is available with the tank full.

3. The BVPS-2 storage tank and distribution pumps are cross-tied with the BVPS-1 storage tank so that water can be transferred between units as necessary.

4. The system supplies demineralized water for makeup as delineated in Section 9.2.3.2.

5. The entire system is constructed of stainless steel and cleaned to Level B, in accordance with ANSI-N45.2.1, 1973 Edition.

6. The system is not safety-related and is designated non-nuclear safety.

7. The system is capable of functioning effectively with a single distribution pump operating.

8. Beaver Valley Power Station - Unit 1 has the capability to effectively store, handle, and dispense all chemicals used in the demineralizing and regeneration process associated with the water treatment system for BVPS-1 and BVPS-2.

9.2.3.2 System Description

The demineralized water makeup system principal component design and performance characteristics are listed in Table 9.2-8. The system consists of a 600,000 gallon storage tank and two 100 percent distribution pumps.

The 600,000-gallon demineralized water storage tank (DWST) receives water from the BVPS-1 water treatment system and stores it prior to distribution. The BVPS-1 demineralized water system, along with the BVPS-2 DWST and demineralized water storage pumps, is sufficient to supply makeup water to both units at all times, including periods of water treatment demineralizer regeneration and routine maintenance. A 6-inch line provides makeup water from the BVPS-1 system to the BVPS-2 storage tank. A return, utilizing the same 6-inch line, connects the BVPS-1 600,000 gallon tank and the BVPS-2 600,000 gallon DWST, via the BVPS-2 pumps' discharges so that water can be transferred between BVPS-1 and BVPS-2, as required. The BVPS-2 demineralized water is supplied to the following components and systems:

1. Cask washdown hose connections (Section 9.2.3).
2. Cask washdown spray ring (Section 9.1).
3. Primary component cooling water makeup (Section 9.2.2.1).
4. Leak collection filter seal tank (Section 9.4.16).
5. Primary sample sink washdown (Section 9.3.2).
6. Primary grade water system backup (Section 9.2.8).
7. Auxiliary feedwater system makeup (Section 10.4.9).
8. Jacket water expansion tank (Section 9.5.5).
9. Recirculation spray cooler tube flushing (Section 9.2.1.1).
10. Recirculation pump test loop (Section 6.2.2).
11. Hot water heating system makeup.
12. Turbine plant component cooling water makeup (Section 9.2.7).
13. Secondary demineralized water tank makeup (Section 9.2.6).
14. Backwash hold tank (Section 10.4.6).
15. Dewatering system flush (Section 10.4.6).

16. Condensate polishing precoating system (Section 10.4.6).

17. Containment vacuum and leakage monitor system (Section 9.5.10).

18. Containment instrument air compressors (Section 9.3.1.3).

19. Gaseous nitrogen system (Section 9.5.9).

20. Auxiliary steam activity monitor (Section 10.4.10).

21. Drum inspection and labeling station (Section 11.4).

22. Condensate demineralizer backwash feed tank (Section 10.4.6).

23. Supplement leak collection and release system (Section 6.5.3.2).

24. Condensate demineralizer sludge tank (Section 10.4.6).

25. Service water radiation monitor flush (Section 9.2.1).

26. Radioactive liquid discharge radiation monitor flush (Section 11.2).

27. Secondary chemical feed mixing tanks.

28. Turbine lube oil purifier (Section 10.2.2).

29. Primary component cooling water activity monitor (Section 9.2.2.1).

30. Primary chemical lab supply (Section 9.3.2.1).

31. Secondary chemical lab supply.

32. Post-accident sampling system.

33. Auxiliary boiler house (Section 10.4.10).

34. Chilled water system (Section 9.2.2.2).

35. Condensate pump seal water backup (Section 10.4.7).

NOTE: The demineralized water system is isolated from the primary grade water system via two normally closed isolation valves with tell-tale leakoff protection provided. This arrangement prevents possible contamination of demineralized water from the primary grade water system.

The water treatment systems are primarily enclosed within temperature-controlled buildings. Tanks and water treatment equipment located outside the building are provided with a means of temperature control so that the entire

system is capable of operating within the environment to which it is exposed.

9.2.3.3 Safety Evaluation

The demineralized makeup water system is not safety-related and the failure or malfunction of this system will not adversely affect the essential systems or components necessary for safe shutdown. The method of isolating the system and/or major system components is by manual isolation.

A nonsafety grade connection is provided to the primary DWST (Section 10.4.9) to allow gravity drain to that tank if additional volume is needed for auxiliary feedwater supply to the steam generators. The safety grade pressure boundary of the primary

demineralized water tank is maintained by a portion of Safety Class 2 piping and closed valves as described in Section 10.4.7.

9.2.3.4 Inspection and Testing Requirements

The demineralized water makeup system is inspected during construction to ensure proper installation. All components are inspected prior to installation to ensure that they comply with the applicable design specification. The demineralized water distribution system is hydrostatically tested after construction. System operability tests are performed as described in Section 14.2.12. The water supply and treatment systems are in continual use and, thus, do not require periodic testing beyond the normal observation and inspection during routine operation to ensure operability. Water samples are taken periodically from the demineralized water makeup system to determine pH value and possible contamination or deterioration. Pressure, temperature, and tank level are monitored periodically to verify proper system operation.

9.2.3.5 Demineralized Water Storage System Instrumentation Requirements

Control switches with indicating lights for the demineralized water distribution pumps are provided in the main control room. Interlocks will stop the pumps upon the loss of discharge header pressure. This is annunciated in the main control room as demineralized water distribution system trouble. This condition is also monitored by the BVPS-2 computer system.

There are two demineralized water distribution pumps rated at 350 gpm each. Under normal operating conditions, one distribution pump will take suction from the storage tank to provide the required demineralized water makeup, and the second pump will provide system backup.

The water storage tank makeup valve will modulate to maintain the required level. The tank high and low level alarm is annunciated in the main control room. These conditions are also monitored by the BVPS-2 computer system.

The level and temperature of the storage tank are continuously monitored in the main control room by indication, annunciation, and the BVPS-2 computer system.

Selector switches for the demineralized water storage tank heaters and heater pumps are provided locally. Interlocks will start and stop the heater and heater pumps on demineralized water storage tank temperature and heater pump discharge temperature. Local indicating lights are provided to indicate when the heaters and heater pumps are operating and when power is available to the heater and heater pumps.

9.2.4 Potable and Sanitary Water Systems

9.2.4.1 Design Bases

Domestic Water System

The domestic water system is designed to provide sufficient treated potable water from the Borough of Midland water system. This supply replaced the original water supply which was provided from onsite wells.

Potable water is distributed to plumbing fixtures, eye wash units, safety showers, and drinking water coolers throughout the station.

In accordance with General Design Criterion 60, the domestic water system is not connected to any system having the potential for containing radioactive material. The system is nonsafety-related and is designated NNS class. The principal components of the system are listed in Table 9.2-9.

Sanitary Sewerage System

The sanitary sewerage system is designed to collect sanitary waste from all plumbing fixtures except lavatories, sinks, and drains containing wastes which are potentially chemically or radioactively contaminated. The collected waste is conveyed to the offsite Shippingport Boro sewage treatment plant. Contaminated or potentially contaminated waste is collected in systems physically separate from the sanitary sewerage system and conveyed directly to the radioactive liquid waste treatment system.

9.2.4.2 System Description

Domestic Water System

Domestic (potable) water is supplied through a connection to a local municipal water system.

The BVPS-2 domestic water system has two 1,300 gallon capacity electric hot water heaters and one circulating pump to provide hot domestic water to the system. The hot water heaters and the hot water circulating pump are located in the BVPS-2 turbine building.

Sanitary Sewerage System

The BVPS sanitary sewerage system collects sanitary waste from plumbing fixtures throughout the station. The sewerage is conveyed to the offsite Shippingport Boro sewerage treatment facility that has sufficient capacity to process anticipated flow.

9.2.4.3 Safety Evaluation

The domestic water and sanitary sewerage systems are nonsafety-related. Operation of the domestic water supply and treatment system is not necessary for safety. There are no interconnections between the domestic water system and the sanitary sewerage system or any other process system having the potential for containing radioactive materials. There are no interconnections between the sanitary sewerage system and any other process system.

The domestic water system is protected by an air gap at all interfaces with the sanitary sewerage system and any other process systems.

9.2.4.4 Inspection and Testing Requirements

After installation, with all pipe joints exposed, the domestic water and sanitary sewerage systems are inspected and tested hydrostatically.

Testing requirements are described in detail in Section 14.2.12.

9.2.4.5 Instrumentation Requirements

Two hot water heating tanks are provided, each with a self-contained electric immersion heater and a local pushbutton with indicating lights for the manually-operated hot water circulating pump.

9.2.5 Ultimate Heat Sink

The ultimate heat sink (UHS) for BVPS-2 is the Ohio River (Section 2.4). The Ohio River will supply water to the SWS (Section 9.2.1.1) and the SSWS (Section 9.2.1.2).

9.2.5.1 Design Bases

The UHS meets the applicable requirements of the following criteria:

1. General Design Criterion 2, as it relates to structures housing the system, and the system itself being capable of withstanding the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods.

2. General Design Criterion 4, with respect to structures housing the system, and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to the capability of shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, to assure:

    a. The capability to transfer heat loads from safety-related structures, systems, and components to a heat sink during both normal operating and accident conditions,

    b. Component redundancy so that the safety function can be performed assuming a single active failure coincident with LOOP, and

    c. The capability to isolate components, subsystems, or piping, if required, so that the system safety function, will not be compromised.

5. General Design Criterion 45, as it relates to design provisions made to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as it relates to design provisions made to permit operational functional testing of safety-related systems and components to assure:

    a. Structural integrity and system leaktightness,

    b. Operability and adequate performance of active system components, and

    c. Capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

7. Regulatory Guide 1.27, as it relates to the requirements of the UHS.

8. Regulatory Guide 1.29, as it relates to the seismic design classification of system components.

9. The UHS meets the requirements of Branch Technical Position ASB 9-2, as it relates to the methods for calculating heat release due to fission product and heavy element decay.

10. The system shall provide water during normal operation, accident, and shutdown conditions at the flow rates,

temperatures and NPSH required by the SWS and the SSWS (Sections 9.2.1.1 and 9.2.1.2).

11. The SWS is designed to handle the loads at a maximum river water temperature of 89°F at either extremes of low river water level (el 648 ft-7 in) or the probable maximum flood (PMF) (el 730 feet). The design basis accident flows have been analyzed for the technical specification elevation limits, as described in Section 9.2.1.

9.2.5.2 System Description

The Ohio River is the UHS. The UHS, the SWS, and the SSWS have interfaces at the SWS intake structure, outfall structure, emergency outfall structure, and the SSWS intake structure all of which are shown on the site plan (Figure 1.2-1).

The Ohio River provides service water to both BVPS-1 and BVPS-2. The flow requirements for BVPS-2 are described in Section 9.2.1. The flow requirements for BVPS-1 are described in Chapter 9 of the BVPS-1 FSAR (Docket No. 50-334). The ability of the Ohio River to meet these flow requirements is discussed in Section 2.4.11.

The inlet water temperature is unaffected by the SWS heat loads, because the outfall structure is located sufficiently downstream of the intake structures to prevent recirculation (Section 2.4.11.6).

9.2.5.3 Safety Evaluation

The flow available for the Ohio River (Section 2.4.11) is large compared to the flow required for safe shutdown of both BVPS-1 and BVPS-2. Since the Ohio River is not man-made, QA and seismic categories are not applicable. The effects of transportation accidents, potential seismically-induced dam failures, ice formation, and channel diversions are discussed in Sections 2.2.3, 2.4.4, 2.4.7, and 2.4.9, respectively.

Technical Specifications and the Licensing Requirements Manual (Section 2.4.14) describe the procedures required in the event of extreme hydrological conditions.

9.2.5.4 Inspection and Testing Requirements

This section does not apply to the UHS.

9.2.5.5 Instrumentation Requirements

The Ohio River temperature can be determined from temperature indicators at several points in the SWS (Section 9.2.1).

The river level can be determined by a depth scale mounted on the outside of the intake structure.

9.2.6 Condensate Storage Facilities

The following tanks store demineralized water of condensate quality and comprise the condensate storage facilities: the DWST, the primary plant demineralized water storage tank (PPDWST), and the secondary plant demineralized water storage tank (SPDWST).

The 600,000 gallon DWST and the 140,000 gallon PPDWST are discussed in Sections 9.2.3 and 10.4.9, respectively.

The 200,000 gallon SPDWST is discussed below.

9.2.6.1 Design Bases

The SPDWST design bases are:

1. The SPDWST stores condensate quality water for makeup to the turbine plant condensate system.

2. The SPDWST is nonsafety-related and is designated NNS class.

   The tank material is ASTM A 240 Type 304 stainless steel or equivalent, and is designated in accordance with API 650 (modified) with an atmospheric design pressure.

3. Continued function of the SPDWST is not required for safe shutdown, and its failure could not reduce the function of any safety-related equipment.

4. The concentration of radioactivity in the SPDWST is within the limits for unrestricted liquids given in 10 CFR 20.

5. The SPDWST and its associated piping are designed in accordance with ANSI B31.1 (Summer 1972 Addenda) and are classified nonseismic.

6. All outside piping is heat-traced and the condensate stored in the SPDWST is recirculated through a heater to avoid freezing.

9.2.6.2 System Description

The 200,000 gallon SPDWST serves as a surge tank for the turbine plant condensate system. On low condenser hotwell level, condensate flows from the SPDWST through the makeup system to the condenser via gravity feed. On high condenser hotwell level, the excess condensate is transferred to the SPDWST by diverting some of the flow from condensate pumps back to the tank.

Freeze protection for the SPDWST consists of a 30 gpm storage tank heater pump, storage tank heater, and heat-traced lines. The heat

tracing is automatically activated when water in the line goes below 35°F. The storage tank heater and heater pump are automatically activated when the temperature in the tank goes below 45°F.

The SPDWST is filled from the 600,000 gallon DWST. Level in the SPDWST is automatically maintained by a level indicator in the tank that actuates a level control valve on the discharge side of the demineralized water distribution pumps.

9.2.6.3 Safety Evaluation

The SPDWST and its associated makeup and transfer piping are designated NNS class.

A failure of the SPDWST or a makeup and transfer system malfunction could not adversely affect essential systems or components necessary for safe shutdown under accident conditions.

Swales and catch basins in the yard area of the tank provide a minimum of 10,000 gpm drainage capacity, thereby providing adequate drainage capacity in the event of a tank rupture. Overflow from the tank is piped directly to a catch basin.

The condensate water may contain a small inventory of radioactive isotopes due to primary to secondary leakage, which enters the condenser as steam and the SPDWST after it is condensed. Radioactive secondary steam concentrations are presented in Section 11.1.

The environmental consequences of radioactive spills caused by tank failures are analyzed in Section 2.4.13.

9.2.6.4 Inspection and Testing Requirements

The SPDWST is hydrostatically tested after installation. Water samples are taken periodically from the SPDWST to determine oxygen content, pH value, and possible radioactive contamination. Pre-operational tests are performed as described in Section 14.2.12.

9.2.6.5 Instrumentation Requirements

The SPDWST water level is automatically controlled by a level controller. A level indicator is provided in the main control room to indicate SPDWST water level. High or low levels of water in the SPDWST will cause an alarm in the main control room and are monitored by the BVPS-2 computer system.

9.2.7 Turbine Plant Component Cooling Water System

The turbine plant component cooling water (TPCCW) system transfers heat from designated nonsafety-related turbine plant equipment to the station service water system (Section 9.2.1). The system is a

closed-loop system using treated demineralized water as cooling water; make-up is supplied from the demineralized water system.

9.2.7.1 Design Bases

The design basis of the TPCCW system is as follows:

1. The system is nonsafety-related and is designated NNS class.

2. The system supplies cooling water at a maximum temperature of 95°F to the components as listed in Table 9.2-10.

3. The system transfers heat to the SWS, which is at a maximum average inlet temperature of 89°F (Section 9.2.1.1).

4. The TPCCW pumps are designed in accordance with Hydraulic Institute Standards 1969 and ASME VIII dated 1971 including all addenda through Summer, 1972, for pressure retaining welds.

5. The TPCCW heat exchangers are designed in accordance with ASME Code for Boilers and Pressure Vessels Section VIII, Division 1 and also comply with the requirements of Tubular Exchange Manufacturers Association Standards.

6. The TPCCW surge tank is designed in accordance with API 650 dated June 1970, including Supplement No. 3, March 1972.

7. The piping system is designed in accordance with ANSI B31.1 dated 1967 including all addenda through June 30, 1972.

8. Table 9.2-11 lists design parameters of the subsystem components.

9.2.7.2 System Description

The TPCCW is pumped through shell- and tube-type heat exchangers where it is cooled by service water. The TPCCW passes from the shell side of the heat exchanger to the principal equipment listed in Table 9.2-10.

Two 100-percent capacity 11,400 gpm pumps and two 100-percent capacity heat exchangers are provided. This capacity is based on the maximum heat load which could occur during normal BVPS-2 operation with a service water inlet temperature of 83°F. Normal plant operation requires one pump and one heat exchanger, with the remaining equipment on standby. Should the service water inlet temperature rise above 83°F, the addition of a second heat exchanger operating in parallel is adequate to remove system heat loads, up to the design basis maximum service water inlet temperature of 89°F.

The TPCCW system is a closed-loop system. Variations in volume due to temperature changes are accommodated by a surge tank located at the pump suctions. The surge tank is situated such that it provides a net positive suction head for the pumps.

The entire system and the equipment cooled by the system, except as follows, are located in the turbine building: the evaporator reboiler drain coolers are located in the waste handling building; the condensate polishing air compressor and the condensate polishing sample cooler are located in the condensate polishing building. The auxiliary boiler sample coolers and auxiliary boiler blowdown vent condenser are in the auxiliary boiler enclosure located in the south office and shop building.

Thermal relief valves are provided on those portions of the system which might be overpressurized by a combination of closed cooling water valves on the inlet and outlet of equipment and heat input from the isolated equipment.

The surge tank capacity of 3,173 gallons is sufficient to accommodate minor system surges and thermal swell. Makeup is supplied from the demineralized water system (Section 9.2.3). An automatic, air-operated valve controls makeup flow to the surge tank. A chemical addition tank is connected to the pump discharge piping. To add chemicals to the system, the tank is isolated, drained, and filled with the desired chemicals. The tank isolation valves are then opened and the discharge pressure of the operating pump forces water through the tank, injecting the mixture into the common return line from the equipment served, and to the pumps. The desired water chemistry is obtained by the addition of appropriate chemicals for corrosion inhibition and pH control.

Service water is pumped from the Ohio River through the tube side of the TPCCW heat exchangers and is returned to the circulating water discharge line from the main condensers.

9.2.7.3 Safety Evaluation

A failure of this system will not affect the integrity of any safety-related equipment because it does not perform a safety function and does not provide cooling water to any safety-related equipment.

The station air-compressors are the only equipment requiring cooling water during plant shutdown and/or LOOP. These compressors are required for operation and maintenance reasons. Under TPCCW shutdown conditions, air compressor jacket cooling water and water for the after coolers is supplied from the domestic water system. A backup service water supply for the station air compressor is provided through a connection between the service water and TPCCW systems (Section 9.2.1).

9.2.7.4 Inspection and Testing Requirements

During the life of BVPS-2, all portions of the system are either in continuous or intermittent operation and performance tests are not required. Components are accessible for observation during routine operation, and following installation of spare parts or piping modifications to confirm normal operation of the system. Preoperational tests are performed as described in Section 14.2.12.

9.2.7.5 Instrumentation Requirements

The TPCCW pumps are controlled from the main control room via individual control switches with appropriate indicating lights. Automatic starting and stopping of the pumps is annunciated in the main control room and this annunciation is also monitored by the BVPS-2 computer.

A minimum flow protection for the TPCCW pumps is provided by a flow control valve which opens when the discharge header flow is low and closes when discharge header flow is normal.

The TPCCW pumps low discharge header pressure is annunciated in the main control room by a common annunciator and monitored by the BVPS-2 computer. This low pressure signal automatically starts the standby pump.

A TPCCW temperature control valve will modulate to bypass cooling water around the heat exchangers.

A TPCCW differential pressure control valve will modulate to maintain a predetermined pressure across the heat exchangers.

The TPCCW heat exchanger high discharge temperature is also annunciated in the control room by a common annunciator and monitored by the BVPS-2 computer.

The TPCCW surge tank levels, high-high, and low-low, are annunciated in the control room by a common annunciator and monitored by the BVPS-2 computer.

The cooling water flow through the major equipment coolers, such as the hydrogen and oil coolers, is controlled automatically to maintain the cooled fluid at a constant temperature. Cooling water supply and return piping for each component contain valves and/or restricting orifices for flow control. The valves are either manually-operated (positioned before BVPS-2 start-up), or automatically air-operated (positioned by temperature control signals originating in the cooled system).

9.2.8 Primary Grade Water System

The primary grade water system is shared with BVPS-1. Two full capacity primary water pumps supply water from two BVPS-1 primary grade water storage tanks for both BVPS-1 and BVPS-2. The two tanks have sufficient capacity to meet the requirement of both BVPS-1 and BVPS-2. The tanks and pumps are located at BVPS-1. The primary grade water system is nonsafety-related.

9.2.8.1 Design Bases

The following constitute the design bases for the primary grade water system:

1. The two BVPS-1 primary grade water storage tanks provide sufficient storage capacity to supply the required makeup water to the reactor coolant system (RCS) via the chemical and volume control system (CVCS) (Section 9.3.4), and to store recovered water from the BVPS-1 boron recovery system (BRS) and the BVPS-1 and BVPS-2 radioactive liquid waste systems (Section 11.2).

2. The two storage tanks (BVPS-1) contain sufficient water to provide the makeup required for plant start-up through 90 percent of equilibrium fuel cycle, and will still be 10 percent full after the start-up operation is complete, with no additional makeup water added to the tanks or system. This requirement is approximately 150,000 gallons.

9.2.8.2 System Description

Primary grade water consists principally of processed radioactive liquid waste and reactor coolant letdown which has been stripped of dissolved gases and processed in the BRS of BVPS-1. Primary grade water is used exclusively in the reactor plant systems; it is not provided to turbine plant systems.

The BVPS-2 primary grade water is supplied from BVPS-1, which has two 75,000-gallon vertical stainless steel tanks for primary grade water storage. Both tanks are equipped with a floating diaphragm roof which rides on the tank water level, thus isolating the water surface from the atmosphere and minimizing the amount of gases dissolved in the water. Each tank is also provided with the following: an atmospheric vent on the gas space above the floating roof, an external thermosiphon heater with an internal horizontal sparger on the hot leg tank entry, pump suction and recycle line connections, level indicators and alarms, and a temperature controller.

The primary grade water storage tanks are supplied with water from the BRS test tanks. Station demineralized water is used for makeup to the primary grade water storage tanks.

The BVPS-1 primary grade water supply pumps, each rated at 200 gpm and 310 feet TDH, obtain suction from the primary grade water storage tanks and discharge to the primary grade water supply header. The normal mode of operation is both tanks and one pump aligned to maintain the primary grade system supply pressure for use on both BVPS-1 and BVPS-2.

The BVPS-2 primary grade water supply header provides primary grade water for the following purposes:

1. Makeup to the RCS via the chemical mixing tank and boric acid blender of the CVCS.

2. Supply to the radioactive solid waste system for spent resin flushing (Section 11.4).

3. Makeup to the spent fuel pool (Section 9.1.2) to compensate for evaporative losses.

4. Supply to the following equipment:

    a. Boric acid batching tank,

    b. Primary component cooling water surge tank fill,

    c. Pressurizer relief tank,

    d. Steam generator blowdown evaporator flush and evaporator sample flush,

    e. Steam generator blowdown evaporator bottoms piping and hold tank flush,

    f. Boric acid transfer pump,

    g. Chemical and volume control demineralizer flush, cesium removal, and fuel pool ion exchanger flush, and

    h. Flush to cleanup ion exchangers.

5. Provide seal injection water for the following pumps:

    a. Steam generator blowdown evaporator bottoms pumps,

    b. Steam generator blowdown evaporator circulation pumps,

c. Steam generator blowdown evaporator bottoms hold tank pump,

A connection is provided from the demineralized water header to the primary grade water header such that demineralized water can serve as an alternate supply of water. A sample connection is also provided for periodic sampling and analysis as required.

9.2.8.3 Safety Evaluation

The primary grade water system function is nonsafety-related. However, it is important for normal plant operation to provide a reliable source of water for reactor coolant makeup. The use of two primary grade water storage tanks prevents contamination of the entire primary grade water supply at any time. With test tanks in the BVPS-1 boron recovery and BVPS-1 and BVPS-2 radioactive liquid waste systems, potential for contamination of the contents of either primary grade water storage tank is minimized.

9.2.8.4 Inspection and Testing Requirements

A program of testing and inspection ensures the design basis capability of the primary grade water system throughout its lifetime. Standby pumps are operated periodically, and equipment is visually examined at appropriate intervals to ensure its availability. Pre-operational tests are performed as described in Section 14.2.12.

9.2.8.5 Instrumentation Requirements

All instrumentation required for the primary grade water tanks, pumps, and supply header is provided at BVPS-1. Local flow indicators are supplied in the pump seal water injection lines to the evaporator circulation pumps, the evaporator bottoms pumps, and the steam generator bottoms hold tank pump.

9.2.9 Reference for Section 9.2

U.S. Nuclear Regulatory Commission (USNRC) 1980. Clarification of TMI Action Plan Requirements. NUREG-0737.

USNRC February 24, 2003. Safety evaluation by the Office of NRR related to Amendment 132 of the operating license (describes commitment regarding flow rate surveillance of RSS heat exchangers).

Tables for Section 9.2

TABLE 9.2-1

STATION SERVICE WATER SYSTEMS
COMPONENT DESIGN DATA

Component	Design Parameters
Service Water Pumps	
Quantity	3
Type	Vertical turbine
Motor, (hp) each	900
Seals	Packed
Rated capacity (gpm)	15,000
Head at rated capacity (ft. of water)	190
Design pressure (psig)	150
Design temperature (°F)	100
Materials[f] (ASTM numbers)	
Bowls or diffusers	SA216 WCB
Shaft	A-479 TP 410 CL2
Impellers	B148 UNS C95800
Discharge column	SA515 GR 70
Head assembly	SA515 GR 70
Condenser Water Booster Pumps	
Quantity	2
Type	Horizontal/centrifugal
Motor, (hp) each	75
Seals	Mechanical
Rated capacity (gpm)	4,500
Head at rated capacity (ft of water)	55
Design pressure (psig)	250
Design temperature (°F)	250
Materials[f] (ASTM numbers)	
Casing	A48 C1 30
Shaft	A576 Gr. 1045
Impeller	B143 Alloy
Standby Service Water Pumps	
Quantity	2
Type	Vertical turbine
Motor, (hp) each	1,250
Seals	Stuffing box
Rated capacity (gpm)	15,000
Head at rated capacity (ft of water)	200
Design pressure (psig)	175
Operating temperature range (°F)	32-89

TABLE 9.2-1 (Cont)

Component	Design Parameters
Materials[1] (ASTM numbers)	
Suction bell	A48 C1 30
Shaft	A582, Type 416
Impeller	B584/932
Discharge column	A106, GR. B
Bowls and diffuser	A48 C1 30
Wash Water Booster Pump	
Quantity	1
Type	Vertical/centrifugal
Motor, (hp)	15
Seals	Mechanical
Rated capacity (gpm)	300
Head at rated capacity (ft of water)	120
Design temperature (°F)	90
Materials[1]	
Casing	A395 GGO-40-18
Shaft	A322 GR.4140
Impeller	A296 CF8M
Emergency Diesel Generator Chemical Addition Pumps	
Quantity	2
Type	Vertical/centrifugal
Motor, (hp) each	1.5
Seals	Packing
Rated capacity (gpm)	10
Head at rated capacity (ft of water)	14
Design temperature (°F)	87
Materials[1]	
Casing	Ductile iron
Shaft	316 SS
Impeller	Ductile iron

TABLE 9.2-1 (Cont)

Component	Design Parameters
Control Room Refrigerant Condenser Recirculation Pumps	
Quantity	2
Type	Horizontal/centrifugal
Motor, (hp) each	1
Seals	Packing
Rated capacity (gpm)	45
Head at rated capacity (ft of water)	20
Design temperature (°F)	104
Materials[1] (ASTM numbers)	
Casing	SA351 CF8M
Shaft	A276, Type 316
Impeller	A744 CF8M

NOTES:

(1) Materials listed in this table may have been replaced with materials of equivalent design characteristics. The term equivalent is described in UFSAR Section 1.12, "Equivalent Materials".

TABLE 9.2-2

SERVICE WATER SYSTEM FLOW REQUIREMENTS

Component (Mark No) [No. of Components]	Normal Operating Condition		Loss of Power (LOOP) Shutdown				DBA Coincident with LOOP			
			Minimum System Flow		Normal System Flow		Minimum System Flow		Normal System Flow	
	No. of Comp. Operating	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)
Recirculation spray coolers (2RSS*E21A,B,C,D) [Total 4]	0	0	0	0	0	0	2	10,600(8)	4	22,000(8)
Emergency diesel generator coolers (2EGS*E21,22,A,B) [Total 2]	0	0	1	625	2	1,250	1	625	2	1,250
Primary component cooling wtr ht exch (2CCP*E21A,B,C) [Total 3]	2	10,988	1	5,494	2	10,988(2)	0(1)	0	0(1)	0
Secondary component cooling wtr ht exch (2CCS-E21A,B) [Total 2]	1	10,988	0	0	0	0	0	0	0	0
Centrifugal water chillers (2CDS-CHL23A,B,C) [Total 3]	2	4,500	0	0	0	0	0	0	0	0
Charging pump coolers (2CHS*E25A,B,C) [Total 3]	2	40	1	20	2	40	1	20	2	40
Rod control area ac units (2HVR*ACU208A,B) [Total 2]	0	0	0	0	0	0	0	0	0	0
Safeguards area ac units (2HVR*ACU207A,B) [Total 2]	2	240	1	120	2	240	1	120	2	240

TABLE 9.2-2 (Cont)

Component (Mark No) [No. of Components]	Normal Operating Condition		Loss of Power (LOOP) Shutdown: Minimum System Flow		Loss of Power (LOOP) Shutdown: Normal System Flow		DBA Coincident with LOOP: Minimum System Flow		DBA Coincident with LOOP: Normal System Flow	
	No. of Comp. Operating	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)
Containment air recirculation cooling coils (2HVR-CLC201A,B,C) (See Note 7)	0	0	0	0	0	0	0	0	0	0
Control room refrigerant condensers(3) (2HVC*REF24A,B) [Total 2]	1	100	1	100	1	100	1	100	1	100
Control room ac units(3) (2HVC*ACU201A,B) [Total 2]	1	95	1	95	1	95	1	95	1	95
Alternate shutdown panel room ac unit	0	0	1	17	1	17	0	0	0	0
Motor control center cooling coils (2HVP*CLC265A,B) [Total 2]	2	10	1	5	2	10	1	5	2	10
Recirculation Spray Heat Exchanger Radiation Monitor Coolers (2SWS-RQI100A,B,C,D) [Total 4]	0	0	0	0	0	0	2	14.2	4	28.4

TABLE 9.2-2 (Cont)

	Normal Operating Condition		Loss of Power (LOOP) Shutdown				DBA Coincident with LOOP			
			Minimum System Flow		Normal System Flow		Minimum System Flow		Normal System Flow	
Component (Mark No.) [No. of Components]	No. of Comp. Operating	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)	No. of Comp.	Req'd (gpm)
	No. Oper.	Flow	No. Oper.	Flow	No. Oper.	Flow	No. Oper.	Flow	No. Oper.	Flow
Service water pumps(3) (2SWS*P21A,B,C) [Total 3]	2	27,016	1	6,361(4)	2	12,605(2)	1	11,864.2(5)	2	23,628.4(5)

Notes:

(1) After CIB signal is reset, system will be returned to a cooldown mode. Flow will be supplied to the primary CCW heat exchangers to remove cooldown heat loads.
(2) The third primary CCW heat exchanger may also be used.
(3) The total flow does not include the flow for the control room ac unit since it does not run concurrently with the control room ac refrigerant condensers. The minimum acceptable condenser cooling water flow is 100 gpm to provide adequate cooling capacity.
(4) The standby service water pumps are required to pump an additional 350 gpm for the traveling screens wash water, pump seal water, and pump motor cooling water.
(5) The service water pumps are required to pump an additional 50 gpm (per pump) for pump seal water, pump motor cooling water and the seal water strainer backwash.
(6) DELETED
(7) Service water is available on the "B" Train only, for backup.
(8) The flows provided represent nominal values. Analyses were completed to show that flows below those provided are acceptable provided that an equivalent heat removal capability is obtained.

TABLE 9.2-3

OPERATION OF SERVICE WATER VALVES

Accident	Initial Valve Action Service Water Valves
Design basis accident loss-of-coolant coincident with loss of normal unit power	1. Open valves to recirculation spray coolers
	2. Open valves to emergency diesel generator cooling system heat exchangers
	3. Close valves to primary and secondary component cooling water heat exchangers and chillers
Loss of offsite power	1. Open valves to emergency diesel generator cooling system heat exchangers
	2. All other valves remain in their normal operating position

TABLE 9.2-4

PRIMARY COMPONENT COOLING WATER SYSTEM
COMPONENT FLOW REQUIREMENTS

Description	Quantity	Required Flow, each (gpm)	Reference FSAR Section
Components in Containment:			
CRDM shroud cooling coils	3	200	9.4.7.4
Reactor coolant pumps thermal barrier, stator, and bearing oil coolers	3	436	5.4.1
Excess letdown cooler	1	167	9.3.4
Neutron shield tank cooler	1	32	9.2.2.3
Containment penetration cooling coils	10	3/coil (minimum)	3.8.1.1.3.1
Primary drains cooler	1	130	9.3.3
RHR pump seal oil coolers	2	5-10	5.4.7
RHR heat exchangers	2	6,457	5.4.7
Components in Fuel Building:			
Fuel pool heat exchangers	2	1,100	9.1.3
Components in Auxiliary Building:			
Seal water heat exchanger	1	124**	9.3.4
Nonregenerative heat exchanger	1	125*	9.3.4
Auxiliary steam degasifier drain coolers	2	51	10.4.10
Primary sample panel coolers	11	12	9.3.2
Primary sample panel temperature control unit	1	5	
Radiation monitors in auxiliary and waste handling buildings	3 coolers 1 sample	15/cooler 3/sample	11.5

TABLE 9.2-4 (Cont)

Description	Quantity	Required Flow, each (gpm)	Reference FSAR Section
Boron recovery system:			
Degasifier vent chiller	2	10	9.3.4.6
Degasifier trim cooler	2	142	9.3.4.6
Degasifier vent condenser	2	133	9.3.4.6
Degasifier circulation pump	2	1	9.3.4.6
Gaseous waste system:			
Overhead gas compressors	2	2	11.3
Components in Waste Handling Building:			
Steam generator blowdown system:			
Evaporator bottoms hold tank vent condenser	1	10	10.4.8
Evaporator distillate cooler	2	120	10.4.8
Evaporator overhead condenser	2	1,039	10.4.8
Evaporator bottoms cooler	1	35***	10.4.8
Components in Main Steam Valve Area:			
Containment instrument air compressors	2	35	9.3.1

NOTES:

* Only normal operating flow is shown. Flow for maximum purification and heatup is larger.
** Heatup flow is shown. Normal operating flow is 98 gpm.
*** Expected makeup flow to cooler.

TABLE 9.2-5

PRIMARY COMPONENT COOLING WATER SYSTEM
SUBSYSTEM COMPONENT DESIGN DATA

Component	Design Parameters	
CCW Heat Exchangers (normal operation)		
Quantity	3	
Duty, each (Btu/hr)	33,000,000	
	Shell	Tube
Design pressure (psig)	225	175
Design temperature (°F)	200	120
Operating pressure (psig)	110	65
Design Operating temperature, in/out (°F)	114.7/100	83*/95
Materials	Carbon steel	SA-249** TP304
Fluids	Demineralized water	Service water
CCW Surge Tanks		
Quantity	2	
Type	Cylindrical, vertical	
Capacity, each (gal)	1,650	
Design pressure (psig)	50	
Design temperature (°F)	300	
Material	SA-285 Gr. C	
CCW Pumps		
Quantity	3	
Type	Horizontal centrifugal	
Motor, each (hp)	400	
Seals	Mechanical	
Capacity, each (gpm)	6,000	
Head at rated capacity (ft of water)	200	
Design pressure (psig)	400	

*River water temperature (tube side inlet) varies from 34° - 89°F.

**SEA-CURE is an acceptable tube material in place of SA-249 TP304.

TABLE 9.2-6

CHILLED WATER SYSTEM,
PRINCIPAL COMPONENT AND DESIGN PARAMETERS

Component	Design Parameters
Chiller Unit	
Quantity	3
Capacity, (tons) each	650
Motor, (hp) each	600
Chilled Water Circulating Pump	
Quantity	3
Capacity, (gpm) each	1,560
Total head (ft of water)	200
Motor, (hp) each	150
Expansion Tanks	
Quantity	2
Capacity, (gal) each	202
Air Separator	
Quantity	1
Capacity (gpm)	3,600
Chemical Feeder	
Quantity	1
Capacity (gal)	8

TABLE 9.2-7

NEUTRON SHIELD TANK COOLING WATER SYSTEM
COMPONENT DESIGN DATA

Component	Design Parameters	
Neutron Shield Tank Cooler		
Quantity	1	
Duty (Btu/hr)	80,000	
	Shell	Tube
Design pressure (psig)	150	150
Design temperature (°F)	300	300
Operating pressure (psig)	50	15
Design operating temperature, in/out (°F)	100*/105	125/115
Material	Type 316 SS	Type 316 SS
Fluids	Component cooling water	Shield tank water
Neutron Shield Tank Expansion Tank		
Quantity	1	
Type	Cylindrical, vertical	
Capacity (gal)	1,275	
Design pressure (psig)	25	
Design temperature (°F)	150	
Material	Stainless steel, Type 304	
Corrosion Control Tank		
Quantity	1	
Type	Cylindrical, vertical	
Capacity (gal)	105	
Design pressure (psig)	130	
Design temperature (°F)	150	
Material	Stainless steel, Type 304L	

* Component cooling water inlet temperature may reach 106°F during periods of maximum river temperature (89°F).

TABLE 9.2-8

DEMINERALIZED WATER MAKEUP SYSTEM COMPONENT
DESIGN DATA

Component	Parameters
Demineralized Water Storage Tank	
Quantity	1
Type	Cylindrical vertical
Capacity (gal)	600,000
Design pressure (psig)	Atmospheric and full of H_2O
Design temperature (°F)	125
Material[1]	ASTM A240 Type 304 Stainless Steel
Design code	API-650
Demineralized Water Distribution Pump	
Quantity	2
Type	Horizontal centrifugal
Motor, (hp) each	40
Seal	Mechanical
Capacity (gpm)	350
Head at rated capacity (ft)	200
Design pressure (psig)	275
Design temperature (°F)	105
Material[1]:	
Casing	ASTM A-744 CF-8M Type 316 Stainless Steel Casting
Shaft	ASTM A-322 4140 Low Alloy Steel
Impeller	ASTM A-744 CF-8M Type 316 Stainless Steel Casting

NOTES 1. Materials listed in this table may have been replaced with materials of equivalent design characteristics. The term equivalent is described in UFSAR Section 1.12, “Equivalent Materials”.

TABLE 9.2-9

POTABLE AND SANITARY WATER SYSTEM PRINCIPAL COMPONENTS

Description	Quantity	Capacity
Centrifugal hot water circulating pump	1	6.5 gpm
Hot water storage tanks	2	1,300 gal

TABLE 9.2-10

TURBINE PLANT COMPONENT COOLING WATER SYSTEM
COMPONENT FLOW REQUIREMENTS

Description	Quantity	Design Data For Each Component (gpm)	Reference FSAR Section
Turbine lubricating oil coolers	2	2,980	10.2
Electro-hydraulic oil coolers	2	22	10.2
Hydrogen side seal oil cooler	1	100	10.2
Air side seal oil cooler	1	260	10.2
Main generator exciter coolers	2	240	10.2
Main generator hydrogen coolers	4	1,503	10.2
Vacuum priming equipment seal coolers	2	150	10.4.5
Blowdown tank drain cooler	1	405	10.4.8
Turbine plant sample coolers	5	15	9.3.2
Evaporator reboiler drain coolers	2	121	11.2
Isolated phase bus duct air coolers	2	93	8.1.3
Station air compressors	2	34.5	9.3.1
Condensate polishing air compressor	1	25	10.4.6
Heater drain pumps	2	8	10.4.7
Separator drain pumps	2	5	10.4.7
Condensate pumps	3	10	10.4.7
Main feed pumps	2	65	10.4.7
Condensate polishing sample sink cooler	1	7	10.4.6

TABLE 9.2-10 (Cont)

Description	Quantity	Design Data For Each Component (gpm)	Reference FSAR Section
Auxiliary boiler sample coolers	2	0.5	10.4.10
Auxiliary boiler blowdown vent condenser	1	138	10.4.10
Startup feedwater pump	1	38	10.4.7
Auxiliary boiler conductivity cooler	1	0.5	10.4.10
Steam generator Blowdown demineralizer Heat exchanger 2BDG-E23	1	1000	10.4.8
Main generator hydrogen dryer cooler 2GMH-E23	1	1	----

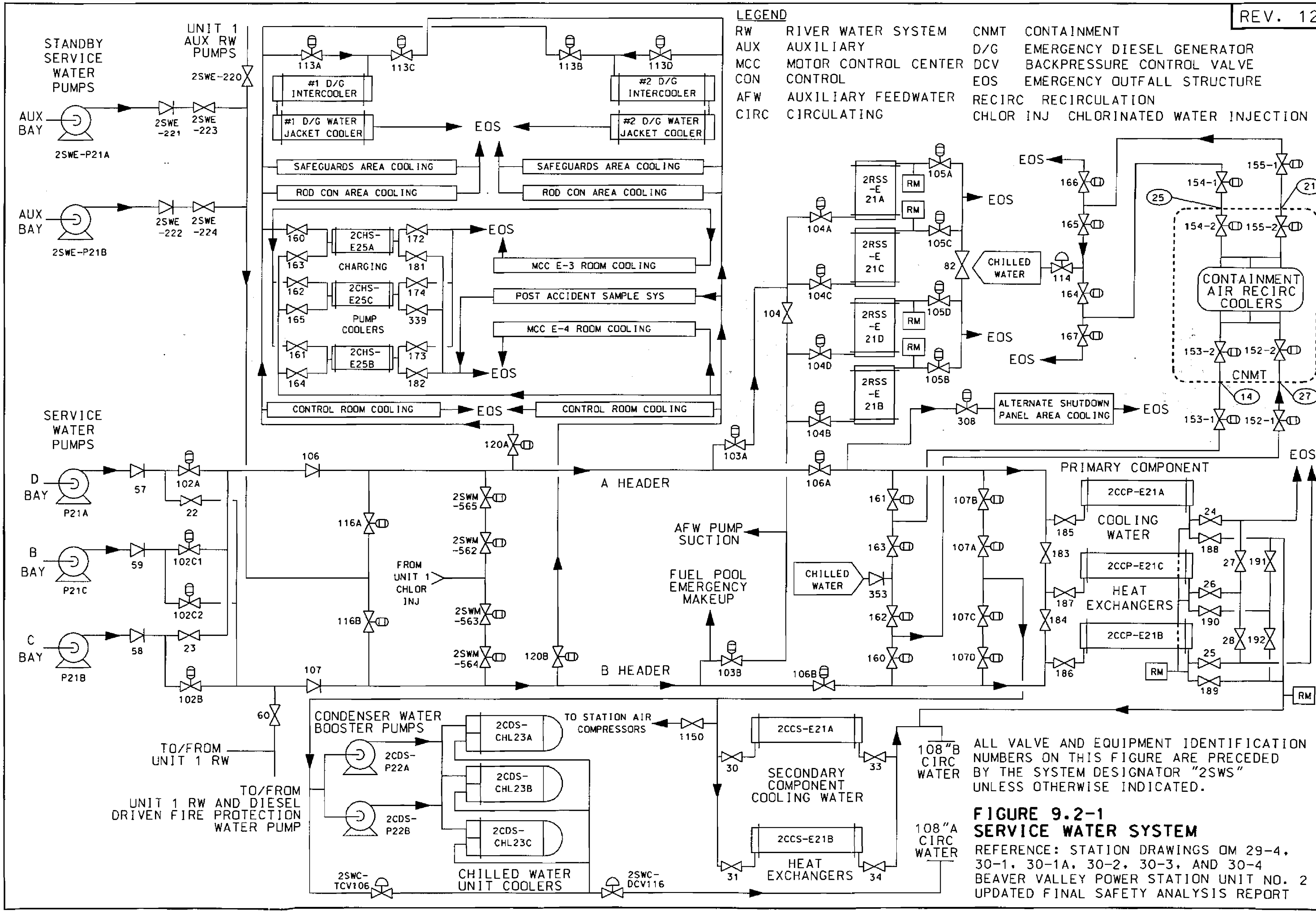
TABLE 9.2-11

TURBINE PLANT COMPONENT COOLING WATER SYSTEM
SUBSYSTEM COMPONENT DESIGN DATA

Component	Design Parameters	
TPCCW Heat Exchangers (Normal Operation)		
Quantity	2	
Duty (MBH)	64.4	
	SHELL	TUBE
Fluids	Treated demineralized water	Service water
Design temperature, (°F)	300	300
Design pressure (psig)	150	150
Design operating temperature (inch °F)	106.7	86[2]
Materials[1]	Carbon steel	CU-NI B-111
Design code	ASME Section VIII	ASME Section VIII
TPCCW Pumps		
Quantity	2	
Type	Dual volume horizontal pump	
Fluid	Treated demineralized water	
Capacity (gpm)	11,000	
Total dynamic head (ft)	160	
Design temperature (°F)	150	
Design pressure (psig)	212	
Material[1]	Cast Iron	
TPCCW Surge Tank		
Quantity	1	
Type	Cylindrical, vertical	
Capacity (gal)	3,173	
Design pressure (psig)	Atmosphere	
Design temperature (°F)	125	
Material[1]	A 285 Grade C	
Design code	API 650	

NOTES 1. Materials listed in this table may have been replaced with materials of equivalent design characteristics. The term equivalent is described in UFSAR Section 1.12, "Equivalent Materials".

2. Technical specifications permit plant operation up to 89°F river water temperature.

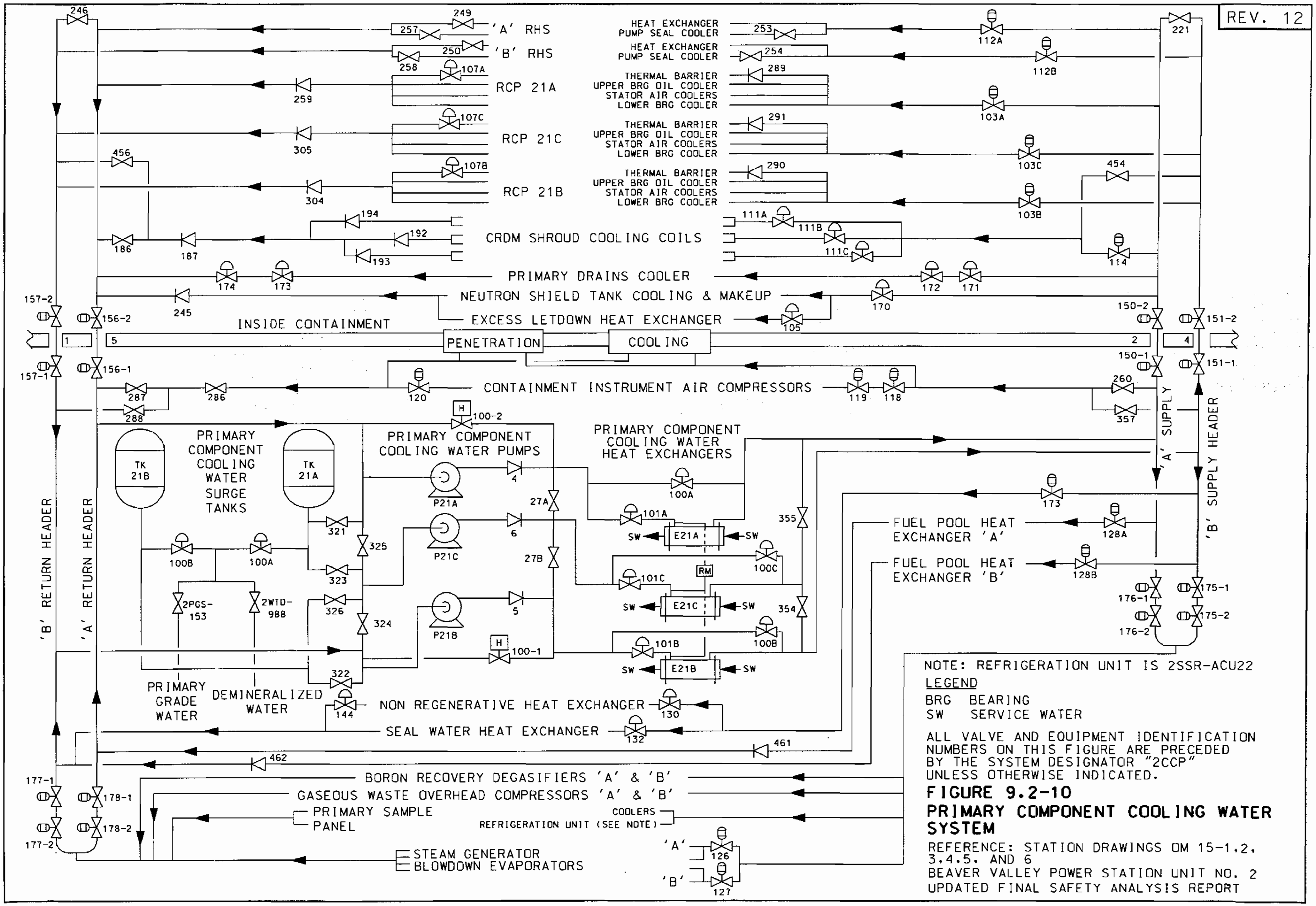


ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2SWS" UNLESS OTHERWISE INDICATED.

FIGURE 9.2-1
SERVICE WATER SYSTEM

REFERENCE: STATION DRAWINGS OM 29-4, 30-1, 30-1A, 30-2, 30-3, AND 30-4

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT



NOTE: REFRIGERATION UNIT IS 2SSR-ACU22

LEGEND

BRG BEARING
SW SERVICE WATER

ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2CCP" UNLESS OTHERWISE INDICATED.

FIGURE 9.2-10
PRIMARY COMPONENT COOLING WATER SYSTEM

REFERENCE: STATION DRAWINGS OM 15-1,2, 3,4,5, AND 6

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air Systems

Three air systems comprise the compressed air systems: the station air system, the condensate polishing air system, and the containment instrument air system. The station air system is divided into two subsystems: the station service air system and the station instrument air system. Figure 9.3-1 illustrates the components and air lines associated with these systems.

9.3.1.1 Station Air System

The station air system is composed of the following air systems: station service air system and the station instrument air system. Both of these air systems are designed to provide sufficient compressed air of suitable quality and pressure to meet individual system requirements.

The station service air system provides air throughout the plant for air-operated maintenance and repair equipment operation. The station service air system can also supply air to the containment instrument air system via a filtering arrangement.

The station instrument air system provides air for air-operated instrumentation and controls outside of the containment. The station instrument air system also provides a backup supply to the containment instrument air system.

9.3.1.1.1 Design Bases

The station air system is designed in accordance with the following criteria:

1. Provides normal station instrumentation air and plant service air.

2. Two identical electric motor-driven station air compressors supply air to the station instrument and station service air systems. To ensure reliability, each air compressor has the capacity to supply 100-percent of station instrument and station service air requirements.

3. To improve plant operability, a nonsafety, onsite diesel generator is available to supply electric power to the station air compressors. This diesel generator will supply power only after a loss of normal power. Additionally, a 100-percent capacity diesel-driven air compressor is provided to supply the instrument air system as a backup to the electric motor-driven compressors.

4. Design temperatures for station air piping are those resulting from extreme ambient conditions. The aftercooler is designed to cool the discharge air to 115°F. The station instrument air design dewpoint is adequate for the entire system. The system is located in heated areas of Beaver Valley Power Station-Unit 2 (BVPS-2).

5. The station instrument and station service air systems are nonsafety-related systems, are classified as non-nuclear safety (NNS) class, and are designed in accordance with ANSI B31.1, dated 1967, including all addenda through June 30, 1972.

9.3.1.1.2 System Description

Two dry-screw electric motor-driven station air compressors provide instrument and service air throughout the plant. Each compressor is rated at 100-percent capacity for the air requirements of the station instrument air and station service air systems collectively. A 100-percent capacity diesel-driven compressor is provided to supply the instrument air system as a backup to the electric motor-driven compressors. (Refer to Figure 9.3-1).

Both electric motor-driven compressors are arranged with discharge piping from individual receivers to individual air dryers. A branch line from the cross-tie line between the discharge piping from the station air receivers supplies air for the station service air system through an air-operated valve (AOV). Station instrument air requirements external to the containment building are normally supplied from one of the two station air receivers through connections upstream of the service air isolation AOV, air passes through one of the two drying units located downstream of the station air receivers, and is supplied to the instrument air receivers. If air pressure in the station instrument air system drops to a predetermined point, the station service air header AOV will automatically close and divert all station air to station instrument air. The station service air header isolation valve must be manually reset after an automatic closure. The diesel-driven air compressor is aligned through check valves to only supply the instrument air system and will auto start at a predetermined point following closure of the AOV.

One electric motor-driven station air compressor operates on a load/unload mode while the other compressor is on a standby automatic mode. The compressor on the automatic mode will start if the instrument air receiver pressure falls to a predetermined point. The diesel-driven instrument air compressor will start automatically when the instrument air header reaches a lower predetermined point.

The electric motor-driven station air compressors operating modes are alternated periodically to maintain uniform wear and to verify proper component operability. The diesel-driven compressor is normally kept in a standby condition.

The air system compressors are equipped with integral relief valves located on the high and low pressure stages for prevention of mechanical damage should there be overpressurization. Relief protection is also provided on the station air receivers to protect them from overpressurization.

For the electric motor-driven compressors, cooling water is provided to the inter- and after-coolers and compressor water jackets from the turbine plant component cooling water (TPCCW) system (Section 9.2.7) during normal plant operation, and from the domestic water system during periods of plant shutdown. The diesel-driven compressor is air cooled.

Because the station instrument air and station service air systems components are located in the turbine building, missile generation from a rupture-type failure of any of these components will not cause damage to any safety-related equipment.

The main components of the station instrument air system are as follows: one diesel-driven air compressor, three heatless regenerative desiccant type air dryers, the required prefilters and afterfilters, and regeneration controls. The dryers and instrumentation are designed for complete, automatic, and continuous operation, providing dry air at 100 psi gage pressure and 100°F. The air passes through one of two adsorber columns for a set period of time. The air flow is then switched automatically to the second tower while the first adsorber is reactivated by a purging air flow to release adsorbed water, enabling the unit to go back on line when required. Compressed dry air is discharged to the station instrument air receiver. A bypass filtering arrangement (FLT37 and FLT39 on Figure 9.3-1) is provided around the normal air dryers to allow the system to stay in operation when providing maintenance and repair to the air dryers.

Sufficient air receiver capacity is provided to meet all instrument air requirements external to the containment for a period of approximately 10 minutes, permitting continuous control during any temporary reduction in supply pressure. This allows sufficient time for the operators to restore supply pressure with such emergency procedures as manually starting the standby compressor in the event that automatic start controls have failed, or closing valves to isolate the service air header in the event of system leakage.

The electric motor-driven station air system compressors have the capability of operating from the nonsafety, onsite diesel generator power supply. The diesel-driven instrument air compressor is capable of starting and supplying the instrument air system regardless of the availability of offsite power.

Table 9.3-1 contains the design data for system components of the station instrument air and station service air systems.

9.3.1.1.3 Safety Evaluation

The two systems which comprise the station air system (station instrument air system and station service air system) are designated NNS class and are designed to ANSI B31.1 standards. The station air system is not required for safe shutdown of BVPS-2.

Portions of the system piping which are in Category I buildings are seismically supported.

Consequences of station air system component failures are presented in Table 9.3-2.

9.3.1.1.4 Inspection and Testing Requirements

Preliminary tests are performed as described in Section 14.2.12. During normal operation, periodic tests are performed on the standby electric motor-driven compressor of the station air system and the diesel-driven instrument air compressor to ensure proper starting when required. Other testing of the station air system is not required as it is normally in operation.

9.3.1.1.5 Instrumentation Requirements

The electric motor-driven station air compressors are controlled manually from the main control room via individual control switches with appropriate indicating lights. These two compressors can also be controlled locally by means of a transfer switch with indicating lights and pushbuttons.

The diesel-driven instrument air compressor is controlled only at the local control panel. The local control panels for the diesel-driven air compressor and associated air dryer contain the necessary indication and alarms to locally assess the operation of the units.

The station air header isolation trip valve is monitored in the main control room by indicating lights. This valve trips closed on low station instrument air header pressure and must be manually reset at the isolation valve.

The domestic water to station air compressors valve is controlled manually from the main control room by a control switch with appropriate indicating lights.

The station and instrument air compressors unloading valves load the compressors on low air receiver pressure and unload the compressors on high air receiver pressure.

The station air compressors supply breakers are controlled locally via individual pushbuttons with appropriate indicating lights. These supply breakers trip open on a motor electrical protection trip.

A common annunciation is provided in the main control room for station and condensate polishing air systems trouble with the following inputs from the station and instrument air systems: station instrument air compressors trouble, (with its following inputs: local control configuration, compressor motor overload, high pressure inlet air temperature high, bleedoff air pressure high, oil temperature high, and oil pressure failure), station instrument air compressors supply breakers motor electrical protection trip, normal station instrument air dryer trouble (failure to shift, high dewpoint), station air receivers pressure low, and station air header pressure low. The preceding inputs are also monitored by the BVPS-2 plant computer.

Annunciation is also provided in the main control room for the station instrument air receiver tank trouble with station instrument air receiver pressure low and station instrument air header pressure low inputs. These inputs are monitored by the BVPS-2 computer.

Local indicating lights are provided.

Indicators are provided in the main control room for: station air receiver pressure, station air header pressure, normal station instrument air receiver pressure, and station instrument air header pressure.

9.3.1.2 Condensate Polishing Air System

The condensate polishing air system provides all compressed air requirements within the condensate polishing building. The system diagram is shown on Figure 9.3-1.

9.3.1.2.1 Design Bases

The condensate polishing air system is designed in accordance with the following criteria:

1. Provides compressed air for the following uses within the condensate polishing building: powdered resin dewatering system, chemistry lab, and various service hose connections throughout the building.

2. One dry-screw condensate polishing compressor has the capacity to supply 100-percent of the air requirements for the condensate polishing building.

3. Design temperatures for condensate polishing air piping are those resulting from extreme ambient conditions.

4. No air drying is required for the condensate polishing air system.

5. The condensate polishing air compressor is nonsafety-related and is classified as NNS class.

6. All air piping is designed in accordance with ANSI B31.1, dated 1967, including all addenda through June 30, 1972.

9.3.1.2.2 System Description

The condensate polishing air system is depicted on Figure 9.3-1.

A single dry-screw air compressor provides compressed air for condensate polishing building uses. The compressor is rated at 100-percent capacity based on the building's air requirements.

In the event that the condensate polishing air compressor is not functioning, a backup supply of compressed air will be provided through a crossover line from the station service air system. The condensate polishing air compressor also acts as a backup air supply for the station air system via the same crossover.

An automatic start feature was added to the condensate polishing compressor. Upon decreasing station air header pressure, the condensate polishing compressor will automatically start.

Design data for the condensate polishing air system are given in Table 9.3-1.

9.3.1.2.3 Safety Evaluation

The condensate polishing air system is NNS class and is designed to ANSI B31.1 piping requirements.

Consequences of condensate polishing air system component failures are presented in Table 9.3-2.

9.3.1.2.4 Inspection and Testing Requirements

Preliminary tests are performed as described in Section 14.2.12. The condensate polishing air system does not require in-service testing as the system will be operating on a regular basis.

9.3.1.2.5 Instrumentation Requirements

The condensate polishing air compressor is controlled from the main control room by a control switch with appropriate indicating lights. The compressor can also be controlled locally by means of a transfer switch with indicating lights and pushbuttons.

The condensate polishing air compressor unloading valve loads the compressor on low air receiver pressure and unloads the compressor on high air receiver pressure.

The condensate polishing air compressor supply breaker is controlled locally by a pushbutton with appropriate indicating lights. This supply breaker trips open on a motor electrical protection trip.

A common annunciation is provided in the main control room for station and condensate polishing air system trouble with the following inputs from the condensate polishing air system: condensate polishing air receiver header pressure low, condensate polishing air compressor trouble (with its following inputs: compressor motor overload, high pressure inlet air temperature high, bleedoff air pressure high, oil temperature high, and oil pressure failure) and condensate polishing air compressor supply breakers motor electrical protection trip. The preceding inputs are monitored by the BVPS-2 plant computer.

Local indicating lights are provided.

9.3.1.3 Containment Instrument Air System

The containment instrument air system provides sufficient compressed air of suitable quality and pressure to instrumentation located within the containment boundary.

9.3.1.3.1 Design Basis

The containment instrument air system is designed to meet the following requirements:

1. To provide air of suitable quality and pressure for the reactor containment building instrumentation.

2. To ensure reliability, two identical 100-percent capacity air compressors are provided.

3. The containment instrument air system compressors and dryer components are Seismic Category II and are located in the main steam valve house.

4. The containment instrument air system supplies air to safety-related valves; however, the system is nonsafety-related because these valves are designed to fail in a safe position upon system loss of compressed air.

5. The operation of the containment instrument air system is required for normal station operation.

6. To improve plant operability following a loss of normal power, a nonsafety, onsite diesel generator is available to supply electric power to the containment instrument air system. This diesel generator will supply power only after a loss of normal station power.

9.3.1.3.2 System Description

Figure 9.3-1 includes the system diagram for the containment instrument air system.

The containment instrument air system supplies air to instrumentation and controls, and valves inside the containment. The system draws air from the containment atmosphere and discharges compressed dry air to the control and instrumentation header (inside containment). This design eliminates pressurization of the containment atmosphere from this source.

The containment instrument air system is a separate, independent compressed air system. Two motor-driven, 100-percent capacity, oil-free (nonlubricated) air compressors are provided for the containment instrument air system. These compressors are located inside the main steam valve house, but draw air from the containment atmosphere. During normal operation, one of the two containment instrument air compressors operates on a load/unload mode while the other operates on an automatic standby mode. The compressor on automatic standby mode starts when the containment instrument air system pressure falls below a predetermined set-point (95 psig). The containment instrument air compressor operating modes are alternated periodically to maintain uniform wear and verify proper component operability.

Both containment instrument air compressors have the capability to be operated from the nonsafety, onsite generator power system.

A 100-percent capacity refrigerant type air dryer is provided in the discharge line from the compressors. The design dewpoint on the discharge of the dryer is +35°F at 95 psig. This is adequate for the instrument air used within the containment. A desiccant-type cartridge filter (FLT23 on Figure 9.3-1) is provided in the bypass around the dryer to facilitate a level of air drying during dryer failure or maintenance. All liquid drains from the dryer are piped

to the liquid waste system (Section 11.2). The dryer is not seismically qualified, but is seismically mounted to meet Seismic Category II requirements.

Two air receivers are provided: a 31.8 ft^3 capacity receiver located in the main steam valve house and an approximately 57 ft^3 capacity receiver located in the containment. The 31.8 ft^3 receiver acts as a general receiver for the system while the approximately 57 ft^3 receiver acts as a reserve supply in the event of a containment

isolation Phase A (CIA) signal. This system supplies air to instruments and AOVs whose total combined requirements are 30 scfm.

Containment isolation valves are safety-related and will close when a CIA signal exists. Containment isolation valves will not close on loss of onsite power, thereby maintaining system operability under this condition.

A backup supply of compressed air is provided from these two sources:

1. A cross-connect from the station service air system within the containment. This cross-connect is provided with (normally closed) isolation valves and a coalescing-type cartridge filter (FLT24 on Figure 9.3-1) to remove moisture from the service air.

2. A cross-connect from the station instrument air system within the main steam valve house. A motor-operated valve (MOV) is provided in this cross-connection. This MOV is remotely operable from the main control room when needed. The compressed air provided is filtered and dried station instrument air.

Cooling water for the containment instrument air compressors is supplied by the primary component cooling water (CCP) system (Section 9.2.2.1). Table 9.3-3 contains design data for components of the containment instrument air system.

9.3.1.3.3 Safety Evaluation

The containment instrument air system is nonsafety-related, and is not required for safe shutdown. Instrumentation and controls served by the system are designed such that the equipment will fail in the safe mode upon loss of air.

The containment instrument air system is a QA Category II system. Since the components and piping are located in Category I buildings, they are protected from earthquakes, flooding, and tornadoes.

Consequences of containment instrument air system component failures are presented in Table 9.3-4.

9.3.1.3.4 Inspection and Testing Requirements

Preliminary tests are performed as described in Section 14.2.12. During normal operation, periodic tests are performed on the standby compressor of the containment instrument air system to ensure its

proper starting when required. Other testing of the containment instrument air system is not required as it is normally in operation.

9.3.1.3.5 Instrumentation Requirements

The containment instrument air compressors are controlled from the main control room via individual control switches with appropriate indicating lights. The containment instrument air compressors can also be controlled locally by means of local selector switches.

The containment instrument air compressors are furnished with a local panel which contains indicating lights for each protective trip device.

A containment instrument air compressor annunciator display is actuated in the main control room whenever any of the protective devices trip a compressor.

Containment instrument air compressor annunciator displays with the associated BVPS-2 computer inputs are actuated in the main control room for feeder circuit breaker auto/manual trip conditions.

The containment instrument air dryer is furnished with locally-mounted pressure and temperature indicators necessary to monitor dryer performance. An alarm is furnished to the control room should a dryer malfunction occur.

An indicator for containment instrument air system air pressure is located in the main control room. An annunciator is actuated on low pressure.

Local pressure indicators are provided for monitoring of containment instrument air compressor operation.

Containment instrument air isolation valves, powered from Class 1E buses, are controlled from the main control room via individual control switches with indicating lights. These containment isolation valves will automatically close when a CIA signal exists.

The containment instrument air receiver backup supply valve is controlled from the main control room with a control switch and appropriate indicating lights.

9.3.2 Process Sampling System

9.3.2.1 Reactor Plant and Process Sampling System

The reactor plant and process sampling (RPPS) system routes liquid and gaseous samples from the various fluid systems to a common sample station where samples are conditioned as required for collection and/or continuous monitoring. The system is used during normal plant operation.

9.3.2.1.1 Design Bases

The RPPS system is designed in accordance with the following criteria:

1. To provide a means of obtaining representative liquid and gaseous samples, as required by Regulatory Guide 1.21, for on-line and grab sample analysis.

2. All RPPS is performed within the primary plant sample cubicle, which is located in the auxiliary building to minimize the potential spread of contamination.

3. The RPPS system is designed to isolate at the containment boundary on a CIA signal (Section 6.2.4) and is in accordance with Appendix A of 10 CFR 50 and General Design Criterion (GDC) 55. The exception is the steam generator blowdown (SGB) sample system, which is in accordance with GDC 57, and the SGB sample isolation valves will close upon the initiation of the auxiliary feedwater system (Section 10.4.9).

4. The sampling system is designed to limit effluents to unrestricted areas, under normal and anticipated malfunctions or failure, in accordance with the guidelines of 10 CFR 20, Section 20.1(c).

5. The system is designed to obtain reactor coolant samples during reactor operation from either the hot or the cold legs of the reactor coolant system (RCS). Reactor coolant samples may also be obtained during cooldown, when the system pressure is low, through the use of sample points in the residual heat removal (RHR) system.

6. The RPPS system is capable of providing samples for laboratory or on-line analysis. High temperature samples are reduced in temperature by sample coolers prior to sample acquisition or on-line analysis. The system is also capable of reducing pressure to a suitable level before sampling.

7. The RPPS system has no engineered safety function and is designated NNS class, QA Category II, with the sample piping being designed in accordance with ANSI B31.1, dated 1967, including all addenda through June 30, 1972. An exception to this is the containment isolation portion of the sample system piping which is designed in accordance with ASME Section III, Code Class 2 and Seismic category I and various process sample tubing lines which are designated Quality Assurance Category I, Seismic Category I, Safety Class 2.

8. General Design Criterion 1, as it relates to quality standards and records.

9. General Design Criterion 2, as it relates to design bases for protection against natural phenomena.

10. General Design Criterion 13, as it relates to instrumentation and control.

11. General Design Criterion 14, as it relates to the reactor coolant pressure boundary.

12. General Design Criterion 26, as it relates to reliably controlling the rate of reactivity changes.

13. General Design Criterion 60, as it relates to control of releases of radioactive materials to the environment.

14. General Design Criterion 63, as it relates to the monitoring of fuel and waste storage.

15. General Design Criterion 64, as it relates to monitoring radioactivity releases.

16. ANSI N13.1-1969, as it relates to the sampling of airborne radioactive material from gaseous process streams and tanks.

9.3.2.1.2 System Description

The RPPS system provides for the remote sampling of process or radioactive systems throughout BVPS-2. All samples are piped to a common sample acquisition and analysis panel.

Sample lines coming from within the containment normally have two remotely-controlled, air-operated containment isolation valves (Section 6.2.4), one inside containment and one outside containment. The SGB system sample lines have one remotely-controlled, air-operated containment isolation valve located outside containment. Sample lines for post-accident sampling, as well as for normal reactor plant sampling, are provided with remotely-operable, solenoid-operated containment isolation valves in lieu of the air-operated type. All sampling system

valves, except the containment isolation valves, are controlled from the primary sampling system panel. The remote sample valves are provided with multi-position switches (Section 9.3.2.1.5). The manually-operated sample valves, located behind the sample panel and the 2-foot concrete shielding, are operated by the use of reach rods.

The primary coolant, RHR system, and safety injection accumulator sample lines join their respective common headers downstream of the selection valve, prior to penetrating the containment.

The reactor coolant samples flow through delay coils permitting sufficient decay of nitrogen-16 to allow safe handling of the samples.

Sample lines are routed to the sampling station located in the auxiliary building at el 718 ft-6 in. Part of the sampling station consists of a conditioning rack which reduces the pressure and temperature of the SGB samples prior to their admittance to the sample panels, to insure safe sample handling. Sample lines from systems that normally operate at high temperatures (Table 9.3-5) or high pressures are routed through the sample system coolers or pressure reducers, as required, before sampling. These coolers use the primary CCW system (section 9.2.2.1) for the removal of heat. The sample panel also has the capability for grab sample acquisition through the sample cylinders or at the sample sink. To insure that representative samples are obtained, sufficient sample purging is done before sample acquisition or analysis. The sample sink collects any spillage during the sampling procedures. An overhead hood exhausts the potentially radioactive gases to the supplementary leak collection and release system (SLCRS) (Section 6.5.3).

The RPPS sampling system is designed to be operated manually during conditions ranging from full power operation to cold shutdown. The SGB system is continuously monitored while other samples are acquired on an intermittent basis.

The SGB samples provide for continuous monitoring for Na (sodium), pH, cation conductivity, and radioactivity. A radiation monitor located on the common header into which the blowdown sample lines discharge, is used to detect excessive radioactivity from the steam generators. Isolation of a faulty steam generator is done by selectively permitting a sample flow to the radiation monitor, from one steam generator at a time.

The SGB sample line isolation is discussed in Section 11.5.2.5.10. A constant temperature bath, located in the conditioning racks is provided for SGB samples. These samples are continuously measured for conductivity in order to minimize errors in conductivity measurement due to temperature differences. The bath temperature is maintained by a closed loop subsystem containing a circulating pump and a mechanical refrigeration unit.

Demineralized water is supplied to clean the sampling sinks and radiation monitoring equipment.

Under normal system operation, the purge flow of reactor plant samples are normally discharged via the volume control purge header to the volume control tank (VCT) or routed to the nuclear vents and drains system (Section 9.3.3).

The SGB purge is routed to a condensate receiver of the auxiliary steam system (Section 10.4.10), where it is returned to the condensate cycle via the main surface condenser. Radioactive SGB samples, as indicated by the SGB sample monitor, are diverted to the nuclear vents and drains system. Reactor plant and process gaseous samples are purged to the sweep gas system (Section 11.3), prior to sampling to insure representative samples. All samples may be purged to the sample sink for flushing before sample acquisition. The sample sink discharges to the nuclear vents and drains system.

Local instrumentation is provided to permit manual control of sampling operations and to ensure that samples are at suitable temperatures and pressures prior to sample acquisition or analysis. Each purge line header contains a flow indicator/controller to regulate the purge flow rate.

Typical analyses performed on grab samples are: boron concentration, fission product, gross and isotopic radioactivity level, dissolved gas content, and corrosion product concentration. Analytical results are used in regulating boron concentration, evaluating fuel element integrity, evaluating mixed bed demineralizer performance, determining releases to the environment, and in regulating concentrations of corrosion-controlling chemicals in the unit fluid systems.

Table 9.3-5 lists the sample points served by the RPPS system, as well as examples of some points for which local sample acquisition capability is provided.

9.3.2.1.3 Safety Evaluation

Except for the containment isolation piping and valves, the RPPS system is not required to function during an emergency nor is it required to prevent an emergency condition. All remotely-operated valves will fail in the safe position.

The RPPS system is designed to limit potential reactor coolant losses. The sample tubing containing reactor coolant is 3/8-inch in diameter, thereby minimizing the magnitude of any postulated leak.

Remote-manual sample isolation valves are provided as close to the sampling source as possible and can be used to isolate a potential leak. These sample isolation valves will fail closed and meet Seismic Category I design requirements.

The design of the RPPS system ensures that by sufficient purging of the grab samples, a representative sample is available at the sample panel. Sample point locations are specified to ensure that samples will reflect the bulk property of the system fluid. Reactor coolant samples are taken during normal reactor operation from sample taps inserted into the coolant main stream. Because the coolant is well mixed during operation and loop isolation valves are normally open, representative samples of reactor coolant may be obtained from any coolant loop. A reactor coolant sample may be taken during cooldown and during cold shutdown by using sampling points in the RHR system (Section 5.4.7).

Radiological protection of personnel from the RPPS system lines is provided by the use of shielding. Potentially radioactive sample lines are run to the sample station in the auxiliary building through pipe chases. This pipe chase area is normally not subject to personnel entry. Personnel access areas in the proximity of the pipe chase area are protected by a minimum of 2-feet thick concrete shielding.

In the sample room, all sample lines are run to the back of the sample panel after passing through 2-feet thick concrete shielding. Manual sampling system valves, located behind the shield, are operated by means of reach rods. The sample panel also provides a certain degree of personnel shielding for the personnel drawing samples, or working in the area, by minimizing direct exposure to potentially radioactive sample lines.

The sample panel and sink are fitted with enclosed, ventilated hoods. The SLCRS (Section 6.5.3) provides a sweep gas effect for the sample area.

All high temperature samples are cooled sufficiently (to approximately 115°F) to guard against personnel handling samples that are at excessive temperatures. The high pressure in some of the sample lines is reduced to 35 psig for safe acquisition of samples.

9.3.2.1.4 Inspection and Testing Requirements

The RPPS system is used continuously (SGB only) and intermittently during normal power operation, thus ensuring the availability and performance of the system.

System pressure testing will be performed in accordance with ASME Section III for Category I piping and ANSI B31.1 for NNS piping.

Preliminary tests are performed as described in Section 14.2.12.

9.3.2.1.5 Instrumentation Requirements

Control switches with indicating lights are provided in the main control room for the following containment isolation valves: primary coolant hot leg sample line, pressurizer relief tank gas sample isolation valves, and RHR sample isolation valves. These valves close automatically whenever a CIA signal is initiated, or manually by means of their control switches. These valves can be opened by means of their control switches, provided a CIA signal is not present. After initiation of a CIA signal, the valves must be reset from the main control room before they can be manually opened by means of their control switches (refer to Section 9.3.2.3.5 for additional control functions).

Control switches with indicating lights, are provided in the main control room for the primary coolant cold leg sample isolation valves, pressurizer vapor sample isolation valves, and safety injection accumulator sample isolation valves. These valves are opened by means of their control switches, provided no CIA signal is present. These valves are closed automatically when a CIA signal exists or manually by means of their control switches.

Multi-position selector switches with indicating lights are provided at the RPPS panel for the following sample valves:

1. Primary sampling system panel for the primary coolant hot and cold legs sample valves,
2. Pressurizer liquid space sample valve,
3. Pressurizer vapor space sample valve,
4. Residual heat removal inlet and outlet sample valves,
5. Safety injection accumulator sample valves,
6. Charging pump discharge sample valves,
7. Letdown flow sample valve,
8. Volume control tank liquid sample valve,
9. Reactor coolant filter sample valve,
10. Fuel pool ion exchanger effluent sample valve,
11. Fuel pool ion exchanger influent sample valve,
12. Pressurizer relief tank gas space sample valve,
13. Volume control tank gas sample valve,

14. Waste gas surge tank sample valve,

15. Gaseous waste storage tank sample valves,

16. Primary drains transfer tank (inside containment) gas space sample valve,

17. Primary drains transfer tank (outside containment) gas space sample valve, and

18. Nitrogen purge isolation valves for the PRT gas sample line and primary drains transfer tank (inside containment) gas sample line.

These sample valves are operated manually and are not energized until the respective selector switch handle is pulled out.

A common control switch with individual indicating lights is provided in the main control room for the steam generators sample isolation valves. These valves can be opened by means of the control switch provided none of the auxiliary feedwater pumps is running. The valves will close on any auxiliary feedwater pump start or steam generator sample radiation high. The valves can be opened by means of the control switch to take a sample even if high radiation is present as long as no auxiliary feedwater pump is running. Releasing of the control switch from the open position in this case automatically closes the valve. The valve can be closed at any time by placing its control switch in close. A selector switch with indicating lights is provided in the main control room for each steam generator's pair of steam generator steam sample valve and SGB sample valve. Selection of one sample valve for testing automatically closes the other sample valves. Both sample valves can be closed manually by placing the selector switch in close or automatically by any auxiliary feedwater pump start or steam generator sample temperature high. The sample temperature high signal is locked in and must be reset, when the temperature returns to normal, by placing the valve selector switch in the close position.

Annunciation is provided in the main control room for primary plant sample panel trouble. This alarm is also monitored by the BVPS-2 computer system.

Annunciation is provided on the primary sampling system panel for cation conductivity-steam generator A, B, or C high, pH-steam generator A, B, or C high, pH steam generator A, B, or C low sodium-steam generator A, B, or C high, and refrigeration system trouble.

A multi-point recorder/datalogger is provided at the RPPS sample panel for steam generators A, B, and C cation conductivity, steam generators A, B, and C pH, steam generators A, B, and C sodium content, and steam generators A, B, and C total conductivity. The recorder/datalogger also transmits all sample data received to a computer in the chemistry lab dedicated to the collection of water chemistry data.

9.3.2.2 Turbine Plant Sampling System

The turbine plant sampling system routes secondary plant steam and liquid samples at varying pressures and temperatures to the turbine plant sample panel. Samples are conditioned to modify pressure, temperature, and flow before analysis. Selected in-line sample analyses are provided with local panel indication, in addition to

grab sample capability for laboratory analysis, which is provided for all samples.

The condenser hotwell sample system is a subsystem of the turbine plant sampling system. This system draws liquid samples from the main condenser hotwells and provides on-line analysis as well as grab sample capability for laboratory analysis.

9.3.2.2.1 Design Bases

The turbine plant sample system is designed in accordance with the following criteria:

1. To provide a means of acquiring representative selected turbine plant samples for on-line and laboratory grab sample analysis.

2. To provide accurate sample pressure flow and temperature conditioning to satisfy the requirements for in-line analyzers, and to ensure personnel safety during grab sample acquisition.

3. To provide sampling capability for the following turbine plant functions: main steam from the individual main steam lines downstream of the main steam isolation valves, steam generator feed pump suction and discharge, condensate pump discharge, heater drain pump discharge, and condenser hotwell.

4. The condenser hotwell sampling system is designed to continuously monitor condensate conductivity levels at various points in the main condenser hotwells. The system is designed so as to minimize the delay time associated with detection of high conductivity in hotwell condensate. The system is also designed to monitor a selected sample stream for sodium.

5. Sample system piping is designed in accordance with ANSI B31.1, dated 1967, including all addenda through June 30, 1972, and is designated NNS class, and QA Category II.

6. In addition, there are three (3) capped sample line connections from the SGBD demineralizers for a future ion chromatograph, and high pressure sample taps for use with the corrosion products monitor.

9.3.2.2.2 System Description

Process liquid and steam samples from individual main steam lines downstream of the main steam isolation valves, steam generator feed- water pump suction and discharge, heater drain pump discharge and condensate pump discharge samples are conveyed to the turbine plant sample panel. Samples are routed via carbon steel piping and stainless steel tubing. Line sizes are designed to meet analyzer and grab sample flow requirements.

The conditioning panel contains the sample coolers, flow regulators, pressure regulating valves, isothermal bath, and local pressure, flow and temperature indicators.

Samples are passed through primary coolers, when required, to reduce sample temperatures to approximately 110°F. Cooling water to the primary coolers is supplied from the TPCCW system (Section 9.2.7). All samples are then passed through a chilled water isothermal bath in which the sample temperature is lowered to approximately 77°F. Cooling water for the bath is supplied by the chilled water system (Section 9.2.2.2). A temperature controller controls the bath temperature by varying the flow of chilled water through the bath cooling coils.

Each sample point is provided with a grab sample valve, located in the conditioning panel, to provide adequate sample flushing prior to

and for grab sample acquisition or admittance to in-line analysis equipment.

The conditioning panel is equipped with a common blowdown header located upstream of the main sample isolation valve for each sample point except the heater drain pump discharge. The blowdown header is provided to flush the incoming sample lines during BVPS-2 start-up.

The blowdown header, pressure relief valve, and the sample sink all discharge to a common waste header, which in turn discharges to the turbine building floor drainage system (Section 9.3.3).

Conditioned samples are routed to the sample analyzer panel that is adjacent to the following in-line sample analyzers:

1. Main steam samples are continuously monitored for conductivity.

2. The feedwater pump discharge sample is continuously monitored for conductivity, pH, hydrazine, sodium, and dissolved oxygen.

3. The feedwater pump suction sample is continuously monitored for conductivity.

4. The condensate pump discharge is continuously monitored for dissolved oxygen, conductivity, and sodium.

5. The condenser hotwell is continuously monitored for conductivity and has the capability to monitor a selected stream for sodium.

6. The heater drain pump discharge sample is continuously monitored for conductivity and sodium.

After passage through analytical equipment, hydrazine-, oxygen-, pH- and sodium-analyzed samples are routed to the turbine building floor drainage system (Section 9.3.3). All other samples are returned to the auxiliary steam system condensate receiver (Section 10.4.10).

The condenser hotwell sampling system, a separate subsystem of the turbine plant sampling system, draws and analyzes condensate samples from various points in the condenser hotwells. Condenser hotwell

samples are analyzed for conductivity content. High conductivity in hotwell condensate indicates condenser tube, circulating water, in leakage.

The hotwell sampling system utilizes six metering type sample pumps which continuously draw condensate samples from the condensate hotwells and discharge to a common hotwell sample panel. The hotwell sample panel is provided with an individual in-line conductivity measuring loop for each of the six sample inputs. Conductivity levels are remotely indicated and alarmed at the hotwell sample monitoring panel. Hotwell sample lines upstream of the sample panel have been sized so as to minimize the delay time associated with high condensate conductivity detection. The hotwell sample panel also maintains the capability to take grab samples for laboratory analysis.

Upon actuation of a high conductivity alarm, the hotwell sampling conductivity indication will indicate the origin of the high, conductivity problem, a specified hotwell sample point, which can be related to a specific condenser tube bundle area.

This specific leak detection ability will enable operators to locate the affected leakage area and isolate that area depending on the severity of in-leakage.

Condensate discharged from the hotwell sample panel is routed back to the main condenser through a strainer, which is designed to trap any resin that may be released from a conductivity column at the hotwell sample panel.

9.3.2.2.3 Safety Evaluation

The turbine plant sampling system performs no safety-related function. The failure of this equipment will not affect the safety functions of other equipment.

The activity levels of the turbine plant systems being sampled are monitored by radiation monitors (Section 11.5) at various points. These points include the SGB lines, air ejector after condenser vent lines, degasifier condensate pump discharge, and evaporator reboiler condensate pump discharge.

9.3.2.2.4 Inspection and Testing Requirements

The turbine plant sampling system is used continuously during normal operation, thus ensuring the availability and performance of the system. System pressure testing will be performed in accordance with ANSI B31.1. Preliminary tests are performed as described in Section 14.2.12.

9.3.2.2.5 Instrumentation Requirements

A common control switch with indicating lights is provided at the hotwell sample panel for the condenser hotwell sample pumps. These

pumps are provided to draw continuous condensate samples from the condenser hotwell, discharging these samples through inline conductivity measuring equipment and then back to the condenser hotwell.

A chilled water bath level control valve is provided to admit TPCCW to the chilled water bath when the level drops to the low level set-point, and to close when the proper level is reached.

Sample pressure reducing valves and flow regulating valves modulate to maintain a set sample pressure and flow prior to entry to the chilled water bath and analytical equipment.

A chilled water bath temperature control valve modulates to admit chilled water to the bath cooling coils to maintain a set bath temperature.

Each sample cooler effluent, except the heater drain pump discharge, has a normally open temperature solenoid valve that closes on high temperature.

A sodium analyzer is provided on the turbine plant panel for the condensate pump discharge, steam generator feedwater pump discharge, and heater drain pump discharge.

An oxygen indicator is provided on the turbine plant sample panel for the condensate pump discharge and steam generator feedwater pump discharge.

Conductivity analyzer/indicators are provided on the turbine plant sample panel for the condensate pump discharge, steam generator feedwater pump discharge, steam generator feedwater pump suction, three (3) main steam lines, and the heater drain pump discharge.

A hydrazine analyzer is provided on the turbine plant sample panel for the steam generator feedwater pump discharge.

A pH analyzer/indicator is provided on the turbine plant sample panel for the steam generator feedwater pump discharge.

A multi-pen recorder is provided on the turbine plant sample panel with the following inputs:

1. Conductivity inputs: main steam line loop I sample to cation exchanger, main steam line loop I sample from cation exchanger, main steam line loop II sample to cation exchanger, main steam line loop II sample from cation exchanger, main steam line loop III sample to cation exchanger, main steam line loop III sample from cation exchanger, condensate pump discharge sample to cation exchanger, condensate pump discharge sample from cation exchanger, steam generator feedwater pump discharge sample to cation exchanger, steam generator feedwater pump discharge from cation exchanger, heater drain pump discharge sample to cation exchanger, heater drain pump discharge sample from cation exchanger, and steam generator feedwater pump suction.

2. pH inputs: steam generator feedwater pump discharge sample.

3. Sodium inputs: condensate pump discharge sample, steam generator feedwater pump discharge sample, heater drain pump discharge sample.

4. Oxygen inputs: steam generator feedwater pump discharge sample, condensate pump discharge sample.

5. Hydrazine inputs: steam generator feedwater pump discharge sample.

Annunciation is provided in the main control room for turbine plant sample panel trouble, which consists of main steam line conductivity high, steam generator feedwater pump discharge conductivity high, steam generator feedwater pump discharge hydrazine low, steam generator feedwater pump discharge pH high-low, steam generator feedwater pump discharge sodium high, steam generator feedwater pump discharge oxygen high, condensate pump discharge oxygen high, condensate pump discharge sodium high, condensate pump discharge conductivity high, condenser

hotwell conductivity high, condenser hotwell sodium high, heater drain pump discharge conductivity high, heater drain pump discharge sodium high, and chilled water bath temperatures high-low. These conditions are also monitored by the BVPS-2 computer system.

Annunciation is provided at the turbine plant sample panel main steam high conductivity, hotwell/condensate pump discharge high sodium, steam generator feedwater pump discharge/condensate pump discharge high/low pH, steam generator feedwater pump discharge hydrazine high/low, condensate pump discharge high oxygen, pumps/hotwell high conductivity, and isobath temperature high/low.

9.3.2.3 Deleted

9.3.3 Equipment and Floor Drainage System

9.3.3.1 Design Bases

The design bases of the reactor plant vent and drain system are:

1. Sumps and sump pumps are sized to handle the expected leakage in the areas served by each sump. Each sump is provided with two pumps for redundancy and to handle surges in flow, except the in-core instrument tunnel sump, gaseous waste storage vault sump, and fuel pool telltale drains catch tank, which all have one pump per sump due to small anticipated leak collection requirements.

2. The majority of the vent and drain system is nonsafety-related and designated NNS. However, there are two portions of the vent and drain system that are considered safety-related. First, containment penetration piping and valves in aerated, gaseous, and hydrogenated portions of the vent and drain system are designated Safety Class 2, Seismic Category I, and designed in accordance with Regulatory Guide 1.29 and QA Category I (Section 6.2.4). Secondly, the portion of the hydrogenated drain system where the RCS spray line scoop drain, RCS excess letdown, and RCS loops drain into a common header is designated Safety Class 1, Seismic Category I, and designed in accordance with Regulatory Guide 1.29 and QA Category I.

3. Each sump has a stainless steel liner to prevent possible diffusion of radioactive fluids through the concrete and to aid in surface decontamination.

4. Sweep gas ventilation is provided on the sumps in the auxiliary building and waste handling area to prevent radioactive gases from venting to the building atmosphere.

5. Valve stem leakoff piping is primarily of welded design to limit leakage of hydrogen and radioactive gases to the building atmosphere, except where flanges are considered necessary for isolation of the system.

6. All vents, aerated and gaseous, are collected and piped via headers to the gaseous waste disposal (GWD) system for discharge to avoid the spread of contaminated gases throughout the building.

9.3.3.2 System Description

The reactor plant vent and drain system collects potentially radioactive fluids and gases from various systems and discharges either to the GWD system (Section 11.3), the liquid waste disposal (LWD) system (Section 11.2), or the boron recovery system (BRS) (Section 9.3.4.6).

The drains are separated into those which contain air (aerated drains) and those which contain hydrogenated reactor coolant fluid. Aerated drains are sent to the LWD system. Hydrogenated drains are sent to the BRS for processing and recovery.

The vents are separated into those which contain air (aerated vents) and those in which hydrogen and radioactive gases are predominant (gaseous vents). Both aerated and gaseous vents are directed separately to the BVPS-1 process vent via the BVPS-1 and BVPS-2 GWD systems.

The vent and drain system component design parameters are given in Table 9.3-6.

Sumps are located in the reactor containment, incore instrumentation tunnel, safeguards areas, tunnel between the reactor containment and auxiliary building, auxiliary building, fuel pool tell-tale drains catch tank, decontamination building, fuel building, condensate polishing building, gaseous waste tank area, and waste handling area. The collected aerated drainage is transferred by sump pumps to the liquid waste drain tanks in the LWD system (Section 11.2).

In the event of high radioactivity, turbine building drains are also transferred to the steam generator blowdown hold tanks instead of discharging via the storm drain system to the Ohio River.

The containment sump collects open drains from the containment and post-accident sample returns from the post-accident sampling system (PASS). The water accumulation in the containment sump is monitored to determine unidentified leakage from the reactor coolant pressure boundary described in Section 5.2.5. The auxiliary building sumps collect floor drains, drains from equipment, ion exchanger drains, and filter drains. The other sumps collect floor drains in their respective areas.

The sumps located in the reactor containment, auxiliary building, safeguards areas, and tunnel between the reactor containment and auxiliary building may be sampled and analyzed during normal plant operation and after an accident using the PASS. The respective sump pumps (with the exception of the containment sump) have isolation valves that switch the normal pump discharge to a bypass which discharges to the PASS panel. The containment sump uses a separate PASS sump pump to transfer liquid to the PASS panel.

Drainage from systems containing reactor coolant or from systems into which reactor coolant might leak (hydrogenated drains) are collected in the PDTT. The PDTT, 2DGS-TK21, located in the containment, receives drains directly from the reactor coolant pump (RCP) numbers two and three seal leakoffs, and also receives drains via the primary drains cooler from the reactor flange leak detection line, the safety injection accumulators, and valve stem leakoffs within the containment. The PRT (Section 5.4) collects reactor coolant from the major relief valve discharges in the RCS, RHR system, the chemical and volume control system (CVCS) (Section 9.3.4), and PASS sample returns. The primary drains transfer pumps, 2DGS-P21A & B, pump the PDTT contents to the degasifiers of the BRS. The primary drains transfer pumps are also used to manually drain the PRT.

The reactor coolant loops can be drained directly or via the excess letdown heat exchanger (Section 9.3.4.2) and primary drains cooler to the PDTT, 2DGS-TK21, inside the containment. All or part of the RCS, with the exception of the reactor vessel, can also be drained to this PDTT.

The PDTT, 2DGS-TK22, located in the auxiliary building, receives drains and relief valve discharge from the VCT, valve stem leakoffs, the sample system liquid header, non-accident sample returns from the PASS, degasifier vent chiller drains, gaseous waste steam trap drains, and charging pump drains. The contents of the PDTT are pumped to the BRS degasifiers.

Two recirculation drain pumps are provided in the safeguards area. They are used in the cans of the recirculation spray pumps (deep-well, vertical pumps). Section 6.2.2.2.2 describes the recirculation spray pumps. The recirculation drain pumps can either discharge to a catch basin in the yard or to the sump in the safeguards building.

Radioactive gases and hydrogen that are vented during normal operation from the PRT, the VCT, the PDTT, and the sampling system gas sample purge line go directly to the gaseous waste disposal system (GWD).

The safety-related sections of piping for the vent and drain system are designed in accordance with ASME Section III. Austenitic stainless steel piping or tubing is used for the transfer of liquids and radioactive gaseous waste, while carbon steel piping is used for non-radioactive gases. Containment isolation valves are provided in all vent and drain lines from the containment. For details, refer to Section 6.2.4.

9.3.3.3 Safety Evaluation

The vent and drain system is sized to handle the maximum amount of liquids and gases expected during normal station operation.

All sumps, except incore instrumentation, gaseous waste storage vault sump, and fuel pool telltale drains catch tank are provided with a double pump arrangement. Operation of the pumps is alternated in service. One pump is on automatic service while the other is on standby. Each pump is full-sized and independently controlled. When the water level in the sump reaches a specified height, one of the pumps will start. If the water level reaches a specified higher level, the second pump starts. The pump(s) will stop automatically upon emptying the sump. Each sump is also provided with a high level alarm. A CIA signal closes the associated containment isolation valves, which also have limit switches that stop the reactor containment sump pumps.

The primary drains transfer pumps are full-sized and independently controlled. Two pumps are provided for each tank. One pump is on automatic service and the other is on standby. When the water level in the tank reaches a specified high level, one of the pumps is started. If the water level reaches a specified higher level, the other pump also starts. The pumps(s) stops automatically upon emptying the tank. Each tank is also provided with a high level alarm. A CIA signal closes the associated containment isolation valves, which have limit switches that stop the primary drains transfer pumps 2DGS-P21A & B.

During normal unit operation, proper operation of the vent and drain system precludes radiological hazard to the public or operating personnel from the drainage or venting of nuclear plant equipment or system components. All drainage liquid which is potentially radioactive is collected, pumped to the BRS degasifiers, and either returned to the RCS or processed for disposal. All vent gas goes to the GWD system.

All liquid drains originating inside containment are collected in either the PRT, the PDTT, 2DGS-TK21, or the containment sump. this arrangement initially retains in the containment all leakage originating from components within the containment, thereby segregating any radiation hazard to operating personnel or to the public that could result from the leakage. Subsequent to collection, the leakage is either returned via the boron recovery degasifiers to the RCS or the LWD system. Gaseous buildup in the PRT will be vented to the GWD system.

Sweep gas ventilation affords a positive means of preventing gaseous outleakage from tanks or confined areas. Application of exhaust ventilation to a tank or confined area draws out any gases contained therein and replaces them with outside air drawn in through a vent. This clean air sweeps through the ventilated area and out again to the GWD system. The sweep gas prevents any gases entrained in the liquid from diffusing into the

auxiliary building atmosphere. Leakage from certain components in the auxiliary building is treated in this same fashion. Leakage or drainage from other components in the auxiliary building which are known to pose a radiation hazard is directed to the PDTT, 2DGS-TK22, and is subsequently returned to the RCS via the BRS. If unit tankage that is normally vented to the atmosphere should contain potentially radioactive water, it is subject to sweep gas ventilation, thus preventing any build up of hydrogen in the tanks and escape of entrained gases to the atmosphere. The sweep gas is routed to the GWD system.

Other areas within BVPS-2 in which radioactive leakage or drainage may be generated are designed with a drainage system with collection sumps. Any drainage collected is pumped to the LWD system.

Because leakage and drainage to the auxiliary building and waste area sumps from the RCA and its subsystems have the potential of carrying entrained radioactive gases and hydrogen, these sumps are covered and ventilated with sweep gas which exhausts to the GWD system. In this manner, any entrained gases, which may be released from the liquid in the sumps, will enter the GWD system and not the building atmosphere. Other area sumps do not have this provision since drainage to these sumps originates from systems which are not anticipated to contain entrained radioactive gases or hydrogen.

9.3.3.4 Inspection and Testing

Preliminary tests are performed as described in Section 14.2.12. ASME Section XI in-service inspection is performed, as necessary, in accordance with Chapter 16.

Testing of this system is in accordance with the BVPS-2 Technical Specifications. Continued routine observations and preventive maintenance are performed in accordance with normal station maintenance procedures.

9.3.3.5 Instrumentation Requirements

Selector switches with indicating lights are provided in the main control room for the incore instrument sump pump. This sump pump is used to pump out the incore sump into the reactor containment sump. Operation of this pump may be manual or automatic when the incore instrument sump level is high.

Selector switches with indicating lights are provided in the main control room for the reactor containment sump pumps. These pumps discharge to the liquid waste drain tanks. These pumps may be operated manually or automatically. Pumps alternate in service as a normal operation. The pumps are started and stopped automatically upon high and low levels, respectively, and a high-high containment sump level will cause both pumps to operate at the same time.

A flow recorder is provided in the main control room for containment sump pump flow.

Level indication is provided in the main control room for incore instrument sump level and reactor containment sump level.

A level recorder is provided in the main control room for reactor containment sump level.

A selector switch with indicating lights is provided in the main control room for the reactor containment sump pump discharge (inside containment) isolation valve. A control switch with indicating lights is provided in the main control room for the reactor containment sump pump discharge (outside containment) isolation valve. These valves are piped in series at the containment penetration for the combined discharge line of the pumps and are interlocked with the containment isolation system.

These containment sump pump discharge isolation valves automatically close when a CIA signal exists. If either discharge isolation valve is closed, in conjunction with either containment sump pump running for a predetermined time, it will automatically stop the respective containment sump pump.

Control switches with indicating lights are provided in the main control room for the primary drains transfer pumps (inside containment). These pumps discharge the tank contents to the degasifier system supply header. The pumps may be started manually or automatically. The lead pump starts on a high tank level, while the backup pump starts on a high-high tank level.

Control switches with indicating lights are provided in the main control room for the primary drains transfer pumps (outside containment). These pumps may be started manually or automatically. The lead pump starts on a high tank level while the backup starts on a high-high tank level.

A selector switch with indicating lights is provided in the main control room for the primary drains transfer discharge header (inside containment) isolation valve. A control switch with indicating lights is provided in the main control room for the primary drains transfer discharge header (outside containment) isolation valve. These valves are piped in series to isolate the system during a CIA, and will automatically close when a CIA signal exists. Either discharge header isolation valve being closed, in conjunction with either primary drains transfer pump running for a predetermined time, will automatically stop the respective primary drains transfer pump.

Selector switches with indicating lights are provided in the main control room for each isolation valve on the vent headers from the PDTTs (inside and outside containment). The valves are closed automatically on a high-high level in its respective PDTT.

Hand/auto control stations are provided in the main control room for the PDTTs (inside and outside containment) nitrogen pressure control valves. These valves ensure that a minimum pressure is maintained within the respective transfer tank to prevent in-leakage of oxygen into the primary drains transfer system provided its respective PDTT vent header isolation valve is closed. The nitrogen pressure control valves will close when its respective PDTT vent header isolation valve is opened.

Control switches with indicating lights are provided in the main control room for the primary drains cooler cooling water supply and return valves. The cooling water valves will open provided there is no CIA signal and will close when the CIA signal is present or the CCW surge tank level is low-low.

Selector switches with indicating lights are provided locally for the north and south safeguards area sump pumps, tunnel sump pumps, fuel building sump pumps, auxiliary building sump pumps, decontamination building sump pumps, and the waste area sump pumps. All these pumps may be started manually or automatically.

A level recorder is provided in the main control room for the PDTT level (inside containment).

Level indication is provided in the main control room for the PDTTs (inside and outside containment) levels. Level indicators in the main control room also monitor the safeguards area sump levels, rod control area pipe tunnel sump level, and the auxiliary building sumps levels.

Pressure indication is provided in the main control room for the primary drains transfer pumps (inside and outside containment) discharge pressure. Pressure indication is also provided in the main control room for the PDTT (inside and outside containment) transfer tank pressure.

Temperature indication is provided in the main control room for the PDTT (inside containment) inlet temperature. Annunciator displays, with associated BVPS-2 computer inputs, are provided in the main control room for incore instrument sump or containment sump level high, and the reactor containment sump pump isolation valve not reset. Annunciation is also provided for the unidentified leakage monitor system, which consists of unidentified leakage system trouble, unidentified leakage flow greater than 60 gal/hr, and unidentified leakage controller failure. Alarms are provided for the primary drains transfer pump (inside and outside containment) or PDTT trouble, which consists of transfer pumps motor thermal overload, transfer tanks level low-low and high-high, transfer tanks pressure low and high, and transfer pumps (inside containment) discharge valves trouble. Annunciators with computer inputs are also provided for the north/south safeguards areas sump level high, rod control area pipe tunnel sump level high, fuel building sump level high, auxiliary building sump level high, decontamination building sump level high, condensate polishing building sump

level high, waste handling area sump level high, fuel pool telltale drains catch tank level high, waste instrument sump level high, containment sump level, unidentified leakage pumps after start, and the unidentified leakage monitor system cycle time (Section 5.2.5). Computer inputs are also provided for the PDTT (inside and outside containment) level and pressure, and for the PDTT (inside containment) inlet temperature.

9.3.4 Chemical and Volume Control System

The CVCS, shown on Figure 9.3-21, provides the following services to the RCS:

1. Maintenance of programmed water level in the pressurizer (maintains required water inventory in the RCS),

2. Maintenance of seal water injection flow to the RCPs,

3. Control of reactor coolant water chemistry conditions (for corrosion control), activity level, soluble chemical neutron absorber concentration (for reactivity control), and makeup,

4. Emergency core cooling. Part of the system is shared with the emergency core cooling system (ECCS),

5. Provide means for filling and draining the RCS, and

6. Cold shutdown. Part of the CVCS functions in conjunction with the other systems of the cold shutdown design (Sections 5.4.7 and 6.3).

9.3.4.1 Design Bases

System design parameters are given in Table 9.3-7, with qualitative descriptions given as follows.

9.3.4.1.1 Reactivity Control

The CVCS regulates the concentration of chemical neutron absorber (boron) in the reactor coolant to control reactivity changes resulting from the change in reactor coolant temperature between cold shutdown and hot full power operation, burnup of fuel and burnable poisons, buildup of fission products in the fuel, and xenon transients.

Reactor Makeup Control

1. The CVCS is capable of borating the RCS through one of several flow paths and from either one of two boric acid sources.

2. The amount of boric acid stored in the CVCS always exceeds that amount required to borate the RCS to cold shutdown concentration, assuming that the rod cluster control assembly with the highest reactivity worth is stuck in its fully withdrawn position. This amount of boric acid also exceeds the amount required to bring the reactor to hot standby and to compensate for subsequent xenon decay.

3. The CVCS is capable of borating the RCS to cold shutdown concentration using only safety grade equipment to provide a continuous flow of 4 weight percent boric acid solution.

9.3.4.1.2 Regulation of Reactor Coolant Inventory

The CVCS maintains the coolant inventory in the RCS within the allowable pressurizer level range for all normal modes of operation, including startup from cold shutdown, full power operation, and plant cooldown. This system also has sufficient makeup capacity to maintain the minimum required inventory in the event of minor RCS leaks. (Chapter 16 discusses maximum allowable RCS leakage.)

9.3.4.1.3 Reactor Coolant Purification

The CVCS is capable of removing fission, activation products, and corrosion products, in ionic form or as particulates, from the RCS in order to control radiation levels to allow access to process lines carrying reactor coolant during operation and to minimize radioactive releases due to leaks.

9.3.4.1.4 Chemical Additions to the Reactor Coolant System

The CVCS provides a means for adding chemicals to the RCS, which controls the pH of the reactor coolant during initial start-up and subsequent operation, scavenges oxygen from the reactor coolant during start-up, and counteracts the production of oxygen in the reactor coolant due to the radiolysis of water in the core region. Hydrogen peroxide may be added during plant shutdown as part of RCS activity reduction efforts.

The CVCS is capable of maintaining the oxygen content and pH of the reactor coolant within limits specified in Table 5.2-5.

9.3.4.1.5 Seal Water Injection

The CVCS is able to continuously supply filtered borated water to each RCP seal, as required by the RCP design specified in Table 9.3-7.

9.3.4.1.6 Emergency Core Cooling

The centrifugal charging pumps in the CVCS also serve as the high head safety injection (HHSI) pumps in the ECCS. Other than the centrifugal charging pumps and associated piping and valves, the CVCS is not required to function during a loss-of-coolant accident (LOCA). During a LOCA, the CVCS is isolated except for the centrifugal charging pumps and the piping in the safety injection path.

Section 6.3 provides further information on the function of the charging pumps during a LOCA.

9.3.4.1.7 Safe Shutdown

The CVCS provides a safety grade means of boration of the RCS to achieve the required cold shutdown concentration. The boric acid tanks, boric acid pumps, charging pumps, portions of the HHSI headers, and throttling valves are provided for boration (Section 6.3). The CVCS also provides for safety grade means of RCS inventory control, utilizing the aforementioned components in conjunction with the reactor vessel head letdown system described in Section 5.4.15. For a complete description of safety grade cold shutdown capability, see Appendix 5A. A nonsafety grade means of storing RCS letdown at the BVPS-1 reactor coolant recovery tanks during abnormal conditions, when the normal letdown path and/or the boron recovery system are inoperable, is also provided (Section 9.3.4.2.1).

9.3.4.2 System Description

The CVCS is shown on Figure 9.3-21, with system design parameters listed in Table 9.3-7. The codes and classifications to which the individual components of the CVCS are designed are listed in Section 3.2. The CVCS consists of three subsystems: the charging, letdown, and seal water system; the reactor coolant purification and chemistry control system; and the reactor makeup control system.

9.3.4.2.1 Charging, Letdown, and Seal Water System

The charging and letdown functions of the CVCS maintain a programmed water level in the RCS pressurizer, thus maintaining proper reactor coolant inventory during all phases of plant operation. This is achieved by means of a continuous feed and bleed process during which the feed rate is automatically controlled based on pressurizer water level. The bleed rate can be chosen to suit various plant operational requirements by selecting the proper combination of letdown orifices in the letdown flow path. Additionally, a part of the charging system is used in the cold shutdown system design (Section 5.4.7).

Reactor coolant is discharged to the CVCS from a reactor coolant loop cold leg, then flows through the shell side of the regenerative heat exchanger, where its temperature is reduced by heat transfer to the charging flow passing through the tubes. The coolant then experiences a large pressure reduction as it passes through the letdown orifice(s) and flows through the tube side of the letdown heat exchanger where it is further cooled by CCW. Downstream of the letdown heat exchanger, a second pressure reduction occurs. This pressure reduction is performed by the low pressure letdown pressure control valve, which maintains upstream pressure and thus prevents flashing downstream of the letdown orifices.

Using either the demineralizer flow path or the direct bypass to the VCT, the coolant flows through the reactor coolant filter, through a sparger for hydrogen dispersing and then into the VCT through a spray nozzle in the top of the tank. Hydrogen, from either the GWD system (Section 11.3) or the generator hydrogen control system (Section 10.2.2.5), may be continuously supplied to the VCT via an in-line bayonet sparger located approximately 80 feet upstream of the VCT in the letdown pipe and also via a connection directly to the top of the VCT. There the hydrogen mixes with fission gasses which are stripped from the reactor coolant into the VCT gas space. The contaminated hydrogen may be vented back to the degasifiers in the BRS, (Section 9.3.4.6), or the hydrogen and fission gasses from the letdown are processed by the BRS. The partial pressure of hydrogen in the VCT determines the concentration of hydrogen dissolved in the reactor coolant for control of oxygen produced primarily by radiolysis of water in the core.

Three centrifugal charging pumps take suction from the VCT and return the cooled, purified reactor coolant to the RCS. Normal charging flow is handled by one of the three charging pumps. This charging flow splits into two paths. The bulk of the charging flow is pumped back to the RCS through the tube side of the regenerative heat exchanger. The letdown flow in the shell side of the regenerative heat exchanger raises the charging flow to a temperature approaching the reactor coolant temperature. The flow is then injected into a cold leg of the RCS. A second flow path is also provided from the regenerative heat exchanger outlet to the pressurizer spray line. An MOV in the spray line provides auxiliary spray to the vapor space of the pressurizer during plant cooldown. This provides a means of cooling the pressurizer when the RCPs, which normally provide the driving head for the pressurizer spray, are not operating.

A portion of the charging flow is directed to the RCPs (nominally 8 gpm per pump) through a seal water injection filter. It is directed down to a point between the pump radial bearing and the thermal barrier heat exchanger cooling coils. Here the flow splits and a portion (nominally 5 gpm per pump) enters the RCS through the labyrinth seals and thermal barrier.

The remainder of the flow is directed up the pump shaft, cooling the radial bearing, and to the number 1 seal leakoff. The number 1 seal leakoff flow discharges to a common manifold, exits from the containment, and then passes through the seal water return filter and the seal water heat exchanger to the suction side of the charging pumps. A very small portion of the seal flow leaks through to the number 2 seal. A number 3 seal provides a final barrier to leakage of reactor coolant to the containment atmosphere. The number 2 leakoff flow is discharged to a standpipe which maintains a back pressure head between the number 2 and number 3 seals. Overflow from the standpipe, as well as the number 3 seal leakoff flow, is discharged to the PDTT (inside containment). When RCS pressure is below 1,000 psig, bypass flow is provided to normal injection flow to cool the RCP.

The excess letdown path is provided as an alternate letdown path from the RCS in the event that the normal letdown path is inoperable. The reactor head vent system also provides this function (Sections 5.4.7 and 5.4.15). Reactor coolant can be discharged from each or all of the RCS cold legs. The coolant then flows through the tube side of the excess letdown heat exchanger where it is cooled by component cooling water. Normally closed MOVs are provided in each excess letdown line from the RCS. Downstream of the heat exchanger a remote-manual control valve controls the letdown flow. The flow normally joins the number 1 seal discharge manifold and passes through the seal water return filter and heat exchanger to the suction side of the charging pumps. The excess letdown flow can also be directed to the PDTT (inside containment) so that it bypasses the number 1 seal return manifold. When the normal letdown line is not available, the normal purification path is also not in operation. Therefore, this alternate condition would allow continued power operation for a limited period of time, dependent on RCS chemistry and activity. The excess letdown flow path also provides additional letdown capability during the final stages of plant heatup. This path removes some of the excess reactor coolant due to coolant expansion as a result of the RCS temperature increase.

Surges in RCS inventory due to load changes are accommodated for the most part in the pressurizer. The VCT provides surge capacity for reactor coolant expansion not accommodated by the pressurizer. If the water level in the VCT exceeds the normal operating range, a proportional controller modulates a three-way valve downstream of the reactor coolant filter to divert a portion of the letdown to the BRS. If the high level limit in the VCT is reached, an alarm is actuated in the main control room and the letdown flow is completely diverted to the BRS. As previously discussed, letdown flow can also be diverted to the BVPS-1 coolant recovery tanks for storage in the event that the path to the BRS is inoperable.

Low level in the VCT initiates makeup from the reactor makeup control system. If the reactor makeup control system does not supply sufficient makeup water to keep the VCT level from falling to a lower level, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, an emergency low level signal from either level channel causes the suction of the charging pumps to be transferred to the refueling water storage tank (RWST).

9.3.4.2.2 Reactor Coolant Purification and Chemistry Control System

Reactor coolant water chemistry specifications are given in Table 5.2-5.

pH Control

The pH control chemical employed is lithium hydroxide. This chemical is chosen for its compatibility with the materials and water chemistry of borated water/stainless steel/zirconium inconel systems. In addition, lithium-7 is produced in the core region due to irradiation of the dissolved boron in the coolant.

The concentration of lithium-7 in the RCS is maintained in the range specified for pH control (Table 5.2-5). If the concentration exceeds this range, as it may during the early stages of a core cycle, the cation bed demineralizer is employed in the letdown line in series operation with a mixed bed demineralizer. Since the amount of lithium to be removed is small and its buildup can be readily calculated, the flow through the cation bed demineralizer is not required to be full letdown flow. If the concentration of lithium-7 is below the specified limits, lithium hydroxide can be introduced into the RCS via the charging flow. The solution is prepared in the laboratory and poured into the chemical mixing tank. Reactor makeup water is then used to flush the solution to the suction manifold of the charging pumps.

Oxygen Control

During reactor startup from the cold condition, hydrazine is employed as an oxygen scavenging agent. The hydrazine solution is introduced into the RCS in the same manner as described previously for the pH control agent.

Hydrogen is employed to control and scavenge oxygen produced due to radiolysis of water in the core region. Sufficient partial pressure of hydrogen is maintained in the VCT such that the specified equilibrium concentration of hydrogen is maintained in the reactor coolant. A pressure control valve maintains a minimum pressure in the vapor space of the VCT. This valve can be adjusted to provide the correct equilibrium hydrogen concentration (25 to 50 cc hydrogen at standard temperature and pressure (STP) per kilogram of water). Hydrogen is supplied from the GWD system or from the generator hydrogen control system.

Reactor Coolant Purification

The letdown stream flows through a mixed bed demineralizer. Two mixed bed demineralizers are provided in the letdown line to provide cleanup of the letdown flow. The demineralizers remove ionic corrosion products and certain fission products. One demineralizer is normally in continuous service and can be supplemented intermittently by the cation bed demineralizer, if necessary, for additional purification. The cation resin removes principally cesium and lithium isotopes from the purification flow. The second mixed bed demineralizer serves principally as a standby unit for use if the operating demineralizer becomes exhausted during operation.

A cleanup feature is provided for use during cold shutdown and RHR operation. A remote operated valve admits a bypass flow from the RHR system into the letdown line upstream of the letdown heat exchanger. The flow passes through the heat exchanger, through a mixed bed demineralizer, and the reactor coolant filter to the VCT. The fluid is then returned to the RCS via the normal charging route.

Filters are provided at various locations to ensure filtration of particulate and resin fines and to protect the seals on the RCPs.

Degasification is performed by diverting a selected amount of the letdown flow to the degasifiers in the BRS. The degassed letdown is then returned either to the VCT or diverted to the SGB hold tanks, or the BVPS-1 coolant recovery tanks, for storage.

9.3.4.2.3 Reactor Makeup Control System

The soluble neutron absorber (boric acid) concentration is controlled by the reactor makeup control system. The reactor makeup control system is also used to maintain proper reactor coolant inventory. In addition, redundant emergency boration flow paths are provided from the boric acid tanks or makeup from the RWST directly to the suction of the charging pumps. Borated water from the charging pumps can be provided to the RCS via the normal charging line or via the HHSI headers which serve as the redundant, safety grade method of boration during abnormal conditions. Sections 5.4.7 and 6.3 provide details on the cold shutdown design.

The reactor makeup control system provides a manually pre-selected makeup composition to the charging pump suction header or to the VCT. The makeup control system functions are those of maintaining desired operating fluid inventory in the VCT and adjusting reactor coolant boron concentration for reactivity control. Primary grade water and boric acid solution (nominal 4 weight percent) are blended together to obtain the reactor coolant boron concentration for use as makeup to maintain VCT inventory, or they can be used separately to change the reactor coolant boron concentration.

The boric acid is stored in two boric acid tanks. Two boric acid transfer pumps are provided, with one pump normally aligned to provide boric acid to the suction header of the charging pumps and the second pump in reserve. On a demand signal by the reactor makeup controller, the valve opens and delivers a preset mix of primary grade boric acid to the suction header of the charging pumps. The boric acid transfer pump can also be used to recirculate the boric acid tank fluid.

All portions of the CVCS which normally contain concentrated boric acid solution (nominal 4 weight percent) are required to be located within a heated area in order to maintain solution temperature at ≥65°F. If a portion of the system which normally contains concentrated boric acid solution is not located in a heated area, it is provided with some other means (such as heat tracing) to maintain the solution temperature at ≥65°F.

The primary grade water pumps, taking suction from the primary grade water storage tanks, are employed for various makeup and flushing operations throughout the systems. These tanks and pumps are shared equipment and are located at BVPS-1. One of these pumps runs continuously on recirculation. On demand from the reactor makeup controller, the CVCS control valve opens and provides flow to the suction header of the charging pumps or to the VCT through the letdown line and spray nozzle.

During reactor operation, changes are made in the reactor coolant boron concentration for the following conditions:

1. Reactor startup - boron concentration must be decreased from shutdown concentration to achieve criticality,

2. Load following - boron concentration must be either increased or decreased to compensate for the xenon transient following a change in load,

3. Fuel burnup - boron concentration must be decreased to compensate for fuel burnup and the buildup of fission products in the fuel, or

4. Cold shutdown - boron concentration must be increased to the cold shutdown concentration.

The reactor makeup control system can be set up for the following modes of operation:

1. Automatic Makeup

   The automatic makeup mode of operation of the reactor makeup control system provides blended boric acid solution to match the boron concentration in the RCS. Automatic makeup compensates for minor leakage of reactor coolant without causing significant changes in the reactor coolant boron concentration.

Under normal plant operating conditions, the mode selector switch is set in the automatic makeup position for initiating system start. This switch position establishes a preset control signal to the total makeup flow controller and establishes positions for the makeup stop valves for automatic makeup. The boric acid flow controller is set to blend the same concentration of borated water as contained in the RCS. A preset low level signal from the VCT level controller causes the automatic makeup control action to start a boric acid transfer pump, open the makeup stop valve to the charging pump suction, and position the boric acid flow control valve and the primary grade water flow control valve. The flow controllers then blend the makeup stream according to the preset concentration. Makeup addition to the charging pump suction header causes the water level in the VCT to rise. At a preset high level point, the makeup is stopped. This operation may be terminated manually at any time.

If the automatic makeup fails, or is not aligned for operation, and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, an emergency low level signal opens the stop valves in the RWST supply line to the charging pumps, and closes the stop valves in the VCT outlet line.

2. Dilution

The dilute mode of operation permits the addition of a pre-selected quantity of primary grade water at a pre-selected flow rate to the RCS. The operator sets the mode selector switch to dilute, the total makeup flow controller set point to the desired flow rate, the total makeup batch integrator to the desired quantity, and initiates system start. This opens the primary grade water flow control valve and opens the makeup stop valve to the VCT inlet. Excessive rise of the VCT water level is prevented by automatic actuation (by the tank level controller) of a three-way diversion valve which routes the reactor coolant letdown flow to the BRS. When the preset quantity of water has been added, the batch integrator causes makeup to stop. Also, the operation may be terminated manually at any time.

3. Alternate Dilution

   The alternate dilute mode of operation, as designated on the switch, is similar to the dilute mode except that a portion of the dilution water flows directly to the charging pump suction, while a portion flows into the VCT via the spray nozzle and then flows to the charging pump suction. This decreases the delay in diluting the RCS caused by directing dilution water to the VCT.

4. Boration

   The borate mode of operation permits the addition of a pre-selected quantity of concentrate boric acid solution at a pre-selected flow rate to the RCS. The operator sets the mode selection switch to borate, the concentrated boric acid flow controller set point to the desired flow rate, the concentrated boric acid batch integrator to the desired quantity, and initiates system start. This opens the makeup stop valve to the charging pumps suction, positions the boric acid flow control valve, and starts the selected boric acid transfer pump, which delivers a nominal 4 weight percent boric acid solution to the charging pumps suction header. The total quantity added in most cases is so small that it has only a minor effect on the VCT level. When the preset quantity of concentrated boric acid solution is added, the batch integrator causes makeup to stop. Also, the operation may be terminated manually at any time.

5. Manual

   The manual mode of operation permits the addition of a pre-selected quantity and blend of boric acid solution to the RWST, or to some other location via a temporary connection. While in the manual mode of operation, automatic makeup to the RCS is precluded. The discharge flow path must be aligned by opening manual valves in the desired path. The manual mode can also be used to provide makeup to the VCT when the auto mode is malfunctioning. The operator sets the mode selector switch to manual, the boric acid and total makeup flow controllers to the desired flow rates, the boric acid and total makeup batch integrators to the desired quantities, and actuates the makeup start switch. The start switch actuates the boric acid flow control valve and the primary grade water flow control valve and starts the pre-selected boric acid transfer pump. When the preset quantities of boric acid and primary grade water have been added, the batch integrators cause makeup to stop. This operation may be stopped manually by actuating the makeup stop switch.

If either batch integrator is satisfied before the other has recorded its required total, the pump and valve associated with the integrator that has been satisfied will terminate flow. The flow controlled by the other integrator will continue until that integrator is satisfied. In the manual mode, the operator normally sets the controls such that the boric acid flow is terminated first to prevent the piping systems from remaining filled with a nominal 4 weight percent boric acid solution.

The quantities of boric acid and primary grade water injected are totalized by the batch counters, and the flow rates are recorded on strip recorders. Deviation alarms sound for both boric acid and primary grade water flow rates when they deviate from their set points.

9.3.4.2.4 Component Description

A summary of principal component design parameters is given in Table 9.3-8, and safety classifications and design codes are given in Section 3.2.

All CVCS piping that handles radioactive liquid is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for hydrostatic testing and maintenance.

Centrifugal Charging Pumps

Three charging pumps are supplied to inject coolant into the RCS. One of these is an installed spare. The pumps are of the single speed, horizontal, centrifugal type. All parts in contact with the reactor coolant are fabricated of austenitic stainless steel or other material of adequate corrosion resistance. The charging pump seals are provided with leakoffs to collect the leakage before it can leak out to the atmosphere. A minimum flow recirculation line to protect the centrifugal charging pumps from a closed discharge valve condition is provided. See Section 6.3 for a description of the charging pump miniflow provisions.

Charging flow rate is determined from a pressurizer level signal. Charging flow control is accomplished by a modulating valve on the discharge side of the centrifugal pumps. The centrifugal charging pumps also serve as HHSI pumps in the ECCS. A description of the charging pump function upon receipt of a safety injection signal is given in Section 6.3.2.2. Power supplies to the charging pumps are provided separately. One pump is powered from the orange Class 1E bus, one is powered from the purple Class 1E bus, and the third pump, which is normally de-energized, can be manually transferred to either Class 1E bus to replace one of the other two pumps.

Boric Acid Transfer Pumps

Two boric acid transfer pumps are supplied. One pump is normally aligned to supply boric acid to the blender while the second serves as a standby. Manual or automatic initiation of the reactor makeup control system will start the one pump to provide a normal makeup of boric acid solution to the blender. Miniflow from this pump flows back to the associated boric acid tank and helps maintain thermal equilibrium. The standby pump can be used intermittently to circulate boric acid solution through the other tank to maintain thermal equilibrium in this part of the system. A redundant emergency boration flow path, which will supply nominal 4 weight percent boric acid solution directly to the suction of the charging pumps, can be provided by opening either a MOV or solenoid-operated valve (at the charging pump suction). These two valves are powered from different Class 1E sources. The transfer pumps also function to transfer solution from the batching tank to the boric acid tanks.

The boric acid transfer pumps are located in the auxiliary building, and the boric acid lines are heat traced as necessary to prevent crystalization of the boric acid solution. All parts in contact with the solution are of austenitic stainless steel.

Regenerative Heat Exchanger

The regenerative heat exchanger is designed to recover heat from the letdown flow by reheating the charging flow, which reduces thermal effects on the charging penetrations into the reactor coolant loop piping.

The letdown stream flows through the shell of the regenerative heat exchanger while the charging stream flows through the tubes. The letdown coolant then experiences a large pressure reduction passing through a restricting orifice upstream of the letdown heat exchanger. The unit is constructed of austenitic stainless steel and is of an all welded construction.

The temperatures of both the letdown and charging outlet streams from the heat exchanger are monitored, with indication given in the main control room. A high temperature alarm is actuated on the main control board if the temperature of the letdown stream exceeds desired limits (Table 9.3-8).

Letdown Heat Exchanger

The letdown heat exchanger cools the letdown stream to the operating temperature of the mixed bed demineralizers. Reactor coolant flows through the tube side of the exchanger while CCW flows through the shell side. All surfaces in contact with the reactor coolant are austenitic stainless steel and the shell is of carbon steel.

The low pressure letdown valve, located downstream of the heat exchanger, maintains the pressure of the letdown flow upstream of the heat exchanger in a range sufficiently high to prevent two-phase flow. Pressure indication and high pressure alarm are provided on the main control board.

The letdown temperature control indicates and controls the temperature of the letdown flow exiting from the letdown heat exchanger. A temperature sensor, which is part of the CVCS, provides input to the controller in the primary CCW system. The exit temperature of the letdown stream is thus controlled by regulating the CCW flow through the letdown heat exchanger. Letdown temperature indication is provided on the main control board. If the outlet temperature from the heat exchanger is excessive, a high temperature alarm is actuated and a temperature control valve diverts the letdown directly to the VCT, bypassing the demineralizers.

The outlet temperature from the shell side of the heat exchanger is allowed to vary over an acceptable range compatible with the equipment design parameters and required performance of the heat exchanger in reducing letdown stream temperature.

Excess Letdown Heat Exchanger

The excess letdown heat exchanger cools excess reactor coolant letdown flow at the flow rate which is equivalent to the portion of the nominal seal injection flow which flows into the RCS through the RCP labyrinth seals.

The excess letdown heat exchanger can be employed either when normal letdown is temporarily out of service, to maintain the reactor in operation, or it can be used to supplement maximum letdown during the final stages of heatup. The letdown flows through the tube side of the unit and CCW is circulated through the shell. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is of carbon steel. All tube joints are welded.

A temperature detector measures the temperature of the excess letdown flow downstream of the excess letdown heat exchanger. Temperature indication and high temperature alarm are provided on the main control board. A pressure sensor indicates the pressure of the excess letdown flow downstream of the excess letdown heat exchanger and excess letdown control valve. Pressure indication is provided on the main control board.

Seal Water Heat Exchanger

The seal water heat exchanger is designed to cool fluid from three sources: RCP number 1 seal leakage, reactor coolant discharged from the excess letdown heat exchanger, and miniflow from a centrifugal charging pump. Reactor coolant flows through the tube side of the heat exchanger, and CCW is circulated through the shell. The design flow rate through the tube side is equal to the sum of the nominal excess letdown flow, maximum design RCP seal leakage which originally assumed operation of the floating ring seals, and miniflow from one centrifugal charging pump. The unit is designed to cool the above flow to the temperature normally maintained in the VCT. All surfaces in contact with reactor coolant are austenitic stainless steel and the shell is of carbon steel.

Volume Control Tank

The VCT provides surge capacity for part of the reactor coolant expansion volume not accommodated by the pressurizer. When the level in the tank reaches the high level set point, the remainder of the expansion volume is accommodated by diversion of the letdown stream to the BRS. The tank also provides one of the means for introducing hydrogen into the coolant to maintain the required equilibrium concentration of 25 to 50 cc hydrogen (at STP per kilogram of water) and may be used for degassing the reactor coolant. It also serves as a head tank for the charging pumps.

Hydrogen is introduced into the letdown stream via an in-line bayonet sparger located upstream of the VCT, and via a direct connection on the VCT from the hydrogen supply system. In addition, a spray nozzle located inside the tank on the letdown line provides additional liquid to gas contact between the incoming fluid and the hydrogen atmosphere in the tank. The hydrogen required is provided by the GWD system or the generator hydrogen control system.

A remotely-operated vent valve, discharging to the GWD system, permits the venting method to be used during normal operation for removal of gaseous fission products. For the normal method of degassification, refer to the BRS Section 9.3.4.6. Relief protection, gas space sampling, and nitrogen purge connections are also provided.

The VCT pressure is monitored, with indication given in the main control room. An alarm is actuated in the main control room for high and low pressure conditions.

Two level channels govern the water inventory in the VCT. Level indication with high and low alarms is provided on the main control board for one controller and local level indication is provided for the other controller. If the VCT level rises above the normal operating range, one level channel provides an analog signal to the proportional controller, which modulates the three-way valve downstream of the reactor coolant filter to maintain the VCT level within the normal operating band. The three-way valve can split letdown flow so that a portion goes to the BRS and a portion to the VCT. The controller would operate in this fashion during a dilution operation when primary grade water is being fed to the VCT from the reactor makeup control system. If the modulating function of the channel fails and the VCT level continues to rise, the high level alarm will alert the operator to the malfunction and the full letdown flow will be automatically diverted by the backup level channel.

During normal power operation, a low level in the VCT initiates auto makeup which injects a pre-selected blend of boric acid solution and primary grade water into the charging pump suction header. When the VCT level is restored to normal, auto makeup stops.

If the automatic makeup fails or is not aligned for operation and the tank level continues to decrease, a low level alarm is actuated. Manual action may correct the situation or, if the level continues to decrease, a low-low signal from either level channel opens the stop valves in the RWST supply line to the charging pump suctions, and closes the stop valves in the VCT outlet line.

Boric Acid Tanks

The combined capacity of the two boric acid tanks is sized to store sufficient boric acid solution for refueling, plus enough for cold shutdown from full power operation immediately following refueling with the most reactive control rod not inserted.

The concentration of boric acid solution in storage is maintained between 4 and 4.4 weight percent. Periodic manual sampling and corrective action, if necessary, assure that these limits are maintained. Therefore, measured amounts of boric acid solution can be delivered to the reactor coolant to control the boron concentration.

A temperature sensor provides temperature measurement of each tank’s contents. Local temperature indication, as well as high and low temperature alarms, are provided on the main control board. Strip heaters are provided to maintain each tank’s contents within the required temperature to prevent boric acid crystallization.

Two level detectors indicate the level in each boric acid tank. Level indication, with high, low, and low-low level alarms, is provided on the main control board. The high alarm indicates that the tank may soon overflow. The low alarm warns the operator to start makeup to the tank. The low-low alarm is set to indicate the minimum level of boric acid in the tank to ensure that sufficient boric acid is available for a cold shutdown with one stuck rod.

Batching Tank

The batching tank is used to provide makeup to the boric acid tanks. A local sampling point is provided for verifying the solution concentration prior to transferring it out of the tank. The tank is provided with an agitator to improve mixing during batching operations and a steam jacket for heating the boric acid solution. A temperature sensor provides temperature measurement of the tank's contents, with local temperature indication. A level sensor provides level measurement of the tank's contents, with local indication.

Chemical Mixing Tank

The primary use of the chemical mixing tank is in the preparation of caustic solutions for pH control, hydrazine solution for oxygen scavenging, and hydrogen peroxide for oxygenation during plant shutdowns as necessary.

Mixed Bed Demineralizers

Two flushable mixed bed demineralizers assist in maintaining reactor coolant purity. A lithium-form cation resin and hydroxyl-form anion resin are charged into one of the demineralizers. The anion resin is converted to the borate form in operation. Both types of resin remove fission and corrosion products. The resin bed is designed to reduce the concentration of ionic isotopes in the purification stream, except for cesium, yttrium, and molybdenum, by a minimum factor of 10. Each demineralizer has more than sufficient capacity for one core cycle with 1 percent of the rated core thermal power being generated by defective fuel rods. One demineralizer is normally in service with the other in standby.

The other demineralizer is normally charged with mixed bed resin. This demineralizer may be charged with cation, anion, or Li-7 cation resin with hydroxyl form anion resin in order to provide flexibility in the support of normal plant operation, shutdown cleanup operations following an activity release, or for reactor coolant deboration purposes.

A temperature sensor monitors the temperature of the letdown flow downstream of the letdown heat exchanger. If the letdown temperature exceeds the maximum allowable resin operating temperature (approximately 140°F), a three-way valve is automatically actuated such that the flow bypasses the demineralizers. Temperature indication and high temperature alarm are provided on the main control board. The air-operated three-way valve in the failure mode will direct flow to the VCT.

Cation Bed Demineralizer

A flushable demineralizer normally charged with cation resin in the hydrogen form is located downstream of the mixed bed demineralizers and is used intermittently to control the concentration of Li^7 which builds up in the coolant from the B^{10} (n, α) Li^7 reaction. The demineralizer also has sufficient capacity to maintain the Cesium-137 concentration in the coolant below 1.0 μCi/cc with 1 percent defective fuel. The resin bed is designed to reduce the concentration of ionic isotopes, particularly cesium, yttrium, and molybdenum by a minimum factor of 10. The demineralizer has more than sufficient capacity for one core cycle with 1 percent of the rated core thermal power being generated by defective fuel rods.

If this demineralizer is not available, other CVCS demineralizers can be used to maintain the Cesium-137 concentration in the coolant below 1.0 μCi per cc with 1 percent defective fuel.

Alternately, the demineralizer may be charged with mixed bed, anion, or Li-7 cation resin with hydroxyl form anion resin in order to provide flexibility in the support of normal plant operation, shutdown cleanup operations following an activity release, or for reactor coolant deboration purposes.

Deborating Demineralizers

Two deborating demineralizers are provided. One of the demineralizer's resin is normally a hydroxyl form anion resin. The capacity is consistent with removing boron to compensate for core burnup beyond about 90 percent of the core cycle. Flow can be diverted to the deborating demineralizers from a point upstream of the mixed bed demineralizers or downstream of the mixed bed and/or the cation bed demineralizer.

Alternately, the demineralizers may be charged with mixed bed, cation, anion, or Li-7 cation resin with hydroxyl form anion resin in order to provide flexibility in the support of normal plant operation, shutdown cleanup operations following an activity release, or for reactor coolant deboration purposes.

Reactor Coolant Filter

The reactor coolant filter is located in the letdown line upstream of the VCT. The filter collects resin fines and particulates from the letdown stream. The nominal flow capacity of the filter is greater than the maximum purification flow rate. Two local pressure indicators are provided to show the pressures upstream and downstream of the reactor coolant filter and thus provide filter differential pressure.

Seal Water Injection Filters

Two seal water injection filters are located in parallel in a common line to the RCP seals where they collect particulate matter that could be harmful to the seal faces. Each filter is sized to accept flow in excess of the normal seal water flow requirements. Normally, one filter is in service with the other in standby. A differential pressure indicator monitors the pressure drop across each seal water injection filter and gives local indication, with high differential pressure alarm on the main control board.

Seal Water Return Filter

This filter collects particulates from the RCP seal water return and from the excess letdown flow. The filter is designed to pass the sum of the excess letdown flow and the maximum design leakage from three RCPs. Two local pressure indicators are provided to show the pressures upstream and downstream of the filter and thus provide differential pressure across the filter.

Boric Acid Filter

The boric acid filter collects particulates from the boric acid solution being pumped from the boric acid tanks by the boric acid transfer pumps. The filter is designed to pass the design flow of two boric acid transfer pumps operating simultaneously. Local pressure indicators indicate the pressure upstream and downstream of the boric acid filter and thus provide filter differential pressure.

Letdown Orifices

Three letdown orifices are provided to reduce the letdown pressure from reactor conditions and to control the flow of reactor coolant leaving the RCS. The orifices are placed into or taken out of service by remote operation of their respective isolation valves. Two of the orifices are designed for normal letdown flow, with one normally on line and the other two serving as standby. One or both of the standby orifices may be used in parallel with the normally operating orifice for either flow control, when the RCS pressure is less than normal, or greater letdown flow during maximum purification or heatup. Each orifice consists of an assembly which provides for permanent pressure loss without recovery, and is made of austenitic stainless steel.

A flow monitor provides indication in the main control room of the letdown flow rate and a high alarm to indicate unusually high flow.

A low pressure letdown controller located downstream of the letdown heat exchanger controls the pressure upstream of the letdown heat exchanger to prevent flashing of the letdown liquid. Pressure indication and high pressure alarm are provided on the main control board.

Valves

Where pressure and temperature conditions permit, diaphragm type valves are used to essentially eliminate leakage to the atmosphere. All packed valves which are larger than 2 inches and which are designated for radioactive services are provided with a stuffing box and lantern leakoff connections. All original plant control (modulating) and three-way valves are either provided with stuffing box and leakoff connections or are totally enclosed. New or replacement control valves contain stuffing box designs that provide an equivalent level of leak protection to the original valves. Leakage to the atmosphere is essentially zero for these valves. The basic material of construction for all valves that handle radioactive liquids or boric acid solutions is austenitic stainless steel.

Relief valves are provided for these lines and components that might be pressurized above design pressure by improper operation or component malfunction:

1. Charging Line Upstream of Regenerative Heat Exchanger

   If the charging side of the regenerative heat exchanger is isolated while the hot letdown flow continues at its maximum rate, the volumetric expansion of coolant on the charging side of the heat exchanger is relieved to the PRT through the pressure relief valve (PRV) upstream of the regenerative heat exchanger.

2. Letdown Line Downstream of Letdown Orifices

   The PRV downstream of the letdown orifices protects the low pressure piping and the letdown heat exchanger from overpressure when the low pressure piping is isolated. The capacity of the PRV is equal to the maximum flow rate through all letdown orifices. The valve set pressure is equal to the design pressure of the letdown heat exchanger tube side.

3. Letdown Line Downstream of Low Pressure Letdown Valve

   The PRV downstream of the low pressure letdown valve protects the low pressure piping and equipment from overpressure when this section of the system is isolated. The overpressure may result from leakage through the low pressure letdown valve. The capacity of the PRV exceeds the maximum flow rate through all letdown orifices. The valve set pressure is equal to the design pressure of the demineralizers.

4. Volume Control Tank

   The PRV on the VCT permits the tank to be designed for a lower pressure than the upstream equipment. This valve capacity was sized to include the RCP floating ring seal return flow, plus excess letdown flow, plus charging pump miniflow for two pumps, and nominal flow from the primary grade water system. With the floating ring seals removed the expected RCP seal leakage is reduced. The valve set pressure equals the design pressure of the VCT.

5. Seal Water Return Line (Inside Containment)

   This PRV relieves overpressurization in the seal water return piping inside containment if the MOV for isolation is closed. The PRV is designed to relieve the maximum leakoff flow from the number 1 seals of the three RCPs plus the design excess letdown flow. The valve is set to relieve at the design pressure of the piping.

6. Seal Water Return Line (Charging Pumps Bypass Flow)

   This PRV protects the seal water heat exchanger and its associated piping from overpressurization. If either of the isolation valves for the heat exchanger are closed and if the bypass line is closed, the piping would be overpressurized by the miniflow from the centrifugal charging pumps. The valve is sized to handle the miniflow from the three centrifugal charging pumps. The PRV is set to relieve at the design pressure of the heat exchanger.

7. Steam Line to Batching Tank

   This PRV protects the low pressure piping and batching tank heating jacket from overpressure when the condensate return line is isolated. The valve is sized to relieve the maximum expected steam inlet flow.

Piping

All CVCS piping that handles radioactive liquids is austenitic stainless steel. All piping joints and connections are welded, except where flanged connections are required to facilitate equipment removal for maintenance and hydrostatic testing.

9.3.4.2.5 System Operation

Reactor Start-up

Reactor start-up is defined as the operations which bring the reactor from cold conditions to normal operating temperature and pressure. It is assumed that:

1. Normal RHR is in progress,

2. Reactor coolant system boron concentration is at the cold shutdown concentration,

3. The reactor makeup control system is set to provide makeup at the cold shutdown concentration,

4. The reactor coolant system is either filled with a pressurizer steam or nitrogen bubble or is drained to minimum level for the purpose of refueling or maintenance. System pressure is maintained by the operation of one charging pump and by the VCT gas overpressure. The RHR/CVCS cross-connect valve is aligned for the letdown flow to bypass the normal letdown via the RHR system, and

5. The charging and letdown lines of the CVCS are filled with coolant at the cold shutdown boron concentration and the letdown orifice isolation valves are closed.

If the RCS requires filling and venting, the following is a representative sequence of events:

1. One charging pump is started, which provides blended flow from the reactor makeup control system at the cold shutdown boron concentration,

2. The vents on the head of the reactor vessel and pressurizer are opened, and

3. The RCS is filled and the vents closed.

Nitrogen gas is placed on the pressurizer and RCS pressure is raised to permit reactor coolant pump operation. A charging pump is in operation, seal water to the RCPs is established, RHRS is in service and letdown is by way of the RHRS to the VCT. The RCPs are intermittently operated and the reactor head is vented in sequence until all air is swept from the loops. RCS pressure is lowered and the head is vented. The primary plant tanks are purged with nitrogen to reduce the oxygen to within chemistry specifications. The pressurizer is filled to a water solid condition and the pressurizer heaters are energized to heat the pressurizer. When the pressurizer is heated to a prescribed temperature, the steam bubble is formed in the pressurizer by manual control of letdown. RCPs can be started and used to heat the RCS. When the pressurizer water level reaches the no-load programmed set point, the pressurizer level control is shifted to control the charging flow to maintain programmed level. The RHRS is then isolated from the RCS and the normal letdown path is established. The pressurizer heaters are now used to increase RCS pressure.

The reactor coolant boron concentration is now reduced by operating the reactor makeup control system in the dilute mode. The reactor coolant boron concentration is corrected to the point where the control rods may be withdrawn and criticality achieved. During heatup, the appropriate combination of letdown orifices is used to provide necessary letdown flow.

Prior to or during the heating process, the CVCS is employed to obtain the current water chemistry in the RCS. The reactor makeup control system is operated on a continuing basis to ensure a desired critical boron concentration. Chemicals are added through the chemical mixing tank to control reactor coolant chemistry such as pH and dissolved oxygen content. Hydrogen overpressure is established in the VCT to assure the appropriate hydrogen concentration in the reactor coolant.

Power Generation and Hot Standby Operation

1. Base Load

   At a constant power level, the rates of charging and letdown are dictated by the requirements for seal water to the RCPs and the normal purification of the RCS. One charging pump is employed and charging flow is controlled automatically by a pressurizer liquid level transmitter signal to the discharge header flow control valve. Occasional adjustments in boron concentration are necessary to compensate for core burnup. As variations in power level occur, some adjustment in boron concentration as well as rod height may be necessary.

   During normal operation, normal letdown flow is maintained and one mixed bed demineralizer is in service. Reactor coolant samples are taken periodically to check boron concentration, water quality, pH, and activity level. The charging flow to the RCS is controlled automatically by the pressurizer level control signal through the discharge header flow control valve.

2. Load Following

   A power reduction will initially cause a xenon buildup followed by xenon decay to a new, lower equilibrium value. The reverse occurs if the power level increases. Initially, the xenon level decreases, then it increases to a new and higher equilibrium value associated with the amount of power level change.

   The reactor makeup control system, or the makeup system and control rod positioning, is normally used to compensate for xenon transients occurring when the reactor power level is changed. The operator may borate or dilute the RCS to compensate for xenon generation or decay.

During periods of plant loading, the reactor coolant expands as its temperature rises. The pressurizer absorbs this expansion as the level controller raises the level set point to the increased level associated with the new power level. The excess coolant due to RCS expansion is letdown and is stored in the VCT. During this period, the flow through the letdown orifice remains constant and the charging flow is reduced by the pressurizer level control signal. This results in an increased temperature at the regenerative heat exchanger outlet. The temperature controller downstream from the letdown heat exchanger increases the CCW flow to maintain the desired letdown temperature.

During periods of plant load reduction, the charging flow is increased to make up for the coolant contraction not accommodated by the programmed reduction in pressurizer level.

3. Hot Standby

For periods of maintenance, or following reactor trips, the reactor can be held subcritical, but with the capability to return to full power within the period of time it takes to withdraw control rods. During this standby period, temperature can be maintained at no-load T_{avg} by initially dumping steam to remove core residual heat, or at later stages, by running RCPs to maintain system temperature.

Following shutdown, xenon buildup occurs and increases the degree of shutdown, that is, with initial xenon concentration and all control rods inserted, the core is maintained at a minimum of 1-percent $\Delta k/k$ subcritical. The effect of xenon buildup is to increase this value to a maximum of about 4-percent $\Delta k/k$ at about 8 hours following shutdown from equilibrium full power conditions. If hot standby is maintained past this point, xenon decay results in a decrease in degree of shutdown. Since the value of the initial xenon concentration is about 3-percent $\Delta k/k$ (assuming that an equilibrium concentration had been reached during operation), boration of the reactor coolant is necessary to counteract the xenon decay and maintain shutdown.

If a rapid recovery is required, dilution of the system may be performed to counteract this xenon buildup. However, after the xenon concentration reaches a peak, boration must be performed to maintain the reactor subcritical as the xenon decays out.

Cold Shutdown

Cold shutdown is the operation which takes the reactor from hot standby conditions to cold shutdown conditions (reactor is subcritical by at least 1-percent $\Delta k/k$ and $T_{avg} \leq 200°F$).

Before initiating a cold shutdown, the RCS hydrogen concentration is lowered by reducing the VCT overpressure, by replacing the VCT hydrogen atmosphere with nitrogen, and by purging to the GWD system.

Before cooldown and depressurization of the reactor plant is initiated, the reactor coolant boron concentration is increased to the cold shutdown value. After the boration is completed and reactor coolant samples verify that the concentration is correct, the operator resets the reactor makeup control system for leakage makeup and system contraction at the shutdown reactor coolant boron concentration.

Contraction of the coolant during cooldown of the RCS causes the pressurizer level to decrease. This causes charging flow to increase which results in a decreasing VCT level. The VCT level controller automatically initiates makeup to maintain the inventory.

After the RHR system is placed in service and the RCPs are shutdown, further cooling of the pressurizer liquid can be accomplished by charging through the auxiliary spray line. Coincident with plant cooldown, a portion of the reactor coolant flow is diverted from the RHR system to the CVCS for cleanup. Demineralization of ionic radioactive impurities and stripping of fission gases via the degasifier (Section 9.3.4.6) reduce the reactor coolant activity level sufficiently to permit personnel access for refueling or maintenance operations. Refer to Section 5.4.7 for additional cold shutdown information.

9.3.4.3 Safety Evaluation

The classification of structures, components and systems is presented in Section 3.2. A further discussion on seismic design categories is given in Section 3.7. Conformance with U.S. Nuclear Regulatory Commission GDC for the plant systems, components, and structures important to safety is presented in Section 3.1. Also, Section 1.8 provides a discussion on Regulatory Guide compliance.

9.3.4.3.1 Reactivity Control

Any time that the unit is at power, the quantity of boric acid retained and ready for injection always exceeds that quantity required for the normal cold shutdown, assuming that the control rod assembly of greatest worth is in its fully withdrawn position. This quantity always exceeds the quantity of boric acid required to bring the reactor to hot standby and to compensate for subsequent xenon decay. An adequate quantity of boric acid is also available in the RWST to achieve cold shutdown.

Two separate and independent flow paths are available for reactor coolant boration: the charging line and the RCP seal injection line. A single failure does not result in the inability to borate the RCS.

If the normal charging line is not available, charging to the RCS is continued via RCP seal injection at the rate of approximately 5 gpm per pump. At the charging rate of 15 gpm (5 gpm per RCP), approximately 6 hours are required to add enough boric acid solution to counteract xenon decay, although xenon decay below the full power equilibrium operating level will not begin until approximately 25 hours after the reactor is shut down.

As backup to the normal boric acid supply, the operator can align the RWST outlet to the suction of the charging pumps.

Since inoperability of a single component does not impair ability to meet boron injection requirements, plant operating procedures allow components to be temporarily out of service for repairs. However, with an inoperable component, the ability to tolerate additional component failure is limited. Therefore, operating procedures generally require immediate action to effect repairs of an inoperable component, restrict permissible repair time, and require demonstration of the operability of the redundant component.

Section 5.4.7 provides a discussion of cold shutdown design.

9.3.4.3.2 Reactor Coolant Purification

The CVCS is capable of reducing the concentration of ionic isotopes in the purification stream as required in the design basis. This is accomplished by passing the letdown flow through one of the mixed bed demineralizers which removes ionic isotopes, except those of cesium, molybdenum and yttrium, with a minimum decontamination factor of 10. Through occasional use of the cation bed demineralizer, the concentration of cesium can be maintained below 1.0 c/cc, assuming 1 percent of the rated core thermal power is being produced by fuel with defective cladding. The cation bed demineralizer is capable of passing the design letdown flow, though only a portion of this capacity is normally utilized. Each mixed bed demineralizer is capable of processing the maximum purification letdown flow rate. If the normally operating mixed bed demineralizer resin has become exhausted, the second demineralizer can be placed in service. Each demineralizer is designed, however, to operate for one core cycle with 1-percent defective fuel.

A cleanup feature is provided for use during RHR operations. A remote-operated valve admits a bypass flow from the RHR system into the letdown line at a point upstream of the letdown heat exchanger. The flow passes through the heat exchanger, then passes through one of the mixed bed demineralizers, and through the reactor coolant filter to the VCT. The fluid is then returned to the RCS via the normal charging route.

The maximum temperature that will be allowed for the mixed bed and cation bed demineralizers is approximately 140°F. If the temperature of the letdown stream approaches this level, the flow will be automatically diverted so as to bypass the demineralizers. If the letdown is not diverted, the only consequence would be a decrease in ion removal capability. Ion removal capability starts to decrease when the temperature of the resin goes above approximately 160°F for anion resin, or above approximately 250°F for cation resin. The resins do not lose their exchange capability immediately. Ion exchange still takes place (at a faster rate) when temperature is increased. However, with increasing temperature, the resin loses some of its ion exchange sites along with the ions that are held at the lost sites. The ions lost from the sites may be re-exchanged farther down the bed. The number of sites lost is a function of the temperature reached in the bed and of the time the bed remains at the high temperature. Capability for ion exchange will not be lost until a significant portion of the exchange sites are lost from the resin.

An effect on reactor operating conditions is the possibility of an increase in the reactor coolant activity level. If the activity level in the reactor coolant were to exceed the limit given in the Technical Specifications, reactor operation would be restricted, as required by the Technical Specifications (Chapter 16). Overheat of resin can lead to corrosive deposits on nuclear fuel as well as formation of deleterious species, which are easily detected by chemical analysis.

9.3.4.3.3 Seal Water Injection

Flow to the RCP seals is assured since there are three charging pumps, any one of which is capable of supplying the normal charging flow plus the nominal seal water flow.

9.3.4.3.4 Hydrostatic Testing of the Reactor Coolant System

Section 5.2.4.7 provides details.

9.3.4.3.5 Leakage Provisions

Components, valves, and piping which are exposed to radioactive service are designed to limit leakage to the atmosphere. The following are preventive means which limit radioactive leakage to the environment:

1. Where pressure and temperature conditions permit, diaphragm type valves are used to essentially eliminate leakage to the atmosphere,

2. All packed valves which are larger than 2 inches and designated for radioactive service at an operating fluid temperature of 212°F or greater and/or pressure $\geq$ 275 psig are provided with a stuffing box and lantern leakoff connections,

3. Welding of all piping joints and connections except where flanged connections are provided to facilitate maintenance and hydrostatic testing, is performed.

The VCT provides an inferential measurement of leakage from the CVCS as well as the RCS. The amount of leakage can be inferred from the amount of makeup added by the reactor makeup control system.

The hydrogen and fission gases in the VCT can be purged to the GWD system via the degasifier, to limit the release of radioactive gases through leakage, by maintaining the radioactive gas level in the reactor coolant several times lower than the equilibrium level. The BVPS-2 is of a continuous degassification design (Section 9.3.4.6). Also provided are two mixed bed demineralizers which maintain reactor coolant purity, thus reducing the radioactivity level of the RCS water.

9.3.4.3.6 Ability to Meet the Safeguards Function

A failure modes and effects analysis (FMEA) of the portion of the CVCS which is safety related (used as part of the ECCS) is included as part of the ECCS FMEA presented in Tables 6.3-5 and 6.3-6.

9.3.4.3.7 Heat Tracing

Heat tracing requirements for boric acid solutions depend mainly on the solution concentration. For this system the concentration of boric acid ranges from 10 ppm to nominal 4 weight percent boric acid. Electrical heat tracing is provided for all CVCS piping and components which contain boric acid of 4 weight percent and are not located in an area where the temperature is at least 65°F. Section 9.3.4.2 provides more information.

9.3.4.3.8 Abnormal Operation

The CVCS is capable of making up for a small RCS leak of approximately 130 gpm, using one centrifugal charging pump, and still maintain seal injection flow to the RCPs. This also allows for minimum RCS cooldown contractions and is accomplished with the letdown isolated.

9.3.4.3.9 Failure Modes and Effects Analysis

The FMEA, summarized in Table 9.3-9, demonstrates that single active component failures do not compromise the CVCS safe shutdown functions of boration and makeup. The FMEA also shows that single failures occurring during CVCS operation do not compromise the ability to prevent or mitigate accidents. These capabilities are accomplished by a combination of suitable redundancy, instrumentation for indication and/or alarm of abnormal conditions, and relief valves to protect piping and components against malfunctions. In addition, the CVCS shares components with ECCS and containment isolation functions. These safeguard functions of the CVCS are addressed in Section 6.3.

9.3.4.4 Inspection and Testing Requirements

As part of plant operation, periodic tests, surveillance inspections, and instrument calibrations are made to monitor equipment condition and performance. Most components are in use regularly and therefore, assurance of the availability and performance of the systems and equipment is provided by main control room and/or local indication.

Technical Specifications and Licensing Requirements Manual requirements have been established concerning calibration, checking, and sampling of the CVCS, and, is addressed in Chapter 16. Preliminary tests are performed as described in Section 14.2.

9.3.4.5 Instrumentation Requirements

Process control instrumentation is provided to acquire data concerning key parameters about the CVCS.

The instrumentation furnishes input signals for monitoring and/or alarming purposes. Indications and/or alarms are provided for the following parameters: temperature, pressure, flow, and water level.

The instrumentation also supplies input signals for control purposes. Some specific control functions are: letdown flow is diverted to the VCT upon high temperature indication upstream of the mixed bed demineralizers, pressure upstream of the letdown heat exchanger is controlled to prevent flashing of the letdown liquid, charging flow rate is controlled during charging pump operation, water level is controlled in the VCT, temperature of the boric acid solution in the batching tank is maintained, and reactor makeup is controlled.

9.3.4.6 Boron Recovery System

The BRS processes reactor coolant letdown and liquid collected in the PDTTs to reduce the concentration of dissolved and entrained gases. The separated gases (hydrogen, nitrogen, argon, krypton, and xenon) are discharged to the GWD system (Section 11.3) for handling and processing. The degassed liquid is either returned to the CVCS (Section 9.3.4) or discharged to either the BVPS-1 coolant recovery tanks or the BVPS-2 SGB tanks, via the cesium removal ion exchangers and coolant recovery filters, to recover both concentrated boric acid solution and evaporator distillate for future use or disposal.

9.3.4.6.1 Design Bases

The BRS is designed to meet the following criteria:

1. General Design Criterion 1, as it relates to system components being assigned quality group classifications and application of quality standards.

2. General Design Criterion 2, as it relates to structures housing the facility and the system itself being capable of withstanding the effects of earthquakes.

3. General Design Criterion 5, as it relates to shared systems and components important to safety being capable of performing required safety functions.

4. The portion of the BRS containing undegassed liquid has a Safety Class 3 classification. The remainder of the system, which includes the degasifier and downstream piping and components, is classified as NNS class. Determination of the safety classification is in accordance with the guidelines as discussed in Regulatory Guide 1.26.

5. The undegassed portion of the BRS is seismically designed to Seismic Category I. The BRS is located in the auxiliary building, a Seismic Category I structure. The safety-related portions of the BRS are in accordance with the guidelines as discussed in Regulatory Guide 1.29.

6. Although this unit is expected to be operating as a base load unit, the facilities are designed to provide unit capability for a flexible weekly load schedule, acceptance of unscheduled load demands, and back-to-back cold shutdowns.

7. As a basis of design, a weekly load schedule has been postulated as follows: 2 days at 30-percent power, followed by 5 days each with 6 hours at 30-percent power, an increase to 100-percent power in 1 hour, 12 hours at full power, a decrease to 30-percent power in 1 hour, and 4 hours at 30-percent power.

8. The total system is designed to enable the unit, in the event of an unscheduled load demand, to increase to the required power level with a ramp change in reactor power of 5-percent of full power per minute through most of each fuel cycle.

9. The coolant storage facilities available in BVPS-1 provide sufficient storage for the stripped liquid produced by 30 days of maximum reactor coolant letdown to the degasifier system, when operating on the postulated weekly load schedule, plus borated water effluent from a back-to-back cold shutdown of one reactor at the end of the 30-day period at 75 percent of the combined design capacity of BVPS-1 boron recovery evaporators and the evaporator available on BVPS-2 (Section 11.2).

The available storage at BVPS-1 is based on the combined BVPS-1 and BVPS-2 evaporator capability to process coolant at the design rate, which is 75 percent of the maximum rate, and the existence of a 13-week differential in the fuel cycle between the two reactors with the resultant variance in the coolant letdown rates. Consequently, the necessary storage requirements for the coolant from both reactors can be accommodated in the BVPS-1 storage facilities. The BVPS-1 coolant recovery tanks are located indoors. The total coolant storage capacity in BVPS-1 of 380,000 gallons is necessary to meet the design criteria.

10. The BRS is not required to operate to achieve cold shutdown; however, degasification of reactor coolant may be an operational consideration in anticipation of refueling or maintenance. The CVCS system has the capability to bypass the BRS and send letdown directly to the BVPS-1 coolant recovery tank for storage as discussed in Section 9.3.4.

9.3.4.6.2 System Description

The BRS, as shown on Figure 9.3-26, includes two degasifiers that remove gases (hydrogen, nitrogen, argon, krypton, and xenon) from reactor coolant letdown or from liquid collected in the PDTT. The two degasifier subsystems are identical to each other in construction and controls except for the minor differences in their inlet and outlet piping arrangement. Although their uses are different under normal circumstances, either subsystem may be used for processing fluid from either potential source and therefore, are considered to be redundant systems.

Flow of reactor coolant to the degasifier equipment is continuous, with the majority of the stripped gases recycled through the GWD system and back to the VCT in the CVCS. The reactor coolant letdown flow is normally directed to degasifier A, but can be directed to either or both degasifiers whenever necessary to facilitate the postulated load schedule. The flow from the PDTTs is intermittently sent to degasifier B. Degassed liquid from degasifier A is directed to the CVCS and/or the cesium removal ion exchangers. All the degassed liquid from degasifier B goes directly to the cesium removal ion exchanger when processing liquid from the PDTTs. The inlet and outlet piping of the degasifiers is arranged such that, under normal conditions, degasifier A processes reactor coolant letdown from the CVCS. Degasifier A receives reactor coolant letdown at a variable rate of up to 75 gpm, as selected by the operator, and operates in the normal mode as part of the continuous degasification capability. Degasifier B processes liquid from the PDTTs (inside and outside containment) via two different sets of primary drains transfer pumps (Section 9.3.3), intermittently at a rate of 25 gpm (50 gpm for short periods if the pumps associated with both tanks cycle on at about the same

time). The fluid from degasifier A is directed to either the coolant recovery tanks in BVPS-1 or the VCT. Degasifier B directs the liquid to the coolant recovery tanks. The discharge liquid from the degasifiers can also be directed to the SGB tanks and then on to the LWD system.

The degasifier systems separate noncondensable gases from the inlet feed. This is accomplished by spraying water containing dissolved gases into the upper portion of the degasifier vessel. The operating conditions maintained in the vessel are 2 psig and 219°F, which are saturation conditions. The feed to the spray nozzles is passed through the degasifier steam heaters and heated to 245°F. Part of this flow flashes to steam, dispersing the remaining water to small droplets and providing a large amount of liquid surface area for the transfer of dissolved gases from the liquid to the vapor phase in the vessel. Since the flashing process results in liquid and vapor at saturation conditions (2 psig and 219°F) and the solubility of a gas in liquid under saturation conditions approaches zero, essentially all dissolved gases are released. The liquid droplets fall to the lower part of the vessel while the gases and some steam flow to the degasifier vent condenser. The vent condenser is supplied with CCW (Section 9.2.2.1) regulated to maintain the degasifier at a pressure of 2 psig. Most of the steam flowing to the vent condenser is condensed and returned to the degasifier vessel via a loop seal. The loop seal is provided for water return to the degasifier vessel so that steam and gases from the vessel can flow only into the top of the condenser, this being required for proper condenser operation.

The noncondensable gases, and a small amount of steam, flow to the degasifier vent chiller through a restricting orifice sized to produce a pressure drop of approximately 1 psi. The vent chiller is cooled by an unregulated supply of CCW. The steam is condensed and directed to the PDTTs while the noncondensable gases are drawn into the GWD system (Section 11.3).

The vent condenser is located above the degasifier vessel. The condenser is connected to the vessel by an 8-inch (nominal size) pipe to allow unrestricted flow from the degasifier vessel to the vent condenser. Flow from the vent condenser to the vent chiller is restricted to limit the flow of steam to the vent chiller and to maintain a low temperature in the vent chiller. This ensures that the noncondensable gases, which are withdrawn to the GWD system contain as little water vapor as possible. Water carried over into the GWD system is removed by water traps and returned to the PDTT outside containment.

When a degasifier is not operating, the system is maintained hot in a recirculation mode. The recirculation mode is accomplished by running the degasifier recirculation pump which draws liquid from the degasifier bottom and pumps it through the pressure control valve, the degasifier steam heater, and back to the degasifier. The forced circulation of the liquid through the steam heaters maintains a steam environment at 2 psig within the vapor space of the degasifier and the unit is ready for instant operation.

The degasifier trim cooler is designed to cool the degassed liquid leaving the degasifier. The CCW, regulated as required, cools the liquid to 120°F.

The degasifier recovery exchangers are designed to recover heat from the degassed liquid leaving the degasifier system by transferring it to the degassed feed liquid entering the system. This reduces the load on the steam heater and the trim cooler during normal operation.

The degasifier circulation pump draws water from the degasifier vessel. Part of the discharge from the pump is mixed with the inlet to maintain a flow rate of 75 gpm through the spray nozzles. The rest is discharged through the recovery exchangers and trim cooler. The pump is designed to transport liquid from the degasifier system to BVPS-1 coolant recovery tanks, the VCT, or the SGB tanks, and then on to the LWD system. The pumps are located below the degasifier vessel to provide sufficient net positive suction head (NPSH).

The cesium removal ion exchangers purify the degasified degassed liquid prior to its reaching either the BVPS-1 coolant recovery tanks or BVPS-2 SGB tanks (normal flow path is to a BVPS-1 coolant recovery tank). The ion exchanger resin is normally of the mixed bed type. The effluent is borated water. The purpose of these ion exchangers is to remove impurities in the degasifier system discharge (primarily cesium). Each of the two cesium removal ion exchangers and each of the two coolant recovery filters is designed for a flow rate of 150 gpm, equal to the combined capacity of the two degasifiers. There is complete redundancy in this portion of the system. Normally, the discharge of the coolant recovery filters is sent to a BVPS-1 coolant recovery tank for storage and processing. There is also the capability to send the discharge to the BVPS-2 SGB tanks and process the liquid in the steam generator evaporators (Section 11.2).

Alternately, the demineralizers may be charged with mixed bed, cation, anion, or Li-7 cation resin with hydroxyl form anion resin in order to provide flexibility in the support of normal plant operation, shutdown cleanup operations following an activity release, or for reactor coolant deboration purposes.

The coolant recovery filters remove resin fines and other particulate matter from the liquid prior to its reaching the BVPS-1 coolant recovery tanks or BVPS-2 SGB tanks.

9.3.4.6.3 Safety Evaluation

Two separate degasifier subsystems are provided and are considered redundant. The inlet piping associated with each degasifier is arranged so that normally degasifier A receives only liquid from the CVCS and degasifier B only from the PDTTs. The outlet piping in the BRS and CVCS is arranged so that normally degasifier A discharges to the VCT, the BVPS-1 coolant recovery tanks and/or the SGB tanks, and then on to the LWD system. Degasifier B discharges to the BVPS-1 coolant recovery tanks or to the SGB tanks, and then on to the LWD system. Degasifier A has sufficient capacity to degasify the normal letdown flow rate of 60 gpm. If the letdown rate to the degasifiers is increased to more than 75 gpm, degasifier B must also be used. This precludes returning all the degasified liquid to the VCT since degasifier B flow is directed to the BVPS-1 coolant recovery tanks via the cesium removal ion exchangers and associated coolant recovery filters. The basis of this flow path is that degasifier B potentially contains liquid of a different boron concentration from the RCS and may be contaminated with foreign material from the PDTTs. This is not an operational restriction because letdown at a rate greater than 60 gpm will only be required when heating up or during dilution of the RCS (Section 9.3.4).

The degasifiers have a combined capacity of 150 gpm, which is sufficient to degasify letdown at the maximum rate plus degasify the liquid pumped by one primary drains transfer pump. Operation of two primary drains transfer pumps simultaneously will result in a slight overload of the two degasifiers (10 gpm each). This is an infrequent and inconsequential occurrence.

In the event of failure of one degasifier, the other degasifier provides a 50-percent degasification capability subject to the following limitations:

1. If degasifier A fails, effluent from degasifier B should not be returned to the CVCS until degasifier B is thoroughly flushed by letdown from the CVCS or sampled to verify boron concentration is the same as the RCS boron concentration and the contents meet the specifications for RCS makeup water.

2. If degasifier B fails, the PDTTs should not be pumped while the BRS is returning effluent to the CVCS. After pumping the PDTTs, degasifier A should be thoroughly flushed with water from the CVCS prior to returning effluent to the CVCS.

Certain active failures can be accepted without loss of the complete capability of the degasifier. These are limited to failures which can be counteracted by manual operation of MOVs and by hand control of the various temperature, pressure, or level control valves. Failure of any control valve, trip valve, or the circulation pump will require shutdown of the degasifier for repair.

The Safety Class 3 portion of the BRS (Figure 9.3-26) includes an AOV on each line connecting to the NNS class portion. A second MOV is provided upstream in the Safety Class 3 portion of each line to ensure isolation when required. These AOVs are designed to the same requirements as the safety portion and are provided with Class 1E electrical power and remote control from the main control room.

9.3.4.6.4 Inspection and Testing Requirements

A program of tests and inspections facilitates maintaining the design basis capability of the BRS throughout the lifetime of BVPS-2.

For both initial and post-operational hydrostatic testing, each degasifier system is tested as a complete unit after being isolated from the rest of the BRS and other systems. The remainder of the BRS is tested in a similar manner. The ion exchangers, filters, and associated piping and valves may be tested individually, or as a group as desired, since there are separate inlet and outlet isolation valves for each component.

Prior to initial unit start-up, each piece of equipment or subsystem that may be independently operated is made to perform at design flow rates, temperatures, and pressures so as to establish control set points. These control set points are used to verify the subsequent proper operation of the subsystems and to ensure that the overall system capability is not reduced by any component of the system.

Preliminary tests are performed as described in Section 14.2.

Temperature and/or pressure sensors on the inlets and outlets of the various heat exchangers allow evaluation of the heat exchangers performance. Indications of pump and valve performance can be gained by observing the various pressure and level instrumentation. There are no specific provisions for testing the pump and valves in service.

9.3.4.6.5 Instrumentation Requirements

Selector switches with indicating lights are provided in the main control room for the degasifier recirculation pumps. These pumps may be started manually or automatically. While in the automatic mode, the pumps are started provided the degasifier level is not low-low, cooling water flow to degasifier recovery exchangers is high, and degasifier feed flow is high. The degasifier recirculation pump will be stopped provided the cooling water flow to the degasifier recovery exchangers is not high or the degasifier level is low-low. The degasifier recirculation pump will not restart in the auto mode, if stopped by a low-low degasifier level, until the level rises above low or low-low level is cleared and the degasifier feed is high.

Manual auto control stations are provided in the main control room for the inlet to trim cooler level control valves. In the auto mode, these valves are modulated to control the degasifier level.

Control switches with indicating lights are provided in the main control room for the degasifier isolation valves. The valves are operated manually.

Standby recirculation trip valves are provided for the degasifier system. These valves have indicating lights in the main control room. These valves are operated automatically when a respective degasifier circulating pump is not in the automatic mode or the pump is not running.

Manual-auto control stations are provided in the main control room for the steam to degasifier heaters temperature control valves. These valves are provided with feed forward control to reduce sudden pressure rises in the degasifier during the transfer to normal operation from the standby mode. These valves are supplied with indicating lights on the main control board.

Manual-auto control stations are provided in the main control room for the cooling water to vent condenser pressure control valves. These valves are used for automatic regulation of the cooling water flow through the vent condenser. These valves are supplied with indicating lights on the main board.

Selector switches with indicating lights are provided in the main control room for the degasifier recovery exchange inlet valves, degasifier trim cooler outlet valves, cesium removal ion exchangers inlet valves and bypass valve, and cesium removal ion exchangers outlet valves. These valves are operated manually.

Manual-auto control stations are provided in the main control room for the feed inlet pressure control valves. These valves maintain the spray nozzle flow rate at a constant value for proper operation of the spray nozzles in the recirculation pump loop.

Manual-auto control stations are provided in the main control room for the cooling water to trim the coolers temperature control valves. These valves are modulated automatically to control the cooling water to the trim coolers.

Control switches with indicating lights are provided in the main control room for the pressure control valves located on the hydrogen supply lines. The hydrogen is provided for purging the degasifier. These valves are operated manually from the main control board or automatically to maintain hydrogen purge pressure.

Control switches with indicating lights are provided in the main control room for the primary CCW supply and return isolation valves. These valves are operated manually. When a CIA signal is not present, these valves may be opened manually. A CIA signal being present and a respective surge tank level low will close these valves automatically.

Control switches with indicating lights are provided in the main control room for the degasifier recovery exchangers isolation valves. These isolation valves are operated manually.

A differential pressure indicator is provided in the main control room for the coolant recovery filters.

Pressure recorders are provided in the main control room for the degasifiers vapor pressures and the degasifiers feed inlet pressures.

Flow indicators are provided in the main control room for the feed flow to the degasifiers.

A level recorder is provided in the main control room for the levels in the degasifiers.

Temperature indicators are provided in the main control room for the outlet temperatures of the trim coolers.

Temperature recorders are provided in the main control room for feed inlet temperatures of the degasifiers, recovery exchangers inlet and outlet temperatures, liquid temperatures of the degasifiers, recirculation pumps discharge temperatures, recovery exchangers bottoms to the trim coolers outlet temperatures, and the vent condensers outlet temperatures.

Annunciation with associated computer inputs is provided in the main control room for the BRS trouble alarm. The trouble alarm consists of high level in the degasifiers, high or low vapor pressures in the degasifiers, boron coolant recovery filter differential pressure high, and the trim coolers for degasifiers high temperature.

Inputs needed but not associated with the annunciation system are provided in the computer for the feed flow of the degasifiers, pressure of the degasifiers, and trim cooler outlet temperature.

9.3.5 Reference for Section 9.3

U.S. Nuclear Regulatory Commission, 1980. Clarification of TMI Action Plan Requirements. NUREG-0737.

Tables for Section 9.3

TABLE 9.3-1

STATION AIR AND CONDENSATE POLISHING AIR SYSTEMS
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters		
Compressor	Station Air System	Instrument Air System	Condensate Polishing Air System
Quantity	2	1	1
Discharge pressure (psig)	120	110	120
Discharge temperature (°F)	115	120	115
Capacity, (scfm) each	728	1500	407
Motor, (hp) each	200	460 (diesel engine)	125

Air Receiver	Station Instrument Air System	Station Service Air System	Condensate Polishing Air System
Quantity	2	2	1
Capacity, (ft^3) each	307.5 & 336.9	160.5	55.4
Pressure, design/ operating (psig) each	125/110 & 150/110	125/110	125/110
Code	ASME VIII	ASME VIII	ASME VIII

Station Instrument Air

Dryer	Normal	Diesel Standby
Number	2	1
Capacity, @ 100 psig scfm	650	1500
Pressure Dew point @ 100 psig, °F	-40	-40
Type	Heatless Regenerative, Dual Tower Desiccant	Heatless Regenerative Desiccant
Prefilter		
Number	1 per dryer & 1 in bypass line	1
Capacity, @ 100 psig scfm	800	1500
Retention size, microns	0.3	0.3 (solids)
Type	Coalescing	Coalescing

TABLE 9.3-1 (Cont)

Station Instrument Air

	Normal	Diesel Standby
Afterfilter		
Number	1 per dryer & 1 in bypass line	1
Capacity, @ 100 psig scfm	750	1500
Retention size, microns	3	3 (solids)
Type	Particulate	Particulate

TABLE 9.3-2

STATION AIR AND CONDENSATE POLISHING AIR SYSTEMS
CONSEQUENCES OF COMPONENT FAILURES

Station Air System

Component	Failure Mode	Consequence
Station air compressors	A compressor casting ruptures, or general compressor failure	Redundant air compressor can be used to achieve full system capability.
Station air system receivers	An air receiver ruptures	Redundant air compressor and other receiver can be used to achieve system capability or receiver bypass can be utilized.
Station instrument air prefilters and afterfilters	Prefilter and/or afterfilter clogs	Appropriate filter bypass may be utilized during maintenance. Cartridge type bypass filters isolating dryer, a pre-filter and afterfilter may be utilized to accomplish partial drying.
Station instrument air dryer	Air dryer ruptures or malfunctions	Desiccant-type cartridge removal filter bypass system would be utilized to supply dry air to instrument air system. Bypass filters supplied by condensate polishing air system can be used.
Electrically-powered station air system compressors	Electrical failure of one electrical bus	Sufficient electrical system redundancy is provided to ensure full system capability (Section 8.3).
Service air portion of station air system	Rupture of service air portion	Service air portion is automatically isolated on low discharge header pressure by an AOV. Must be manually reset to restore pressure to service system.

TABLE 9.3-2 (Cont)

Condensate Polishing Air System

Component	Failure Mode	Consequence
Condensate polishing air compressor	Compressor casting ruptures, or general compressor failure	No compressor redundancy provided. Crossover to station air system will provide required air for system.
Condensate polishing air compressor aftercooler	Aftercooler tube ruptures	No compressor redundancy provided. Crossover to station air system will provide required air for system.
Condensate polishing air receiver	Air receiver ruptures	No compressor redundancy provided. Crossover to station air system will provide required air for system.
Electrically-powered condensate polishing air compressor	Electrical failure of electrical bus	No electrical redundancy provided. Crossover to station air system will provide required air for system.

TABLE 9.3-3

CONTAINMENT INSTRUMENT AIR SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Compressors	
Quantity	2
Suction pressure (psia)	9.5
Suction temperature (°F)	60
Discharge pressure (psia)	109.7
Discharge temperature (°F)	66
Capacity, (scfm) each	30
Motor, (hp) each	40
Air Receiver	
Quantity	2
Capacity (ft^3)	1 at approx. 57 & 1 at 31.8
Pressure design/operating, (psig) each	150/110
Code	ASME VIII
Dryer	
Quantity	1
Capacity (scfm)	30
Dew point at 100 psig (°F)	+35*
Type	Refrigerant
Inlet Filter	
Quantity	1
Capacity (scfm)	100
Retention size (microns)	**
Filter element	Dry cartridge
Outlet Filter	
Quantity	1
Capacity (scfm)	30
Retention size (microns)	5
Filter element	Ceramic

TABLE 9.3-3 (Cont)

Components	Design Parameters
Bypass Filters	
Quantity	2
Capacity, (scfm) each	
2IAC-FLT24	100
2IAC-FLT23	72
Retention size (microns)	1
Filter element	Wool felt, silica gel, Borosilicate glass (FLT 24)

NOTES:

*Temperature limitation due to freezing of refrigerant coil at lower temperatures.

**Filters will remove all particles greater than 10 microns, and 98 weight percent of all particles greater than 3 microns.

TABLE 9.3-4

CONTAINMENT INSTRUMENT AIR SYSTEM
CONSEQUENCES OF COMPONENT FAILURES

Component	Failure Mode	Consequence
Containment instrument air heat exchangers	Heat exchanger tube ruptures	Redundant air compressor can be used to achieve full system capability.
Containment instrument air receiver outside the containment	Air receiver ruptures	Air receiver has bypass to ensure full system capability.
Containment instrument air dryer	Air dryer ruptures	Bypass around air dryer through standby dehydrating filter ensures system capability.
Electrically-powered containment instrument air compressors	Electrical failure of one electrical bus	Sufficient electrical system redundancy is provided to ensure full system capability (Section 8.3).

TABLE 9.3-5

REACTOR PLANT AND PROCESS SAMPLING SYSTEM SAMPLING CAPABILITIES

High Temperature Samples

Pressurizer vapor
Pressurizer liquid
Residual heat removal liquid - downstream of the residual heat removal pumps
Residual heat removal liquid - downsteam of the residual heat removal heat exchangers
Primary coolant from each of the reactor coolant loops
Steam generator blowdown taken from each of the blowdown lines

Low Temperature Samples

Safety injection system accumulators (three)
Supply header to chemical and volume control system demineralizers
Discharge header to chemical and volume control system demineralizers - reactor coolant filter influent
Chemical and volume control system deborating demineralizer effluent (two)
Chemical and volume control system mixed bed demineralizer effluent (two)
Chemical and volume control system cation demineralizer effluent
Volume control tank liquid
Volume control tank vapor space
Pressurizer relief tank gas space
Component cooling water
Degasifier liquid effluent (two)
Charging pump discharge from each of the charging pump discharge headers
Gaseous waste storage tanks
Primary drain transfer tanks
Waste gas surge tank
Primary grade water
Letdown flow
Fuel pool
Cesium removal influent and effluent
Test tanks

Examples of Lines With Local Sample Acquisition Capability

Refueling water storage tank
Boric acid batch tank
Chemical addition tank

TABLE 9.3-6

NUCLEAR VENTS AND DRAINS SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters	
Primary Drains Transfer Tanks		
Quantity	2	
Capacity, (gal) each	900	
Operating pressure (psig)	7	
Design pressure (psig)	50	
Operating temperature (°F)	100	
Design temperature (°F)	300	
Material	Type 304 stainless steel	
Primary Drains Transfer Pumps		
Quantity	2(P21A & B)	2(P22A & B)
Capacity, (gpm) each	25	25
TDH, (ft) each	200	160
Design temperature (°F)	150	150
Motor, (hp) each	5	5
NPSH, required (ft) each	3	3
Primary Drains Cooler		
Quantity	1	
Duty (Btu/hr)	$1.5^{7}\text{x}10^{6}$	
Tube side, nuclear vents drains (lb/hr)	3,683	
Operating pressure (psig)	12	
Design pressure (psig)	150	
Operating temperature, in/out (°F)	212/170	
Design temperature (°F)	300	
Material	Type 304 stainless steel	
Shell side, component cooling water (lb/hr)	65,000	
Operating pressure (psig)	135	
Design pressure (psig)	175	
Operating temperature, in/out (°F)	100/127	
Design temperature (°F)	240	
Material of construction	Carbon steel	

TABLE 9.3-7

CHEMICAL AND VOLUME CONTROL SYSTEM
DESIGN BASES AND DESIGN PARAMETERS

Design Bases	Design Parameters
Seal water supply flow rate for three RCPs, nominal (gpm)	24
Seal water return flow rate for three RCPs, nominal (gpm)	9
Letdown flow	
Normal (gpm)	60
Maximum (gpm)	120*
Charging flow (excludes seal water)	
Normal (gpm)	45
Maximum (gpm)	105*
Temperature of letdown reactor coolant entering system (°F)	528.5 to 543.1
Temperature of charging flow directed to RCS (°F) (approximately)	497
Temperature of effluent directed to BRS (°F)	115
Centrifugal charging pumps bypass flow, each (gpm)	60
Maximum pressurization required for hydrostatic testing of RCS (psig)	3,107

*Maximum letdown and charging flows may be increased to 180 gpm in Mode 5 to assist in RCS cleanup.

TABLE 9.3-8

CHEMICAL AND VOLUME CONTROL SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Centrifugal Charging Pumps	
Quantity	3
Design pressure (psig)	2,800
Design temperature (°F)	300
Design flow, (gpm) each	150
Design head (ft)	5,800 (minimum)
Motor, (hp) each	600
Material	Austenitic stainless steel
NPSH, required (ft @ max design flow)	40
Boric Acid Transfer Pumps	
Quantity	2
Design pressure (psig)	150
Design temperature (°F)	200
Design flow, (gpm) each	75
Design head (ft)	235
Motor, (hp) each	15
Material	Austenitic stainless steel
Regenerative Heat Exchanger	
General	
Quantity	1
Heat transfer rate at normal conditions (Btu/hr)	8.34×10^6
Heat transfer rate at maximum conditions (But/hr)	17.0×10^6
Shell side	
Design pressure (psig)	2,485
Design temperature (°F)	650
Material	Austenitic stainless steel

TABLE 9.3-8 (Cont)

Tube side		
Design pressure (psig)	2,735	
Design temperature (°F)	650	
Material	Austenitic stainless steel	
Operating parameters	Normal	Maximum Purification
Shell side		
Flow (lb/hr)	29,826	59,700
Inlet temperature (°F)	542.5	542.5
Outlet temperature (°F)	283.3	281.2
Tube side		
Flow (lb/hr)	22,370	52,250
Inlet temperature (°F)	130	130
Outlet temperature (°F)	489	448.2
<u>Letdown Orifices</u>		
General		
Design pressure (psig)	2,485	
Design temperature (°F)	650	
Normal operating inlet pressure (psig)	2195	
Normal operating temperature (°F)		290
Material of construction	Austenitic stainless steel	
60 gpm Orifice		
Quantity	2	
Design flow (lb/hr)	29,826	
Differential pressure at design flow (psig)	1,900	
Diameter (inches)	0.242	
45 gpm Orifice		
Quantity	1	
Design flow (lb/hr)	22,370	
Differential pressure at design flow (psi)	1,900	
Diameter (inches)	0.215	

TABLE 9.3-8 (Cont)

Letdown Heat Exchanger

General	
Quantity	1
Heat transfer rate at design conditions (Btu/hr)	15.8×10^6
Heat transfer rate at normal conditions (Btu/hr)	5.1×10^6
Shell side	
Design pressure (psig)	150
Design temperature (°F)	250
Fluid	CCW
Material	Carbon Steel
Tube side	
Design pressure (psig)	600
Design temperature (°F)	400
Fluid	Borated reactor coolant
Material	Austenitic stainless steel
Operating parameters	
Shell side	
Flow (lb/hr)	62,700
Design Inlet temperature (°F)	100*
Design Outlet temperature (°F)	181
Tube side	
Flow (lb/hr)	28,820
Inlet temperature (°F)	287
Outlet temperature (°F)	115

* Temperature range is approximately 80 - 106°F depending on river (service water) temperature and plant operation.

TABLE 9.3-8 (Cont)

Excess Letdown Heat Exchanger

General	
Quantity	1
Heat transfer rate at design conditions (Btu/hr)	3.23×10^6
Design fouling factors (hr/ft^2 - °F/Btu)	
Shell	0.0005
Tube	0.0003
Shell side	
Design pressure (psig)	150
Design temperature (°F)	250
Design flow rate (lb/hr)	83,500
Design operating inlet temperature (°F)	100*
Design operating outlet temperature (°F)	138.7
Fluid	CCW
Material	Carbon steel
Tube side	
Design pressure (psig)	2,485
Design temperature (°F)	650
Design flow rate (lb/hr)	7,500
Normal operating inlet temperature (°F)	547
Normal operating outlet temperature (°F)	139
Fluid	Borated reactor coolant
Material	Austenitic stainless steel

* Temperature range is approximately 80-106°F depending on river (service water) temperature and plant operation.

TABLE 9.3-8 (Cont)

Seal Water Heat Exchanger

General	
Quantity	1
Heat transfer rate at design conditions (Btu/hr)	1.45×10^6
Shell side	
Design pressure (psig)	150
Design Temperature (°F)	250
Pressure loss at design conditions (psi)	8.3
Nozzle size (in)	4
Fluid	CCW
Material	Carbon steel
Tube side	
Design pressure (psig)	200
Design temperature (°F)	250
Fluid	Borated reactor coolant
Material	Austenitic stainless steel
Design operating parameters	
Shell side	
Flow (lb/hr)	49,400
Inlet temperature (°F)	100*
Outlet temperature (°F)	122.1
Tube side	
Flow (lb/hr)	42,000
Inlet temperature (°F)	141
Outlet temperature (°F)	115

Seal Water Return Filter

Quantity	1
Design pressure (psig)	200
Design temperature (°F)	250
Normal flow rate (gpm)	9
Maximum flow rate (gpm)	320
Retention for 25-micron particles (%)	98

* Temperature range is approximately 80-106°F depending on river (service water) temperature and plant operation.

TABLE 9.3-8 (Cont)

Material	Austenitic stainless steel

Seal Water Injection Filters

Quantity	2
Design pressure (psig)	2,735
Design temperature (°F)	200
Flow rate, (gpm) each	80
Retention for 5-micron particles (%)	98
Material, vessel	Austenitic stainless steel

Boric Acid Filter

Quantity	1
Design pressure (psig)	200
Design temperature (°F)	250
Design flow rate (gpm)	150
Maximum flow rate (gpm)	120
Maximum differential pressure, 100% fouled (psi)	20
Retention for 25-micron particles (%)	98
Material	Austenitic stainless steel

Boric Acid Tanks

Quantity	2
Capacity, (gal) each	12,500
Design pressure	Atmospheric
Design temperature (°F)	200
Normal operating temperature span (°F)	80-90
Material	Austenitic stainless steel

Mixed Bed Demineralizers

Quantity	2
Type	Flushable
Vessel design pressure (psig)	200
Vessel design temperature (°F)	250
Design flow rate, (gpm) each	120
Material	Austenitic stainless steel

TABLE 9.3-8 (Cont)

Cation Bed Demineralizer

Quantity	1
Type	Flushable
Vessel design pressure (psig)	200
Vessel design temperature (°F)	250
Design flow rate (gpm)	60
Material	Austenitic stainless steel

Deborating Demineralizer

Quantity	2
Type	Flushable
Vessel design pressure (psig)	200
Vessel design temperature (°F)	250
Design flow rate (gpm) each	120
Material	Austenitic stainless steel

Resin Fill Tank

Quantity	1
Capacity (gal)	65
Design pressure	Atmospheric
Design temperature (°F)	200
Normal operating temperature	Ambient
Material	Austenitic stainless steel

Chemical Mixing Tank

Quantity	1
Capacity (gal)	5.0
Design pressure (psig)	150
Design temperature (°F)	200
Normal operating temperature	Ambient
Material	Austenitic stainless steel

TABLE 9.3-8 (Cont)

Batching Tank

Quantity	1
Type	Jacketed
Capacity (gal)	400
Design pressure	Atmospheric
Design temperature (°F)	250
Normal operating temperature (°F)	165
Material, tank	Austenitic stainless steel
Material, jacket	Carbon steel

TABLE 9.3-9

FAILURE MODES AND EFFECTS ANALYSIS - CHEMICAL AND VOLUME CONTROL SYSTEM
ACTIVE COMPONENTS - NORMAL PLANT OPERATION, LOAD FOLLOW, AND SAFE SHUTDOWN

Component	Failure Mode	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
1. Air-operated glove valve LCV-460A (LCV-460B analogous).	a. Fails open.	a. Charging and volume control - letdown flow.	a. Failure reduces redun-ancy of providing letdown flow isolation to protect PRZ heaters from uncovering at low water level in PRZ. No effect on system operation. Alternate isolation valve (LCV-460B) provides backup letdown flow isolation.	a. Valve position indication (open to closed position change) at MCB.	1. Valve is designed to fail closed and is electrically wired so that the electrical solenoid of the air diaphragm operator is energized to open the valve. Solenoid is de-energized to close the valve upon the generation of a low level PRZ control signal. The valve is electrically interlocked with three letdown orifice isolation valves and may not be opened manually from the MCB if any of these valves are in an open position.
	b. Fails closed.	b. Charging and volume control - letdown flow.	b. Failure blocks normal letdown flow to VCT. Minimum letdown flow requirements for boration of RCS to hot standby concentration level may be met by establishing letdown flow through alternate excess letdown flow path.	b. Valve position indication (closed to open position change) at MCB; letdown flow temperature indication (TI-140) at MCB; letdown flow-pressure indication (PI-145) at MCB; letdown flow indication (FI-150) at MCB; and VCT level indication (LI-115) and low water alarm at MCB.	
2. Air-operated globe valve LCV-8149B (LCV-8149C and 8149A analogous).	a. Fails open.	a. Charging and volume control - letdown flow.	a. Failure prevents isolation of normal letdown flow through regenerative HX when bringing the reactor to a cold shutdown condition after the RHRS is placed into operation.	a. Valve position indication (open to closed position change) at MCB. Valve open position monitor light for group monitoring of compo-	1. Valve is of similar design as that stated for item 1. Solenoid is deenergized to close the valve upon the generation of a low

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			No effect on hot standby operation. Containment isolation valve (8152) may be remotely closed from the MCB to isolate letdown flow through the HX.	nents at MCB.	level PRZ signal or closing of letdown isolation valves (LCV-460A and LCV-460B) upstream of the regenerative HX. A solenoid is also deener-gized to close the valve on the generation of an ESF T signal.
	b. Fails closed.	b. Charging and volume control - letdown flow.	b. Failure blocks normal letdown flow to VCT. Normal letdown flow to VCT may be maintained by opening alternate letdown orifice isolation valve (8149C). Minimum letdown flow requirements for boration of RCS to hot standby concentration level may be met by opening letdown orifice isolation valve (LCV-8149A or LCV-8149C). If common mode failure (loss of instrument air) prevents opening of these valves, boration of RCS to hot standby condition can be met by establishing alternate flow through excess letdown flow path. An additional means of letdown is provided via the reactor vessel head vent system.	b. Same methods of detection as those stated for item 1, failure mode fails closed.	
3. Air-operated globe valve LCV-8152.	a. Fails closed.	a. Charging and volume control - letdown flow.	a. Same effect on system operation as that stated for item 1, failure mode fails closed.	a. Same methods of detection as those stated for item 1, failure mode fails closed. In addition, closed position	1. Valve is of similar design as that stated for item 1. Solenoid is deenergized to close the valve upon the gener-

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
				group monitoring light at MCB.	ation of an ESF T signal.
	b. Fails open.	b. Charging and volume control - letdown flow.	b. Failure has no effect on CVCS operation during normal plant operation and load follow. However, under accident conditions requiring containment isolation, failure reduces the redundancy of providing isolation of normal letdown line.	b. Valve position indication (open to closed position change) at MCB.	
4. Air-operated globe valve PCV-145.	a. Fails open.	a. Charging and volume control - letdown flow.	a. Failure prevents control of pressure to prevent flashing of letdown flow in letdown HX and also allows high pressure fluid to mixed bed demineralizers. Relief valve (8119) opens in demineralizer line to release pressure to VCT, and valve (TCV-143) changes position to divert flow to VCT. Boration or RCS to hot standby concentration level is possible with valve failing open.	a. Letdown HX tube discharge flow indication (FI-150) and high flow alarm at MCB; temperature indication (TI-143) and high temperature alarm at MCB; and pressure indication (PI-145) at MCB.	1. Valve is designed to fail open and is electrically wired so that control solenoid of the air diaphragm operation is energized to close the valve. 2. As a design transient, the letdown HX is designed for complete loss of charging flow.
	b. Fails closed.	b. Charging and volume control - letdown flow.	b. Same effect on system operation as that for item 1, failure mode fails closed. In addition, a manual bypass valve (8409) is provided.	b. Letdown HX discharge charge flow indication (FI-150), pressure indication (PI-145), and high pressure alarm at MCB.	

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
5. Air-operated three-way valve TCV-143.	a. Fails open for flow only to VCT.	a. Charging and volume control - letdown flow.	a. Letdown flow bypassed from flowing to mixed bed demineralizers. Failure prevents ionic purification of letdown flow. Boration of RCS to hot standby concentration level is possible with valve failing open for flow only to VCT.	a. Valve position indication (VCT) at MCB and RCS activity level when sampling letdown flow.	1. Electrical solenoid of air diaphragm operator is electrically wired so that solenoid is energized to open valve for flow to the mixed bed demineralizers. Valve opens for flow to VCT on high letdown temp.
	b. Fails open for flow only to mixed bed deminer-alizer.	b. Charging and volume control - letdown flow.	b. Continuous letdown to mixed bed demineralizers. Failure prevents automatic isolation of mixed bed demineralizers under fault condition of high letdown flow temperatures. These systems may be manually isolated using local valves (8524A and 8524B) at mixed bed demineralizers. Boration of RCS to hot standby concentration level is possible with failing open for flow only to demineralizer.	b. Valve position indication (demineralizer) at MCB.	2. Technical Specifications provide a limit on RCS activity.
6. Relief valve 8117	a. Fails open.	a. Charging and volume control - letdown flow.	a. Letdown flow is relieved to PRT. Failure inhibits use of demineralizers for reactor coolant purification. Normal letdown line can be isolated and minimum letdown flow requirements for hot standby may be met by establishing letdown	a. High temperature relief line indication (TI-141) and alarm at MCB. VCT level indication (LI-115) and low water level alarm at MCB.	1. Radioactive fluid contained.

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			flow through alternate excess letdown flow path.		
7. Relief valve 8119.	a. Fails open.	a. Charging and volume control - letdown flow.	a. Letdown flow is relieved to VCT. Failure inhibits use of demineralizers for reactor coolant purification. Normal letdown line can be isolated and minimum letdown flow requirement for hot standby may be met by establishing flow through alternate excess letdown flow path.	a. RCS activity level when sampling letdown flow low pressure in demineralizer header.	1. Radioactive fluid contained.
8. Air-operated three-way valve LCV-115A.	a. Fails open for flow to BRS recycle holdup tank.	a. Boron concentration control - letdown flow.	a. Failure bypasses letdown flow to BRS recycle holdup tank. Boration of RCS to hot standby concentration level is possible with valve failing open only for flow to BRS.	a. Valve position indication (hold up tank) at MCB. VCT level indication (LI-115) and low water level alarm at MCB.	1. Electrical solenoid of air diaphragm operator is electrically wired so that solenoid is energized to open valve for flow to BRS recycle holdup tank.
9. Air-operated valve HCV-137.	a. Fails closed.	a. Charging and volume control - letdown flow.	a. Failure inhibits use of the excess letdown fluid system of the CVCS as an alternate system that may be used for letdown flow control during normal plant operation, and inhibits use of the excess letdown system to control water level in the PRZ of the RCS during final stage of plant startup due to flow blockage.	a. Valve position indication (degree of opening at MCB). Excess letdown pressure indication (PI-138) and temperature indication (TI-159) at MCB.	

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
10. Motor-operated globe valve 8153.	a. Fails closed.	a. Charging and volume control - letdown flow.	a. Same effect on system operation as that stated above for item 9.	a. Same methods of detection as those stated above for item 9.	
11. Motor-operated gate valve 8168A (8168B and 8168C analogous).	a. Fails closed.	a. Charging and volume control - seal water flow.	a. No makeup of seal water to seal standpipe that services the number 3 seal of RCP 1. No effect on operation to bring the plant to standby condition.	a. Valve position indication (closed to open position change) and low standpipe level alarm at MCB.	1. Low level standpipe alarm conservatively set to allow additional time for RCP operation without a complete loss of seal water from being injected to the number 3 seal after sounding of alarm.
12. Relief valve 8121.	a. Fails open.	a. Charging and volume control - seal water flow.	a. RCP seal water return flow and excess letdown flow bypassed to PRT of RCS. Failure inhibits use of the excess letdown fluid system of the CVCS as an alternate system that may be used for letdown flow control during normal plant operation, and inhibits use of excess letdown system to control water level in the PRZ of the RCS during final stage of a plant startup.	a. Decrease in VCT level, causing RMCS of CVCS to operate. Increase in PRT level and pressure	1. The relief valve capacity bounds the maximum flow from the RCP seals. 2. Radioactive fluid contained.
13. Motor-operated globe valve 8112 (8100 analogous).	a. Fails open.	a. Charging and volume control - seal water flow and excess letdown flow.	a. Failure has no effect on CVCS operation and load follow. However, under accident conditions requiring containment isolation,	a. Valve position indication (open to close position change) at MCB.	1. Valve is normally at a full open position and motor-operator is energized to close

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			failure reduces redundancy of providing isolation of seal water flow and excess letdown flow.		the valve upon the generation of an ESF T signal.
	b. Fails closed.	b. Charging and volume control - seal water flow and excess letdown flow.	b. RCP seal water return flow and excess letdown flow blocked. Failure inhibits use of the excess letdown fluid system of the CVCS as an alternate system that may be used for letdown flow control during normal plant operation, and degrades cooling capability of seal water in cooling RCP bearings.	b. Valve position indication (closed to open position change) at MCB; group monitoring light at MCB; and seal water return flow recording (FR-154B) and low seal water return flow alarm at MCB.	
14. Motor-operated gate valve 8107 (8146 analogous).	a. Fails open.	a. Charging and volume control - charging flow.	a. Failure has no effect on CVCS operation during normal plant operation and load follow. However, under accident condition requiring isolation of charging line, failure reduces redundancy of providing isolation of normal charging flow.	a. Valve position indication (open to closed position change) at MCB.	1. Valve is normally at a full open position and motor operator is energized to close the valve upon the generation of a safety injection signal.
	b. Fails closed.	b. Charging and volume control - charging flow.	b. Failure inhibits use of normal charging line to RCS for boration, dilution, and coolant makeup operations. Seal water injection path remains available for boration of RCS to a hot standby concentration level and makeup of	b. Valve position indication (closed to open position change) and group monitoring light (valve closed) at MCB; letdown temperature indication (TI-140) and high temperature alarm at MCB; charging flow	

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			coolant during operations to bring the reactor to hot standby condition.	temperature indication (TI-123) at MCB; CVCS charging water flow pressure indication (PI-121) at MCB; VCT level indication (LI-115) and high level alarm at MCB.	
15. Air-operated glove valve HCV-186	a. Fails open.	a. Charging and volume control - seal water flow.	a. Failure prevents manual adjustment at MCB of seal water flow to RCP seals. Boration of RCS to a hot standby concentration level and makeup of coolant during operations to bring reactor to hot standby condition is still possible through normal charging flow path. Manual adjustment could be achieved via bypass valve (8389).	a. Seal water flow pressure indication (PI-156A, 156B & 156C) at MCB; seal water return flow alarm at MCB.	1. Valve is designed to fail open on loss of air, or an electrical failure, to ensure flow to the number 1 seal of RCPs.
	b. Fails closed.	b. Charging and volume control - seal water flow.	b. Same effect on system operation as that stated above for failure mode, fails open.	b. Seal water flow pressure indication (PI-156A, 156B, and 156C) at MCB; seal water return recording (FR-154B); and low seal water return flow alarm at MCB.	
16. Motor-operated gate valve 8106.	a. Fails open.	a. Charging and volume control - charging flow and seal water flow.	a. Failure has no effect on CVCS operation and load follow. However, under accident condition requiring isolation of centrifugal charging pump miniflow line, failure reduces redun-	a. Valve position indication (open to closed position change) at MCB.	1. Same remark as that stated for item 14. 2. During plant operation, one charging pump is normally used to deliver

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			dancy of providing isolation of miniflow to suction of pumps via seal water HX		charging and seal water flow.
	b. Fails closed.	b. Charging and volume control - charging flow and seal water flow.	b. Failure blocks miniflow to suction of centrifugal charging pumps via seal water HX. Normal charging flow and seal water flow prevents deadheading of pumps when used. Boration of RCS to a hot standby concentration level and makeup of coolant during operations to bring reactor to hot standby condition is still possible.	b. Valve position indication (closed to open position change) at MCB; group monitoring light (valve closed) and alarm at MCB; and charging flow indication (FI-122A) and high flow alarm at MCB.	
17. Motor-operated globe valve 8109A (8109C analogous).	a. Fails open.	a. Charging and volume control - charging flow and seal water flow.	a. Failure has no effect on CVCS operation during normal plant operation and load follow. However, under accident condition requiring isolation of centrifugal charging pump miniflow line, failure reduces redundancy of providing isolation of miniflow to suction of pumps via seal water HX.	a. Valve position indication (open to closed position change) at MCB.	1. Same remarks as those stated for item 16.
	b. Fails closed.	b. Charging and volume control - charging flow and seal water flow.	b. Failure blocks miniflow to suction of centrifugal charging pump 1 via seal water HX. Normal charging flow and seal water flow prevents deadheading	b. Valve position indication (closed to open position change) at MCB; group monitoring light (valve closed) and alarm at MCB.	

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			of pump when used. Boration of RCS to a hot standby concentration level and makeup of coolant during operation to bring reactor to hot standby condition is still possible.		
18. Motor-operated gate valve 8146.	a. Fails open.	a. Charging and volume control - charging flow.	a. Failure has no effect on CVCS operation during normal plant operation, load follow, and hot standby operation. However, under accident condition requiring containment isolation, failure reduces the redundancy of providing isolation of normal charging line.	a. Valve position indication (open to closed position change) at MCB.	1. Same remark as that stated for item 14.
	b. Fails closed.	b. Charging and volume control - charging flow.	b. Failure blocks normal charging flow to the RCS. Boration of RCS to hot standby concentration level is possible with valve failing closed by using seal water flow.	b. Valve position indication (closed to open position change) and group monitoring light (valve closed) at MCB; charging flow indication (FI-122A) and low flow alarm at MCB; regenerative HX shell side exit temperature indication (TI-140) and high temperature alarm at MCB.	
19. Relief valve 8123.	a. Fails open.	a. Charging and volume control	a. Failure results in a portion of seal water	a. Local pressure indication (PI-	1. Radioactive fluid contained.

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
		- charging flow.	return flow and centrifugal charging pump miniflow being bypassed to VCT. Boration of RCS to a hot standby concentration level and makeup of coolant during operations to bring reactor to hot standby condition is still possible.	151B and PI-153B) in discharge line of centrifugal charging pumps. b. High VCT temperature and seal water HX temperature is high.	
20. Air-operated globe valve FCV-122	a. Fails open.	a. Charging and volume control - charging flow.	a. Failure prevents automatic adjustment of charging water flow through the control of PRZ water level and charging flow. Boration of RCS to a hot standby concentration level and makeup of coolant during operations to bring reactor to hot standby condition is still possible through normal charging flow path.	a. Charging water flow indication (FI-122A) and high flow alarm at MCB.	1. Valve is designed to fail open on loss of air or an electrical failure.
	b. Fails closed.	b. Charging and volume control - charging flow.	b. Same effect as that stated above except boration using normal charging flow path cannot be accomplished. Operator can borate RCS to a hot standby concentration level using seal water flow. Manual valve in bypass line may also be opened to borate RCS, using normal charging line.	b. Charging water flow indication (FI-122A) and low flow alarm at MCB.	

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
21. Check valve 8481A (8481C analogous).	a. Fails open.	a. Charging and volume control - charging flow and seal water flow.	a. Failure reduces redundancy of providing charging and seal water flow to RCS. Discharge of centrifugal charging pump 1 is open in backflow when centrifugal charging pump 3 is placed into operation and centrifugal charging pump 1 is not used to deliver charging and seal water flow. Boration of RCS to hot standby concentration level is possible through operator action of placing both pumps in operation.	a. Charging water flow indication (FI-122A) and low flow alarm at MCB. Local pressure indication (PI-151B) in centrifugal charging pump 1 discharge line.	1. Centrifugal charging pump 1 may be isolated by the closing of manual valves in pump's suction and discharge lines. 2. Methods of detection apply when centrifugal charging pump 3 is only pump in operation. 3. Analysis assumes centrifugal charging pump 2 is out-of-service and flow isolated from charging.
22. Centrifugal charging pump 1, APCH-01 (Pump 3 analogous).	a. Fails to deliver working fluid.	a. Charging and volume control flow and seal water flow.	a. Failure reduces redundancy of providing charging and seal water flow to RCS. Delivery of charging and seal water flow by centrifugal charging pump 1 is not available. No effect on normal plant operation, load follow, or bringing reactor to hot standby condition. Centrifugal charging pump 1 may be taken out of service and system aligned by operator for operation using	a. Same methods of detection as those stated above for item 21 when centrifugal charging pump 1 is the only pump in operation. In addition, open pump switchgear circuit breaker indication, circuit breaker close position monitor light for group monitoring of components, and common breaker trip alarm at MCB.	1. Operator action is required to place centrifugal charging pump 2 in service (valve flow alignment and pump alignment to ESF actuation trains).

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			centrifugal charging pumps 2 and 3.		
23. Air-operated globe valve 8156.	a. Fails closed.	a. Chemical control, purification and makeup - oxygen control.	a. Failure blocks hydrogen flow to VCT, resulting in loss of gas stripping of fission products from RCS coolant. No effect on operation to bring the reactor to hot standby condition.	a. VCT pressure indication (PI-117) and low pressure alarm at MCB.	1. Plant Technical Specifications set limits on RCS activity level.
24. Relief valve 8120.	a. Fails open.	a. Charging and volume control - charging flow and sealwater flow	a. Failure allows VCT liquid to be relieved to nuclear vent and drain system, resulting in a loss of VCT liquid and makeup coolant available for charging and seal water flow during normal plant operation, load follow, and bringing the reactor to a hot standby condition. VCT isolation valves (LCV-115C and LCV-115E) close on low water level of tank level signal, causing the suction of charging pumps to be transferred to the RWST.	a. Decrease in VCT level causing RMCS to operate; VCT level indication (LI-115) and low water level alarm at MCB; and BRS recycle holdup tank level increase.	1. Radioactive fluid contained.
25. Motor-operated gate valve LCV-115C (LCV-115E analogous).	a. Fails open.	a. Charging and volume control - charging flow and seal water flow.	a. Failure has no effect on CVCS operation during normal plant operation, load follow, and bringing reactor to a hot standby condition. However, under accident conditions requiring isolation	a. Valve position indication (open to closed position change) at MCB.	1. During normal plant operation and load follow, valve is at a full open position and the motor operator is energized to close the valve upon the genera-

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
			of VCT, failure reduces redundancy of providing isolation for discharge line of VCT.		tion of a VCT low water level signal or upon the generation of a safety injection signal.
	b. Fails closed.	b. Charging and volume control - charging flow and seal water flow.	b. Failure blocks fluid flow from VCT during plant operation, load follow and when bringing the reactor to a hot standby condition. Alternate supply of borated coolant from the RWST to suction of charging pumps can be established from the MCB by the operator through the opening of RWST isolation valves (LCV-115B and LCV-115D).	b. Valve position indication (closed to open position change) at MCB; group monitoring light (valve closed) at MCB; charging water flow indication (FI-122A) and low flow alarm at MCB.	
26. Air-operated globe valve 8101.	a. Fails closed.	a. Chemical control, purification, and makeup - oxygen control.	a. Failure blocks venting of VCT gas mixture to boron recycle degassifier for stripping of fission products from RCS coolant during normal plant operation and load follow.	a. VCT pressure indication (PI-117) and high pressure alarm at MCB.	1. Same remark as that stated for item 23 in regard to RCS activity. 2. Valve is designed to fail closed on loss of air supply.
27. Air-operated globe valve 8157.	a. Fails closed.	a. Chemical control, purification, and makeup-oxygen control.	a. Failure blocks venting of VCT gas mixture to BRS degassifier for stripping of fission products from RCS coolant during normal plant operation and load follow.	a. VCT pressure indication (PI-117) and high pressure alarm at MCB.	1. Same remark as that stated for item 23 in regard to RCS activity.

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
28. Air-operated globe valve FCV-113B	a. Fails closed.	a. Boron concentration control - reactor makeup control: boration; auto makeup, and alternate dilution.	a. Failure blocks fluid flow from RMCS for automatic boric acid and reactor water makeup addition during normal plant operation and load follow. Failure also reduces redundancy of fluid flow paths for dilution of RCS coolant by reactor makeup water, and blocks fluid flow for boration of the RCS coolant when bring-ing the reactor to a hot standby condition. Bora-tion (at boric acid tank boron concentration level) of RCS coolant to bring the reactor to hot standby condition is possible by opening of emergency boration isolation valve (8104) at MCB.	a. Valve position indication (closed to open position change) at MCB; total makeup flow recording (FR-113) and flow deviation alarm at MCB; and VCT level indication (LI-115) and low water level alarm at MCB.	1. Valve is designed to fail closed and is electrically wired so that solenoid of the air diaphragm operator is energized to open the valve.
	b. Fails open.	b. Boron concentration control - reactor makeup control: boration, auto makeup, and alternate dilution.	b. Failure allows for alternate dilute mode type operation for system operation of normal dilution of RCS coolant. No effect on CVCS operation during normal plant operation and load follow, and when bringing the reactor to a hot standby condition.	b. Valve position indication (open to closed change) at MCB.	
29. Air-operated globe valve FCV-114B.	a. Fails closed.	a. Boron concentration control - reactor makeup control: dilution and alternate dilu-	a. Failure blocks fluid flow from RMCS for dilution of RCS coolant during normal plant operation and load follow. No effect on	a. Same methods of detection as those stated above for item 28.	1. Same remark as that stated for item 28 in regard to valve design.

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
		tion.	CVCS operation. Operator can dilute RCS coolant by establishing alternate dilute mode of system operation. Dilution of RCA coolant not required when bringing the reactor to a hot standby condition.		
	b. Fails open.	b. Boron concentration control - reactor makeup control: boration and auto makeup.	b. Failure allows for alternate dilute mode type operation for system operation of boration and auto makeup of RCS coolant. No effect on CVCS operation during normal plant operation and load follow when bringing the reactor to a hot standby operation.	b. Valve position indication (open to closed position change) at MCB.	
30. Air-operated globe valve FCV-113A	a. Fails open.	a. Boron concentration control - reactor makeup control: boration and auto makeup.	a. Failure prevents the addition of preselected quantity of concentrated boric acid solution at a pre-selected flow rate to the RCS coolant during normal plant operation, load follow, and when bringing the reactor to a hot standby condition. Boration to bring the reactor to a hot standby condition is possible; however, flow rate of solution from boric acid tanks cannot be automatically controlled.	a. Valve position indication (open to closed position change) at MCB; and boric acid flow recording (FR-113) and flow deviation alarm at MCB.	1. Same remark as that stated for item 4 in regard to valve design.
	b. Fails closed.	b. Boron concentration control	b. Failure blocks fluid flow of boric acid	b. Valve position indication	

TABLE 9.3-9 (Cont)

Component	Failure Modes	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
		- reactor makeup control: boration and auto makeup.	solution from boric acid tanks during normal plant operation, load follow, and when bringing the reactor to a hot standby condition. Boration (at boric acid tank boron concentration level) of RCS coolant to bring the reactor to hot standby condition is possible by opening of emergency boration isolation (8104) at MCB.	(closed to open position change) at MCB; and boric acid flow recording (FR-113) and flow deviation alarm at MCB.	
31. Air-operated globe valve FCV-114A.	a. Fails closed.	a. Boron concentration control - reactor makeup control: dilute, alternate dilute, and auto makeup.	a. Failure blocks fluid flow of water from RMCS during normal plant operation and load follow. No effect on system operation when bringing the reactor to a hot standby condition.	a. Valve position indication (closed to open position change) at MCB; VCT level indication (LI-115) and low water level alarm at MCB; and makeup water flow recording (FR-113) and flow deviation alarm at MCB.	1. Same remark as that stated for item 28 in regard to valve design.
	b. Fails open.	b. Boron concentration control - reactor makeup control: dilute, alternate dilute, and auto makeup.	b. Failure prevents the addition of a pre-selected quantity of water makeup at a pre-selected flow rate to the RCS coolant during normal plant operation and load follow. The reactor can be brought to hot standby (Mode 3) through operator action with the CVCS.	b. Valve position indication (open to closed position change) at MCB and makeup water flow recording (FR-113) and flow deviation alarm at MCB.	

TABLE 9.3-9 (Cont)

Component	Failure Mode	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
32. Motor-operated globe valve 8104.	a. Fails closed.	b. Boron concentration control - reactor makeup control: boration and auto makeup.	b. Failure reduces redundancy of flow paths for supplying boric acid solution from boric acid tanks to RCS via charging pumps. No effect on CVCS operation during normal plant operation, load follow, or hot standby operation. Normal flow path via RMCS remains available for boration of RCS coolant.	a. Valve position indication (closed to open position change) at MCB and flow recording (FR-113) and flow deviation alarm at MCB.	1. Valve is at a closed position during normal RMCS operation. 2. If both flow paths from boric acid tanks are blocked due to failure of isolation valves (FCV-113 and 8104), borated water from RWST is available by opening isolation valve (LCV-115B or LCV-115D).
	b. Fails open.	b. Boron concentration control - reactor makeup control: boration and - auto makeup.	b. Failure prevents the addition of a pre-selected quantity of concentrated boric acid solution at a pre-selected flow rate to the RCS coolant during normal plant operation, load follow, and when bringing the reactor to a hot standby condition. Boration to bring the reactor to a hot standby condition is possible; however, flow rate of solution from boric acid tanks cannot be automatically controlled.	b. Valve position indication (open to closed position change) at MCB and flow recording (FR-113) and flow deviation alarm at MCB.	
33. Boric acid transfer pump 1, APBA-01 (BA Transfer pump 2 analogous).	a. Fails to deliver working fluid.	a. Boron concentration control - reactor makeup control: boration and auto makeup.	a. No effect on CVCS system operation during normal plant operation, load follow or bringing reactor to hot standby condition. Alternate boric acid transfer pump provides necessary delivery of working fluid for CVCS system operation.	a. Pump motor start relay position indication (open) at MCB and local pump discharge pressure indication (PI-110).	

TABLE 9.3-9 (Cont)

Component	Failure Mode	CVCS Operation - Function	*Effect on System Operation and Shutdown	**Failure Detection Method	Remarks
34. Motor-operated globe valve 8145.	a. Fails open.	a. Charging and volume control - charging flow.	a. Failure results in inadvertent operation of auxiliary spray that results in a reduction of PRZ pressure during normal plant operation and load follow. PRZ heaters operate to maintain required PRZ pressure. Boration of RCS to a hot standby concentration level and makeup of coolant during operation to bring reactor to hot standby condition is still possible.	a. Valve position indication (open to closed position change) at MCB and PRZ pressure indication (PI-455, 456, & 457) and low pressure alarm at MCB.	1. Same remark as that stated for item 14, except valve is normally at a full closed position with power locked out.
	b. Fails closed.	b. Charging and volume control - charging flow.	b. Failure has no effect on CVCS operation during normal plant operation, load follow, and hot standby operation. Valve is used during cold shutdown operation to activate auxiliary spray for cooling down the pressurizer after operation of RHRS.	b. Valve position indication (closed to open position change) at MCB.	

TABLE 9.3-9 (Cont)

LIST OF ACRONYMS AND ABBREVIATIONS

BRS	-	Boron Recovery System
MCB	-	Main Control Board
CVCS	-	Chemical and Volume Control System
ESF	-	Engineered Safety Features
HX	-	Heat Exchanger
PRT	-	Pressure Relief Tank
PRZ	-	Pressurizer
RCP	-	Reactor Coolant Pump
RCS	-	Reactor Coolant System
RHRS	-	Residual Heat Removal System
RMCS	-	Reactor Makeup Control System
RWST	-	Refueling Water Storage Tank
VCT	-	Volume Control Tank

NOTES:

* See list at end of table for definition of acronyms and abbreviations used. Analysis is for a plant condition of charging pump 1 in-service with charging pump 2 out-of-service and charging pump 3 is on standby. Charging pump 3 is lined up on ESF actuation Train B when replacing charging pump 2, and on actuation Train A when replacing charging pump 1.

** As part of plant operation, periodic tests, surveillance inspections, and instrument calibrations are made to monitor equipment and performance. Failures may be detected during such monitoring of equipment in addition to detection methods noted.

TABLE 9.3-10

BORON RECOVERY SYSTEM
COMPONENT DESIGN DATA

Component	Design Parameter
Degasifiers	
Quantity	2
Capacity, (gpm) each	75
Operating pressure (psig)	2
Design pressure (psig)	125/Full vacuum
Operating temperature (°F)	219
Design temperature (°F)	353
Material	Type 304 stainless steel
Degasifier Recovery Exchangers	
Quantity	4
Duty, (Btu/hr) each	3,000,000
Tube side, degasified borated water (gpm)	75
Operating pressure (psig)	100
Design pressure (psig)	200
Operating temperature, in/out (°F)	219/139
Design temperature (°F)	350
Material	Type 304 stainless steel
Shell side, gasified borated water (gpm)	75
Operating pressure (psig)	50
Design pressure (psig)	200
Operating temperature, in/out (°F)	100/180
Design temperature (°F)	350
Material	Type 304 stainless steel

TABLE 9.3-10 (Cont)

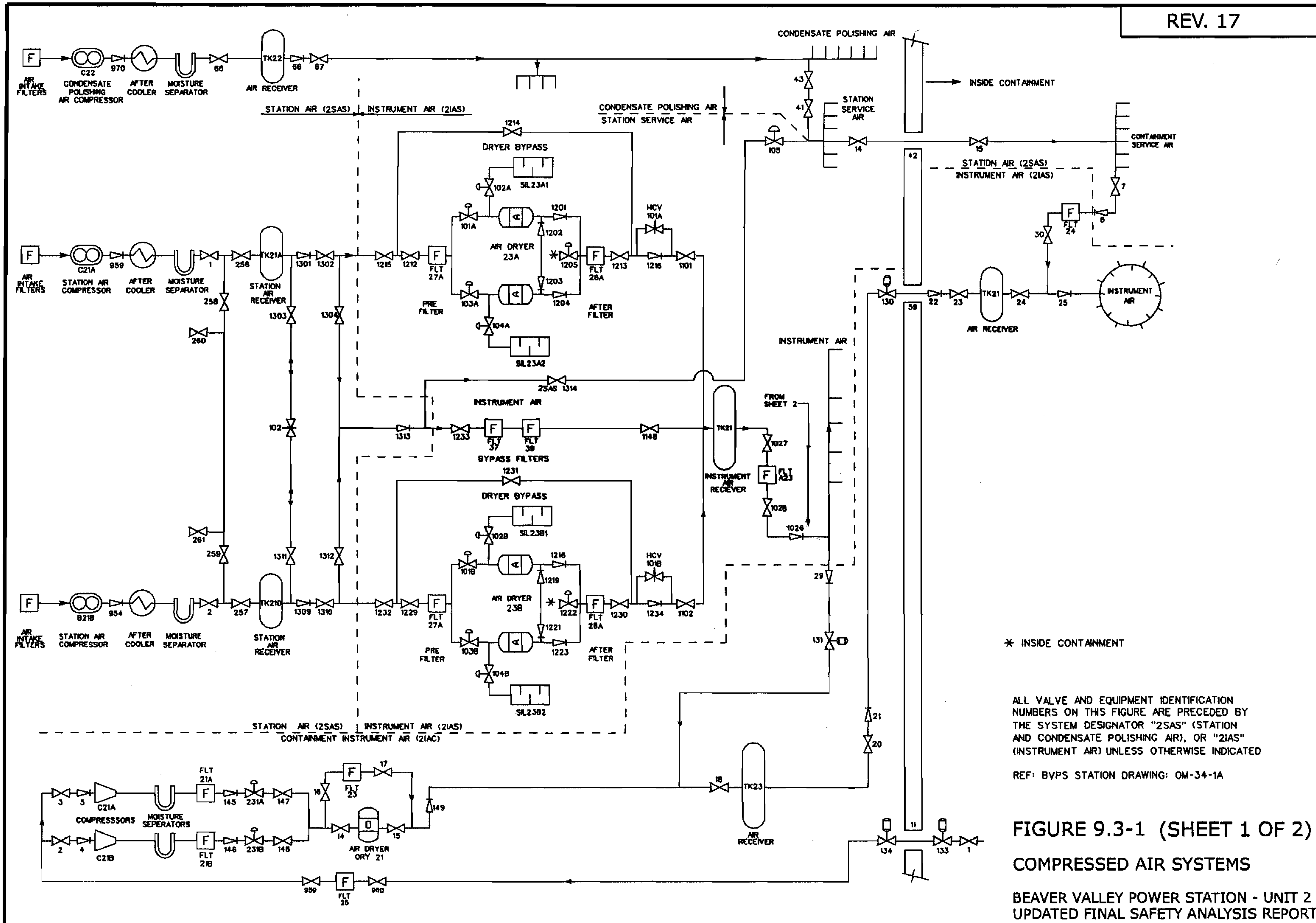
Component	Design Parameter
Degasifier Steam Heaters	
Quantity	2
Duty, (Btu/hr) each	4,460,000
Tube side, gasified borated water (gpm)	85
Operating pressure (psig)	25
Design pressure (psig)	200
Operating temperature, in/out (°F)	135/240
Design temperature (°F)	360
Material	Type 304 stainless steel
Shell side, steam (lb/hr)	5,000
Operating pressure (psig)	100
Design pressure (psig)	165
Operating temperature, in/out (°F)	338/338
Design temperature (°F)	375
Material	Carbon Steel SA-106-B
Degasifier Vent Condensers	
Quantity	2
Duty, (Btu/hr) each	905,000
Tube side, component cooling (gpm)	133
Operating pressure (psig)	60
Design pressure (psig)	150
Operating temperature, in/out (°F)	105/119
Design temperature (°F)	350
Material	Type 304 stainless steel
Shell side, degasified gas stream (lb/hr)	935
Operating pressure (psig)	2
Design pressure (psig)	150
Operating temperature, in/out (°F)	219/219
Design temperature (°F)	350
Material	Type 304 stainless steel

TABLE 9.3-10 (Cont)

Component	Design Parameter
Degasifier Circulation Pumps	
Quantity	2
Capacity, (gpm) each	75
Operating pressure (psig)	115
Design pressure (psig)	150
Operating temperature (°F)	219
Design temperature (°F)	219
TDH (ft)	260
Motor, (hp) each	20
Material	Type 304 stainless steel
Degasifier Vent Chillers	
Quantity	2
Duty, (Btu/hr) each	12,340
Tube side, component cooling water (gpm)	10
Operating pressure (psig)	60
Design pressure (psig)	150
Operating temperature, in/out (°F)	105/107.5
Design temperature (°F)	350
Material	Type 304 stainless steel
Shell side, degasified gas stream (lb/hr)	11.4
Operating pressure (psig)	1
Design pressure (psig)	150
Operating temperature, in/out (°F)	215/110
Design temperature (°F)	350
Material	Type 304 stainless steel

TABLE 9.3-10 (Cont)

Component	Design Parameter
Trim Coolers	
Quantity	2
Duty, (Btu/hr) each	710,000
Tube side, borated water (gpm)	75
Operating pressure (psig)	90
Design pressure (psig)	200
Operating temperature, in/out (°F)	139/120
Design temperature (°F)	350
Material	Type 304 stainless steel
Shell side, component cooling (gpm)	142
Operating pressure (psig)	60
Design pressure (psig)	150
Operating temperature, in/out (°F)	105/115
Design temperature (°F)	350
Material	Carbon Steel
Cesium Removal Ion Exchangers	
Quantity	2
Capacity, (gpm) each	150
Operating pressure (psig)	150
Design pressure (psig)	175
Operating temperature (°F)	130
Design temperature (°F)	200
Material	Type 304 stainless steel
Coolant Recovery Filters	
Quantity	2
Capacity, (gpm) each	150
Operating pressure (psig)	120
Design pressure (psig)	150
Operating temperature (°F)	130
Design temperature (°F)	250
Material	Type 304 stainless steel



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2SAS" (STATION AND CONDENSATE POLISHING AIR), OR "2IAS" (INSTRUMENT AIR) UNLESS OTHERWISE INDICATED

REF: BVPS STATION DRAWING: OM-34-1A

FIGURE 9.3-1 (SHEET 1 OF 2)

COMPRESSED AIR SYSTEMS

BEAVER VALLEY POWER STATION - UNIT 2
UPDATED FINAL SAFETY ANALYSIS REPORT

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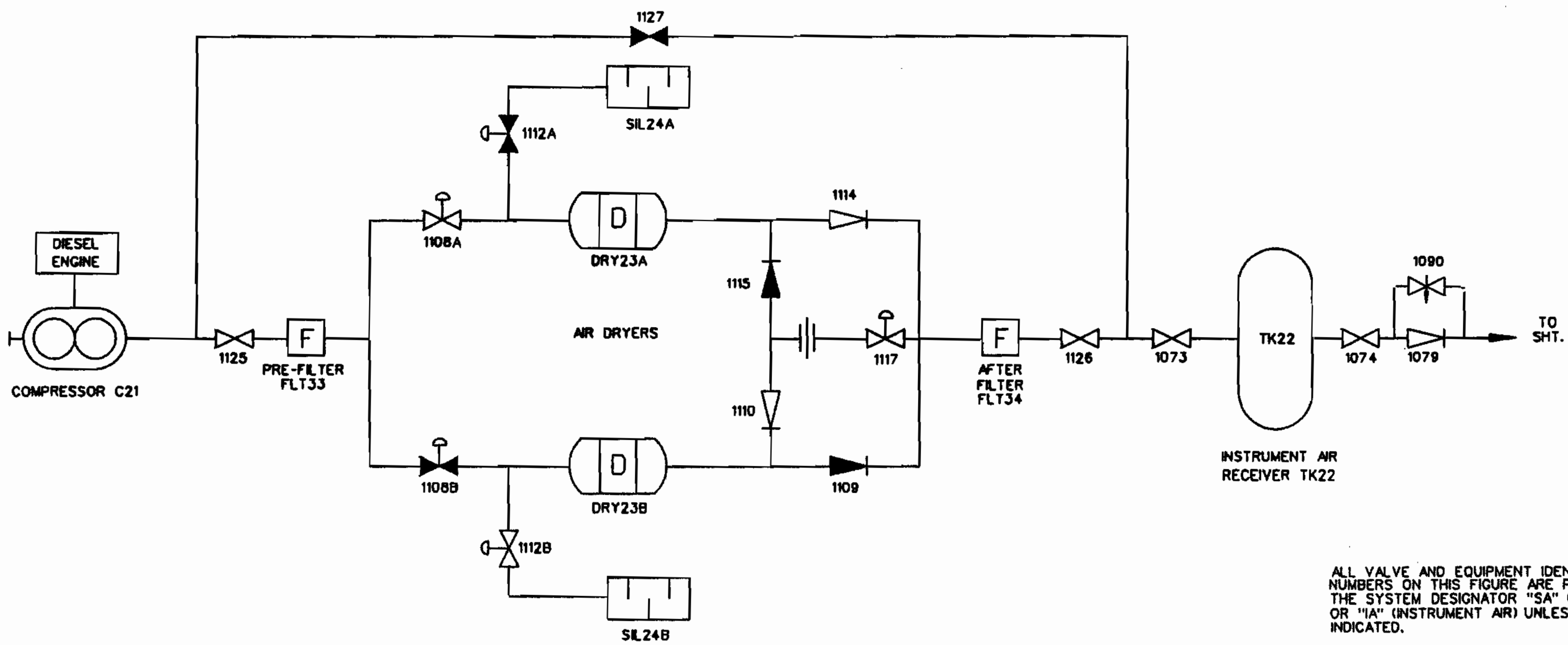


ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "SA" (STATION AIR) OR "IA" (INSTRUMENT AIR) UNLESS OTHERWISE INDICATED.

FIGURE 9.3-1 (SHEET 2 OF 2)

COMPRESSED AIR SYSTEMS

BEAVER VALLEY POWER STATION UNIT NO.2
UPDATED FINAL SAFETY ANALYSIS REPORT

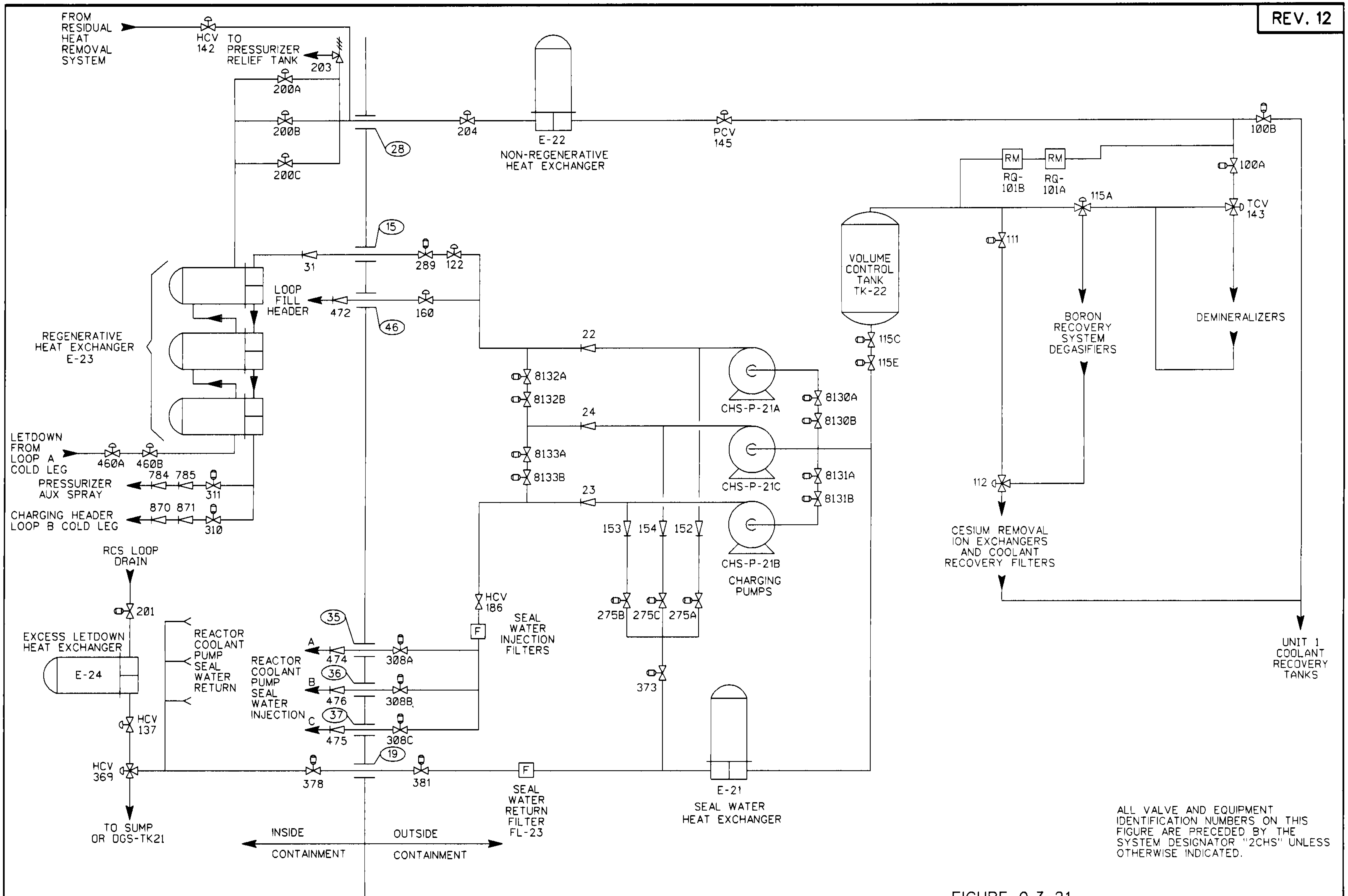
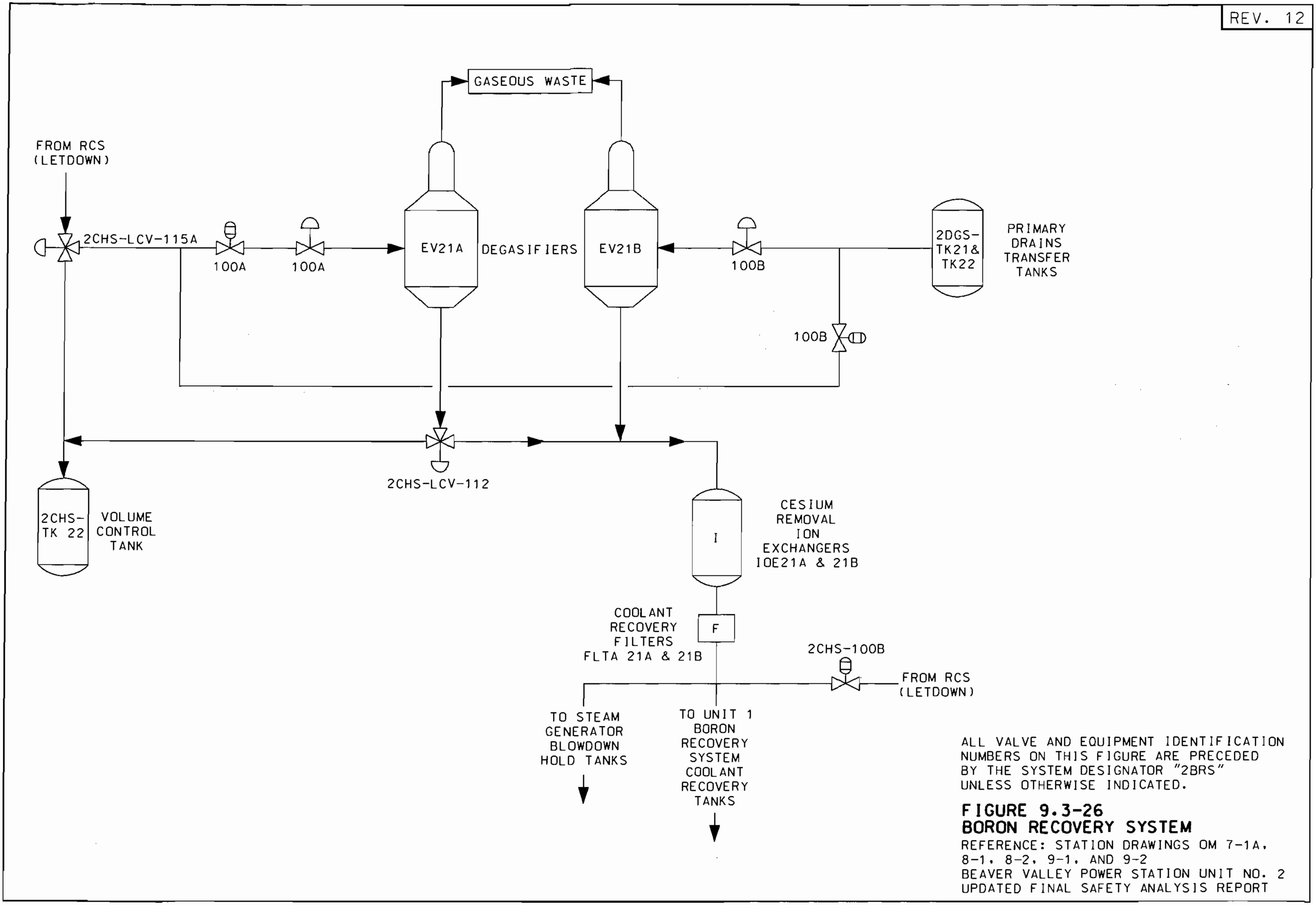


FIGURE 9.3-21
CHARGING AND VOLUME CONTROL SYSTEM

REFERENCE DRAWINGS OM 7-1A, 7-1B, 7-2 AND 7-3
BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2BRS" UNLESS OTHERWISE INDICATED.

FIGURE 9.3-26
BORON RECOVERY SYSTEM

REFERENCE: STATION DRAWINGS OM 7-1A, 8-1, 8-2, 9-1, AND 9-2

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

9.4 AIR-CONDITIONING, HEATING, COOLING, AND VENTILATION SYSTEMS

Heating, ventilating, and air-conditioning systems are provided in the control building (Section 9.4.1), fuel building (Section 9.4.2), auxiliary building (Section 9.4.3), turbine building (Section 9.4.4), engineered safety features equipment areas (Section 9.4.5), emergency diesel generator building (Section 9.4.6), containment structure (Section 9.4.7), intake structure (Section 9.4.8), main steam valve area (Section 9.4.9), service building (Section 9.4.10), safeguards area (Section 9.4.11), cable vault and rod control area (Section 9.4.12), decontamination building (Section 9.4.13), cooling tower pumphouse (Section 9.4.14), gland seal steam exhaust (Section 9.4.15), and condensate polishing building (Section 9.4.16).

The ventilation and/or air-conditioning systems for the control building, emergency diesel generator building, auxiliary building, fuel building, intake structure, safeguards area, and cable vault and rod control area are all, or in part, safety-related. Some of these systems are also classified as engineered safety features (ESF) since they mitigate the consequences of postulated accidents (Section 6.5.1).

The safety-related ventilation and air-conditioning systems for the control building are designed to maintain control room habitability (Section 6.4) under all foreseeable conditions. The supplementary leak collection and release system (SLCRS) is designed to control the release of gaseous radioactive effluents to the environment in the event of an accident (Section 6.5.3.2). The ventilation systems are designed to maintain temperature and/or humidity conditions, to control the air flow from areas with lesser potential for contamination to areas with greater potential for contamination, to minimize buildup of airborne radioactivity in the buildings, and to control the release of gaseous effluents to the atmosphere.

Table 9.4-1 lists all plant ventilation systems and their modes of operation. All air-conditioning, heating, and ventilation systems are designed for the following outdoor conditions (Design Weather Data, Section 2.3):

Summer

Design dry bulb	90°F
Design wet bulb	75°F
Design daily range of design basis	22°F

Winter

Design dry bulb	-5°F

9.4.1 Control Building Ventilation System

The functions of the control building ventilation system are to provide cooling, heating, ventilation, pressurization, and smoke removal for the several areas within the control building.

Two ventilation subsystems service the control building areas: the control room air-conditioning subsystem and the control building air-conditioning subsystem. The control room air-conditioning subsystem ventilates the main control room and two adjoining areas: the computer room and the HVAC equipment room. The control building air-conditioning subsystem ventilates the remainder of the control building, which consists of the cable tunnel to the auxiliary building, the instrumentation and relay room, the cable spreading area, the motor control center (MCC) room, and the communications room. The intake and exhaust fans and cooling coils for this subsystem are located in the equipment room of the auxiliary building.

The control room and the control building ventilation subsystems are shown on Figures 9.4-1 and 9.4-2, respectively.

The control room and the control building ventilation subsystems design temperatures, principal components and design parameters, and description of operation are outlined in Tables 9.4-2, 9.4-3, and 9.4-4, respectively.

9.4.1.1 Design Bases

The design of the control room and control building heating, ventilation, and air-conditioning (HVAC) is in accordance with the following criteria:

1. General Design Criterion 2 and Regulatory Guide 1.29, as they relate to seismic design classification of the system components and the capability of the structures housing the system to withstand the effects of natural phenomena, as described in Chapters 2 and 3. The system is designed to Seismic Category I criteria.

2. General Design Criterion 4, as it relates to the structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems and components important to safety.

4. General Design Criterion 19, and 10 CFR 50.67 where applicable, as they relate to providing adequate protection to permit access and occupancy of the control room under accident conditions.

5. General Design Criterion 60, as it relates to the systems' capability to suitably control release of gaseous radioactive effluents to the environment.

6. Regulatory Guide 1.52, as it relates to system design requirements, maximum system flow requirements, and system functional performance requirements for air filtration and adsorption units of the atmosphere cleanup system, with the exceptions described in Section 1.8.

7. Regulatory Guide 1.78, as it relates to instrumentation capability to detect and alarm on any hazardous chemical release in the BVPS-2 vicinity, and as it relates to the systems' capability to isolate the control room from such a release. The intent of this Regulatory Guide is met through the clarifications described in Section 1.8.

8. Single failure criterion, as it relates to air-conditioning and emergency supply filtration equipment.

9. Design temperatures and parameters, as given in Tables 9.4-2 and 9.4-3.

10. Detection of high radiation levels in the control room, or a containment isolation phase B (CIB) shall automatically close the control room outside air intake dampers. During this condition, the control room is to be maintained above atmospheric pressure by pressurization fans equipped with charcoal and HEPA filters to provide filtration of the outside air.

11. The capability of the smoke purge function of the control building HVAC system to exhaust smoke generated by a fire. A smoke detector in the control room air intake will initiate an alarm in the control room.

12. The capability of the non-safety related features (in-line electric heaters) to maintain their structural integrity in the event of a safe shutdown earthquake (SSE) in order not to compromise the function capability of the system.

13. The capability to prevent building overpressurization in the event of a CO_2 discharge associated with fire suppression.

9.4.1.2 System Description

The HVAC system of the control building consists of two subsystems - one for the control room envelope and the other for the remainder of the building. The control room envelope and control building HVAC systems are shown on Figures 9.4-1 and 9.4-2. The principal component design and performance characteristics are given in Table 9.4-3. Modes of operation of the control room ventilation system are given in Table 9.4-4.

The Beaver Valley Power Station - Unit 1 (BVPS-1) and Beaver Valley Power Station - Unit 2 (BVPS-2) control room air-conditioning systems are independent and physically separate. The main control room areas are open to each other and are in the same pressure envelope. The control and operation of the two air-conditioning systems are not interconnected. The BVPS-1 and BVPS-2 control areas of the main control room are permanently occupied and their respective operators may adjust operating parameters within system limitations.

9.4.1.2.1 Main Control Room Area Air Conditioning

The control room air-conditioning system serves the control room, computer room, and the HVAC equipment room. The system consists of two 100-percent capacity air-conditioning units (ACU), each containing one fan, one service water cooling coil, a direct-expansion cooling coil, an electric resistance preheater, a bag-type filter, and a roll type filter. Each direct-expansion coil is provided with a separate refrigeration unit, which consists of compressor, condenser, and refrigerant piping (Figure 9.4-1).

One of the two ACUs supplies a mixture of outside and return air to the control room envelope during normal operation. The proportions of outdoor air quantities in terms of air changes per hour are listed in Table 9.4-5.

Individual zone heating is provided by seismic duct-mounted non-safety related electric heating coils, controlled by space thermostats.

In the event of a CIB signal or a high area radiation signal in either plant, redundant motorized dampers in the outdoor air intake and exhaust ductwork will close fully, and the air-conditioning system will continue to run on recirculation.

After a preset time delay, redundant parallel motorized dampers will open, and the selected control room emergency supply fan will automatically start, maintaining a positive pressure in the area as long as is required. Air is drawn through one of two redundant emergency supply filtration units, each unit consisting of a moisture separator, an electric heating coil, a high efficiency particulate air filter (HEPA), a charcoal bank filter, and a second HEPA. A loss of flow from the emergency supply fan will cause the redundant fan to be energized.

The smoke detector, located in the air intake for the control room area, alarms locally and annunciates in the control room. Intake dampers are manually closed to isolate outside smoke, and the air-conditioning system continues to run on 100-percent recirculation air.

The smoke detection system located within the control room area alarms locally and annunciates in the control room. Purging of smoke from the control room area is accomplished by manually positioning the outdoor, recirculation, and exhaust air dampers and running the system on a 100-percent outdoor air supply and 100-percent exhaust mode. Ventilation to the computer room is isolated upon initiation of the halon fire suppression system.

9.4.1.2.2 Control Building Air-Conditioning System (Except Main Control Room Area)

Two 100-percent supply fans and two 100-percent return/exhaust fans ensure sufficient ventilation and heat removal for the cable tunnels, instrument and relay room, cable spreading room, MCC room, and communications room. During normal operating conditions, one supply air fan and one return air fan operate. Intake and exhaust air dampers are in the minimum open position, and the recirculation damper is in the fully open position. Ventilation air is cooled by a single chilled water coil, controlled by a valve actuated by pneumatic thermostatic controls (Figure 9.4-2). Refer to Section 9.2.2.2 for a discussion on the chilled water coil.

A manual bypass damper is provided around the chilled water coil and its associated roll air filter to permit operation of the ventilation system when the filter or coil is not in operation.

When the chilled water coil is unable to operate and the space temperature reaches the thermostat setting, the pneumatically-controlled outdoor, exhaust, and return air dampers will modulate to vary the ratio of outdoor air and return air to maintain a constant temperature in the air leaving the space. Redundant dampers are provided.

On a loss of instrument air, or a high space temperature, the outdoor and exhaust air dampers open fully and the recirculation air dampers close. This puts the air-conditioning system into a once-through mode of operation. Smoke/atmospheric contaminant purging is accomplished by repositioning the outdoor, recirculation, and exhaust air dampers and running the system on 100 percent outdoor air mode.

The smoke detection system for the control building air-conditioning system annunciates an alarm in the control room.

9.4.1.3 Safety Evaluation

The essential ventilation equipment within the control building includes a subsystem servicing the main control room and adjoining areas and a second subsystem servicing the rest of the control building. The essential ventilation and air-conditioning equipment (specifically, the Service Water supplied cooling coils) in the Control Room subsystem and all the Control Building (separate from the Control Room), including all ductwork, piping, instrumentation, and valves, are designed as Seismic Category I systems. All equipment is located within the control building or the auxiliary building, both Seismic Category I structures.

Upon loss of static pressure across the operating air-conditioning unit, the redundant standby unit starts automatically. However, if the static pressure of the operating control room air-conditioning unit is not lost, and the temperature in the control room continues to rise (indicating loss of refrigerant supply to air-conditioning unit failure), a manual transfer of air-conditioning units is required. The operation of safety class equipment, motors, and controls is maintained during loss of normal station power and loss of normal offsite power by connection of the emergency diesel generators to the emergency buses.

After initiation of a CIB or detection of high radiation levels, the control room envelope outdoor air intake and outlet dampers are closed, and the emergency supply filtration unit starts to introduce outdoor air. This pressurized and filtered outdoor air keeps the control room envelope continuously and indefinitely under positive pressure.

Radiation levels in the main control room area are monitored continuously by redundant safety-related area monitors and by an airborne monitor which analyzes a sample drawn from the combined recirculation and supply air duct.

The BVPS-2 control room emergency supply filtration unit has sufficient capacity to filter the total volume of air required for pressurization of the control room envelope in the once-through mode.

The design of the control room emergency supply filtration unit is in accordance with Regulatory Guide 1.52, with a few exceptions (Section 1.8).

The mechanical refrigerant units in the Control Room ventilation system are non-safety related, and are employed to maintain a comfortable environment during normal operations (typically 75°F).

Two service water cooling coils in the return air stream are also provided as the primary credited method of cooling the control room envelope following a design basis accident or event. This system is designed to maintain the control room envelope below the 120°F equipment limit. Refer to Section 9.2.1 for a discussion of the cooling coil.

The control building (except the control room area) air-conditioning is a separate independent system. Filtration, heating, and cooling is provided for the air delivered to this section of the building. The supply fans as well as the recirculation fans have 100-percent redundant units.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I&C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria (GDC) and the Institute of Electrical and Electronics Engineers (IEEE) Standard 279-1971 requirements are satisfied, has been performed on the control building and control room ventilation systems. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7). A more detailed description of the safety evaluation of the control room ventilation system is provided in Section 6.4, Habitability Systems.

9.4.1.4 Inspection and Testing Requirements

All control building air-conditioning, ventilation, and chilled water systems are initially tested and inspected for air balance, water balance, and completeness of installation. Design provisions have been made that will permit appropriate in-service inspection and functional testing of system components important to safety. The BVPS-2 maintenance program will include replacement of useable parts such as seals and linkages.

Preliminary tests are performed as described in Section 14.2.12. The system is in continuous operation. Periodic operation of the standby equipment, in conjunction with routine observation and maintenance during normal operation, are sufficient to ensure system availability.

9.4.1.5 Instrumentation Requirements

9.4.1.5.1 Main Control Room Area

Control switches with indicating lights are provided on the building service control panel in the main control room for the main control room area HVAC systems. Either of the two ACUs supplies filtered conditioned air to each of the three zones, consisting of the control room, computer room, and HVAC equipment room. The supply air handling unit may be started manually or automatically. During normal operation, one air handling unit is in operation while the other is in standby.

Air cooling and dehumidification is provided by direct-expansion freon cooling coils in each air handling unit. Discharge air temperature control is regulated by maintaining a constant evaporator coil pressure. Evaporator coil pressure is controlled by the compressor unloaders. Return air duct-mounted temperature switches will energize/deenergize a liquid line solenoid valve in accordance with the demands of their respective areas.

Either of the two freon refrigerant/condensing units provides the necessary cooling capacity for the system. Heat is rejected through the condenser to the BVPS-2 service water system (SWS). The refrigerant/condensing units are interlocked with their respective air-conditioning units and controlled automatically from the compressor suction pressure operating on a continuous pumpdown cycle.

Individual zone heating is provided by duct-mounted electric heating coils, controlled by space thermostatic controls. Each ACU is provided with a service water cooling coil to serve as an additional backup cooling system. This additional backup system is a manually operated system.

Control switches with indicating lights are provided on the building service control panel in the main control room for each motor-actuated damper.

The BVPS-2 control area is part of a single control room envelope that includes the BVPS-1 control area. Thus, to ensure BVPS-2 personnel safety, the air intakes and exhaust dampers of both units will be closed to isolate the control room envelope from the outside in case of a CIB or high radiation signal in either unit, a high radiation signal from any one of the control room area monitors in either unit. In addition, when either unit is in a shutdown mode, that respective unit's air intake and exhaust dampers will be administratively closed.

Following one of these conditions, air will be supplied from one of the emergency supply filtration units, which operate automatically to supply filtered air to the area.

Failure of the selected train filtration unit to start, as detected by loss of flow from the fan, initiates the start of the redundant train filtration unit.

Control switches with indicating lights are provided on the building service control panel in the main control room for the emergency control room supply air fans. These supply air fans operate automatically. Temperature indication is provided in the main control room for outdoor air temperature, return air temperature, and discharge air temperature. A flow recorder is also provided in the main control room for the control room emergency ventilation system.

Annunciation is provided in the main control room for the control room air-conditioning unit auto trip, control room emergency supply unit auto trip, control room air-conditioning compressors auto trip, emergency supply air low flow, central room area radiation high, smoke detection in outdoor air supply to air-conditioning units, common dirty filter alarm for emergency supply air units moisture separators and filters, high temperature in the charcoal bed of control room emergency air supply, and high-high temperature in charcoal bed of control room emergency air supply. These are also monitored by the BVPS-2 computer system.

9.4.1.5.2 Control Building (Except Main Control Room Area)

Control switches with indicating lights are provided on the building service control panel in the main control room for each control building supply air and exhaust air fan.

Two supply air and two return/exhaust air fans powered from emergency sources ensure sufficient ventilation of the cable tunnel, cable spreading area, MCC room, communications room, and instrumentation and relay room to dissipate heat loads generated by equipment during normal and emergency operation.

During normal conditions, one supply air and one return air fan operate. The chilled water coil is controlled by a valve actuated by pneumatic thermostatic controls in the supply air duct.

On a loss of instrument air, or a high space temperature, outdoor and exhaust air dampers open fully and return air dampers close. The lead supply air fan and associated return air fan will start and stop automatically, as required, to maintain space temperature within minimum and maximum limits.

Annunciation is provided in the main control room for supply air and return/exhaust air fans auto trip, control building high temperature and control building low temperature. These are also monitored by the BVPS-2 computer system.

A further description of I&C is given in Section 7.6.6.

9.4.2 Spent Fuel Pool Area Ventilation System

The spent fuel pool area ventilation system removes heat generated by equipment, and water vapor due to fuel pool evaporation, to provide an environment suitable for equipment operation and personnel during normal plant operating conditions. The fuel building ventilation system is not required to operate during accident conditions.

9.4.2.1 Design Bases

The design bases of the spent fuel pool area ventilation system include the following:

1. To maintain the spent fuel pool area indoor air temperature between 76°F and 96°F during normal operation.

2. The spent fuel pool area ventilation system is nonnuclear safety (NNS) class except for the exhaust portion of the ductwork connected to the leak collection system, which is Safety Class 3.

3. General Design Criterion 2, and Regulatory Guide 1.29, as they relate to seismic design classification. The distribution ductwork of the ventilation system is seismically designed and will withstand seismic forces so that the safety-related equipment within the fuel building will not be damaged by ductwork during the postulated seismic events.

4. General Design Criterion 5, as it relates to shared systems and components important to safety. No portion of this system is shared.

5. General Design Criterion 60 and Regulatory Guide 1.52, as they relate to the ability of the system to minimize the release of airborne radioactivity by maintaining the fuel building at negative pressure and by discharging exhaust air through charcoal filtration units which are part of the SLCRS, as described in Section 6.5.3.2.

6. General Design Criterion 61 and Regulatory Guide 1.13, as they relate to spent fuel pool facility design basis controlled leakage during refueling operations. Air flow is maintained from noncontaminated to potentially contaminated areas.

7. During accident conditions, this system is not required to operate, but the SLCRS continues to operate to exhaust and filter air and to maintain a negative pressure in the spent fuel pool area. Filtration following a fuel handling accident is not required to maintain doses within the limits of 10 CFR 50.67.

9.4.2.2 System Description

The principal components and design parameters of the spent fuel pool area ventilation system are given in Table 9.4-6.

The recirculation portion of the system includes a 20,000 cfm air handling unit that consists of a roll filter, two chilled water cooling coils, two hot water reheat coils, a fan, controls, and distribution ductwork to all levels.

The exhaust portion of the system, 3,000 cfm, continuously maintains a negative pressure in the building and is connected with the SLCRS.

Condensate from the air handling unit is directed to the fuel pool
(Section 9.1.3).

9.4.2.3 Safety Evaluation

The spent fuel pool area ventilation system is nonsafety-related and is not required to operate during accident conditions. The exhaust portion, which is a part of the safety-related SLCRS, continues to operate during a DBA. Air is drawn from the spent fuel pool area, which maintains a negative pressure, and is normally passed through a filtration unit before being released to the atmosphere. This procedure ensures that the release of airborne radioactivity to the atmosphere is minimized. Airborne radiation levels are measured by a radiation monitor installed in the exhaust duct, which is part of the supplementary leak collection system.

9.4.2.4 Inspection and Testing Requirements

Routine observation and maintenance is performed to ensure operability of the system. The filtration unit housings and filters are components of the supplementary leak collection system and are factory- and site-tested, as described in Section 6.5.1.4. Preliminary tests are performed as described in Section 14.2.12.

9.4.2.5 Instrumentation Requirements

A control switch with indicating lights for the spent fuel pool area air-conditioning unit is provided on the local control panel. Cooling and dehumidification is provided by a chilled water cooling coil thermostatically-controlled valve to maintain a constant discharge air temperature. The reheat coils and the unit space heaters are thermostatically-controlled to maintain the space temperature.

Indication on the local control panel is provided for return air temperature, cooling coils discharge air temperature, supply air temperature, and outdoor air temperature. Annunciators for spent fuel pool area recirculation fan auto trip, spent fuel pool area high temperature, and high radiation in the spent fuel pool area exhaust are provided in the main control room and are also monitored by the BVPS-2 computer system.

9.4.3 Auxiliary Building and Radwaste Area Ventilation System

The auxiliary building ventilation system provides an environment suitable for personnel and equipment operation and minimizes the potential for spread of airborne radioactive material within the building during normal operation. The auxiliary building ventilation system is nonsafety-related, is designated NNS class, and Seismic Category II. Normally operating portions of this system are not required to operate during accident conditions; however, a Category I backup system is provided for those segments of the building with equipment required during accident conditions. The ventilation system for those portions of the auxiliary building are described in Section 6.5.3.

The radwaste area ventilation system is an extension of the auxiliary building ventilation system. The radwaste area ventilation system is nonsafety-related and is designated NNS class. The radwaste area ventilation system is not seismically designed. It removes heat dissipated into the building from machinery, piping, lighting, and the environment, maintains an environment suitable for personnel access and equipment operation, and minimizes the potential for the spread of radioactive airborne particulates within the building.

9.4.3.1 Design Bases

The design bases of the auxiliary building and radwaste area ventilation system include the following:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of the auxiliary building and radwaste area ventilation system is shared.

3. General Design Criterion 60, as it relates to control of the release of radioactive materials to the environment.

4. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The auxiliary building ventilation system is Seismic Category II.

6. Regulatory Guide 1.140, as it relates to the design, testing, and maintenance criterion for atmosphere cleanup systems.

7. To maintain the auxiliary building air temperature in the ventilation equipment area (at el 773 ft - 6 in) and in general areas (below el 773 ft - 6 in) between 60°F and 104°F coincident with outdoor design temperatures.

8. To maintain the component cooling water pump area and charging pump cubicles at a temperature below 104°F normally but not more than 120°F in those circumstances as discussed in Section 6.5.3.2.2 where the Supplemental Leak Collection and Release System (SLCRS) is not available for post-DBA ventilation. This safety feature is provided by the component cooling water pump general area and charging cubicles emergency exhaust system. This portion of the auxiliary building exhaust is constructed in accordance with Category I design criteria and consists of redundant fans and Category I ductwork and dampers.

9. To maintain the ambient temperature in the radwaste area between 65°F and 104°F, coincident with outdoor design temperatures.

10. To decrease the likelihood of the spread of airborne radioactivity within the auxiliary building by supplying air only to clean areas.

11. To maintain a slightly negative pressure within the auxiliary building and radwaste area by exhausting at a rate higher than the supply air rate.

12. To maintain air flow paths from areas with a lesser potential for contamination into areas with a greater potential for contamination.

13. The normal flow portions of the auxiliary building and radwaste area ventilation system is NNS class, although the distribution ductwork is additionally supported to withstand seismic forces.

14. To maintain an inward velocity of ventilation air to the shielded cubicle entrances.

15. To prevent area overpressurization from a full CO_2 system discharge if required for fire suppression.

9.4.3.2 System Description

The principal component and design parameters of the auxiliary building ventilation system are given in Table 9.4-7. The air supply portion of the auxiliary building ventilation system includes two 50 percent capacity, 28,200 cfm each, air handling units.

Each air handling unit includes a preheat coil using hot water as the heating medium, a cooling coil using chilled water (Section 9.2.2.2) as the cooling medium, a reheat coil using hot water as heating medium, and a motor-driven fan. Air is supplied to all levels and to the containment through ductwork. The system is designed on a once-through basis, with the exception that 8,200 cfm of air is recirculated from the auxiliary building equipment room. One air handling unit is used to supply conditioned air for purging the reactor containment when required, as described in Section 9.4.7.3.

The two filter exhaust fans of the SLCRS (Section 6.5.3.2) are used to exhaust the air. Air is exhausted at a rate higher than the supply to maintain the buildings under negative pressure. Exhaust air is continuously filtered in the main filter banks of the SLCRS prior to discharge to the atmosphere through the elevated release.

Where clean areas are adjacent to potentially contaminated areas, air is supplied to the clean areas and exhausted from the potentially contaminated areas to decrease the possibility of any spread of contamination.

Smoke detectors, located in the supply air ductwork downstream of the air-conditioning units, alarm locally and annunciate in the control room.

As described in Section 6.5.3.2.1, an emergency safety-related exhaust fan system consisting of two axial flow exhaust fans, ducting, and dampers, provides ventilation for the charging pump cubicles and component cooling water pumps general area (Figure 9.4-4) in the event of a failure of the credited Supplemental Leak Collection and Release System (SLCRS). During this period, air enters the auxiliary building through the air intake plenum and then into the charging pump cubicles and component cooling water pumps area. Provisions have been made in the ductwork for the addition of portable radiation monitors to monitor exhaust from the emergency safety-related exhaust fan system.

Recirculation fans and service water cooling coils are provided for each of two redundant MCCs located in the enclosure at el 755 ft-6 in of the auxiliary building. Fans and coils are shown on Figure 9.4-12 and equipment parameters are listed in Table 9.4-7.

Additional cooling is provided in the air ejector and charcoal delay beds cubicles by recirculation air fans and chilled water coils. Equipment parameters are listed in Table 9.4-7. In addition, smoke detectors are located in recirculation ductwork which alarm locally and annunciate in the control room upon detection of smoke in the air ejector and charcoal delay beds.

The auxiliary building elevator machinery room is cooled by an exhaust fan with an associated automatically operated, fresh air inlet damper. Fan parameters are listed in Table 9.4-7.

An air-conditioning system, consisting of a self-contained air-conditioning unit and associated ductwork and registers, cools the post-accident sampling system cubicle at El 735'-6" of the auxiliary building. Equipment parameters are listed in Table 9.4-7.

The radwaste area ventilation system consists of an air supply that comes from the auxiliary building ventilation system air handling units. The air supply ductwork includes a hot water heating coil for heating the building.

9.4.3.3 Safety Evaluation

Air from the auxiliary building and radwaste area is exhausted through the safety-related, redundant filters of the SLCRS. This reduces the potential for radioactively contaminated air being released to the atmosphere.

The motor-operated interface dampers between the auxiliary building and radwaste area ventilation system and SLCRS are Category I safety-related dampers (Figure 9.4-4). These dampers are part of the SLCRS and are described in Section 6.5.3.2.

The supply and exhaust ductwork of the auxiliary building portion of the ventilation system is designed to withstand seismic forces, and the operation of safety-related equipment will not be affected by ductwork during the postulated seismic events.

The radwaste area ventilation system meets the criteria for a NNS class system in Regulatory Guide 1.26 since it does not perform a safety function. Its failure will not cause any safety-related system to fail. The system is designed to provide a controlled environment for personnel access and equipment operation.

Concentrations of airborne particulate and noble gases are continually sampled and analyzed by a radiation monitoring system.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279 1971 requirements are satisfied, has been performed on the auxiliary building and radwaste area ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.4.3.4 Inspection and Testing Requirements

The auxiliary building ventilation system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. The system is in continuous operation and, as such, periodic inspection is not required. Preliminary tests are performed as described in Section 14.2.12.

9.4.3.5 Instrumentation Requirements

The auxiliary building ventilation system air handling units are controlled from the main control room via individual control switches with appropriate indicating lights.

Pneumatic temperature controllers and a flow controller maintain the control point for the preheat coils, cooling coils, hot water control valves, reheat coils, and an air-operated vane damper.

Local flow, pressure differential, and temperature indicators are provided for monitoring of the auxiliary building ventilation system.

Annunciator displays, with associated BVPS-2 computer inputs, are actuated in the main control room for air-handling unit auto-trip, high air flow, no air flow, and high discharge temperature, preheat coil low temperature, prefilter high differential pressure, and loss of instrument air supply.

Flow indicators, mounted locally and in the main control room, are provided for monitoring of the auxiliary building emergency exhaust system.

Annunciator displays, with the associated BVPS-2 computer inputs, are actuated in the main control room for auxiliary building emergency exhaust fans motor overload and charging pump cubicle and component cooling water pump area low air flow.

A temperature controller, installed in the radwaste area, automatically modulates a hot water control valve to maintain the desired space temperature.

Local flow and temperature indicators are provided for monitoring of the waste handling building air system.

The radwaste area motor-operated exhaust dampers and the emergency exhaust fans are controlled from the main control room via individual control switches, with appropriate indicating lights.

9.4.4 Turbine Building Area Ventilation System

The turbine building area ventilation system removes heat dissipated by equipment, piping, lighting, and solar heat gains, and maintains an environment suitable for personnel access and equipment operation in the turbine building. The system uses outside air as the cooling medium.

The turbine, service, and auxiliary building walkway system ensures a safe means of egress from plant areas.

The system is nonsafety-related and is designated NNS class.

9.4.4.1 Design Bases

The design bases of the turbine building ventilation system are as follows:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of the turbine building area ventilation system is shared.

3. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

4. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The turbine building area ventilation system is nonseismic.

5. During the summer, to maintain the turbine building temperature range from 103°F at the operating floor to 110°F just below the roof in unoccupied areas, coincident with outdoor design temperatures. During the winter, to maintain the indoor temperature at a minimum of 60°F, coincident with outdoor design temperatures.

6. General Design Criterion 60 does not apply since provisions are made to prevent airborne radioactivity from entering the turbine building environment (vents from the air ejector condensers and the gland exhaust condensers are hard piped from the turbine building and monitored before discharge to the environment) and valve stem leakoff collection is provided for valve stems.

7. Positive pressure in the turbine, service, and auxiliary building walkway spaces is provided to ensure a safe egress for personnel in the event of smoke conditions.

9.4.4.2 System Description

The turbine building area ventilation system is shown on Figure 9.4-7 and the principal components and design parameters are listed in Table 9.4-8.

The supply portion of the system consists of two axial flow supply fans (125,000 cfm each), associated ductwork, and nine banks of paired wall intake air dampers (total 18). Each fan supplies outside air, or a mixture of outside air and recirculated air, to maintain the designated system exit air temperature of 65°F. The supply fans are located on the north wall of the turbine building.

The ventilation supply air is distributed through ductwork to all levels of the turbine building.

In addition, there are two propeller-type recirculation fans to provide mixing of the air to create a more uniform temperature in the building.

The exhaust portion of the system consists of ten exhaust fans located on the turbine building roof, one exhaust fan in the elevator machinery room, one exhaust fan in the toilet room, and one exhaust fan in the battery room. Each of nine exhaust fans of the ten roof exhaust fans has two air intake dampers associated with it which open when the associated fan starts and close when the fan stops. The

The remaining roof exhaust fan is used for building depressurization and has no associated intake damper.

Hot water unit heaters are provided to maintain the turbine building at an ambient temperature of 60°F during plant shutdown or as required during plant operation, coincident with the outside winter design temperature.

The turbine, service, and auxiliary building walkway is ventilated by supply and exhaust fans for smoke removal. The supply fan is of greater capacity than the exhaust fan to provide positive pressure in the walkway, and to prevent infiltration of smoke from adjacent areas. A fire damper is located adjacent to the supply fan in the turbine building wall to maintain the integrity of the fire barrier boundary.

9.4.4.3 Safety Evaluation

The ventilation system for the turbine building and turbine, service, and auxiliary building walkway does not have safety-related functions and its failure will not compromise other safety-related systems within the turbine building.

9.4.4.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and, as such, periodic inspection is not required.

9.4.4.5 Instrumentation Requirements

Control switches with indicating lights for the turbine building ventilation supply fans and the turbine building power roof ventilators are provided on a local ventilation control panel.

Selector switches for the ventilation louvers and control switches with indicating lights for the turbine building recirculation air fans are also provided on this local ventilation control panel.

A local control switch and thermostat are provided for the elevator machinery room exhaust fan located within the elevator machinery room.

The turbine building ventilation system provides outdoor air as required for cooling, and recirculation of air to maintain the space ambient temperature required to ensure proper operation of equipment and controls during normal plant operations.

When a ventilation supply fan is started, a solenoid air valve is energized to allow signal air to pass from a receiver controller to

the outdoor air and return air damper actuators. As the temperature rises above the set point of the receiver controller, the outdoor air damper will modulate open and the return damper will modulate close as required to maintain desired unit discharge temperature. When the discharge temperature drops below the set point, the reverse will occur.

Indication on the local ventilation control panel is provided for discharge air temperature. Main control room annunciation is provided for a loss of air flow from the turbine building battery room and this annunciation is also monitored by the BVPS-2 computer system.

9.4.5 Engineered Safety Features Ventilation Systems

The engineered safety features ventilation systems (ESFVS) ventilate various areas of BVPS-2 that house ESF equipment. The ventilation systems use outdoor air or service water, or a combination of outdoor air and service water, cooling to provide a suitable and controlled environment for personnel and equipment, with maximum safety against the spread of radioactive contamination. An exhaust system for these areas is provided by the SLCRS described in Section 6.5.3.

9.4.5.1 Design Bases

The design bases for the various systems that comprise the ESFVS are described in their respective sections, as listed in Section 9.4.5.2.

9.4.5.2 Systems Description

The ESFVS is comprised of the emergency diesel generator ventilation system (Section 9.4.6), the intake structure ventilation system (Section 9.4.8), the main steam and feedwater valve area ventilation system (Section 9.4.9), the battery room ventilation system (Section 9.4.10.2), the emergency switchgear ventilation system (Section 9.4.10.3), the safeguards area ventilation system (Section 9.4.11), the cable vault and rod control area ventilation system (Section 9.4.12), and the fission product removal and control system (Section 6.5). The system descriptions of these ESFVS are described in detail in the aforementioned sections.

9.4.5.3 Safety Evaluation

Safety evaluations for the systems that comprise the ESFVS are described in their respective sections, as listed in Section 9.4.5.2.

9.4.5.4 Inspection and Testing Requirements

Inspection and testing requirements that apply to each of the ESFVS are described in their respective sections, as listed in Section 9.4.5.2.

9.4.5.5 Instrumentation Requirements

Instrumentation and controls applicable to the systems that comprise the ESFVS are described in their respective sections, as listed in Section 9.4.5.2.

9.4.6 Emergency Diesel Generator Building Ventilation System

The emergency diesel generator building ventilation system removes heat dissipated into the building from the equipment, lighting, and environment to maintain conditions suitable for personnel access and equipment operation during normal and post-accident conditions.

9.4.6.1 Design Bases

The emergency diesel generator building ventilation system is a safety-related system and is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3.

2. General Design Criterion 4, as it relates to the system being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, in that no systems or system components important to safety are shared.

4. General Design Criterion 17, as it relates to power being available to the emergency diesel generator ventilation system in the event of loss of offsite power (LOOP).

5. Regulatory Guide 1.26, as it relates to the quality group classification of the equipment.

6. Regulatory Guide 1.29, as it relates to the seismic design classification of the equipment.

7. No high or moderate energy line breaks are anticipated to occur in the diesel generator building.

8. Each emergency diesel generator room is maintained below 122°F when its emergency diesel generator is operating. When the emergency diesel generators are not operating, each room is maintained below 104°F in the summer and above 60°F in the winter, coincident with outdoor design temperatures.

9. It meets the single failure criterion in that a failure in the emergency diesel generator ventilation system in one

emergency diesel generator room does not affect the ventilation system in the other diesel generator room.

9.4.6.2 System Description

The emergency diesel generator building ventilation system is shown on Figure 9.4-8. The principal components and design parameters are given in Table 9.4-9.

There are two adjacent, totally independent, emergency diesel generator rooms. Each room has an independent ventilation system, consisting of a normal exhaust fan, a primary supply fan, and a secondary supply fan.

The normal exhaust fan maintains minimum ventilation in the room, when the emergency diesel generator is not operating, in order to remove heat gains from transmission and lighting sources. The normal exhaust fan also prevents the accumulation of gases or fuel-vapor mixtures within the emergency diesel generator room. The normal exhaust fan is provided with Class 1E power and will run in conjunction with the primary and secondary supply fans.

Each normal exhaust fan exhausts through backdraft dampers. Air enters the room by infiltration. Heating is provided by electric unit heaters in order to maintain a 60°F ambient temperature for personnel comfort. The electric unit heaters are QA Category III, are seismically supported, but are not seismically designed.

The primary supply fan automatically starts when its associated emergency diesel generator starts up. The secondary supply fan will run in parallel with the primary supply fan, and will operate when needed to supplement the primary supply fan. In the event that CO_2 is being discharged into the emergency diesel generator room, the associated primary supply fan will not start and the normal exhaust fan will shut off.

The primary and secondary supply fans remove heat dissipated from the diesel engine, engine exhaust system, generator, lighting sources, solar transmission, and other miscellaneous heat gains into the diesel generator space whenever the emergency diesel generator is operating. Each primary supply fan is accompanied by seismically supported, motorized, outdoor air and return air dampers, supply air ductwork, and control instrumentation. Each secondary supply fan is also accompanied by ductwork and control instrumentation. The intake and exhaust openings are missile-protected.

The diesel engine combustion air intake pipes and exhaust muffler pipes are independent of the emergency diesel generator building ventilation system.

9.4.6.3 Safety Evaluation

The emergency diesel generator building ventilation system maintains an ambient temperature suitable for personnel and equipment. The ventilation system is designed so that the temperature in each diesel generator room does not exceed 122°F when the diesel generator is operating.

Operation of the primary and secondary supply fans, normal exhaust fans, and associated motorized dampers is maintained during loss of normal station power by automatic connection to the emergency buses.

An independent ventilation system is provided for each emergency diesel generator room in compliance with the single failure criterion. Failure of one independent ventilation system will not compromise operation of the other independent ventilation system.

The independent ventilation system for each emergency diesel generator room and the related intake and exhaust dampers are designed as Safety Class 3, Seismic Category I, and QA Category I.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisfied, has been performed on the emergency diesel generator building ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.4.6.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Periodic operating of the system in conjunction with routine observation and maintenance during operation ensures system availability. The normal exhaust ventilation system is in continuous operation and periodic inspection is not required. Preliminary tests are performed as described in Section 14.2.12.

9.4.6.5 Instrumentation Requirements

Each emergency diesel generator room normal exhaust fan is controlled locally via individual control switches with indicating lights. The exhaust fans run continuously in the automatic mode or manual mode provided no fire generator high temperature exists in the associated room.

Each emergency diesel generator room primary supply fan is controlled from the main control room via individual control switches with indicating lights. The supply fan will automatically start with its

associated diesel generator start-up, provided no fire generated high temperature exists in the room associated.

Each emergency diesel generator room secondary supply fan is electrically interlocked with its primary supply fan, and is thermostatically controlled locally and from the main control room via individual control switches with indicating lights. The secondary supply fan will operate provided no fire generated high temperature exists in the room.

Air is supplied to the secondary supply fan from the mixed air plenum of the primary supply fan. The fan is automatically controlled and is started by a room thermostat set below 122° to prevent the ambient air temperature of the space from exceeding its setting.

Whenever an emergency diesel generator room primary supply fan starts, its associated exhaust air damper will open fully, and the outdoor air and return air dampers will be modulated via a temperature controller located in the discharge air duct. When the supply fan stops, its associated exhaust and outdoor air dampers will close, and the return air damper will be fully opened. A computer point will be energized whenever the exhaust air damper is fully closed.

Annunciation is provided in the main control room for each supply fan motor thermal overload, and each emergency diesel generator room high and low temperatures. The previous conditions are also monitored by the BVPS 2 computer.

Unit heaters are provided in the emergency diesel generator rooms and are controlled by wall-mounted thermostats to maintain a predetermined temperature in the area.

9.4.7 Containment Ventilation System

The containment ventilation systems are comprised of the following three systems: containment atmosphere recirculation system, containment purge air system, and control rod drive mechanism ventilation system.

9.4.7.1 Containment Atmosphere Recirculation System

The containment atmosphere recirculation system portion of the containment ventilation systems is designed to maintain the bulk air temperature in the containment suitable for personnel and equipment operation during normal plant operation. The system is nonsafety-related and is designated NNS class.

9.4.7.1.1 Design Basis

The design basis of the containment atmosphere recirculation system is in accordance with the following criterion: To limit the containment bulk air temperature to 108°F during normal operation.

Performance characteristics of the containment atmosphere recirculation system are given in Table 9.4-10.

9.4.7.1.2 System Description

The containment atmosphere recirculation system is shown on Figure 9.4-9. The principal components and design parameters are listed in Table 9.4-11. The containment atmosphere recirculation system consists of three 50-percent capacity atmosphere recirculation unit coolers with air distribution ductwork. Each unit cooler consists of a motor-driven fan and cooling coils.

Two of the three atmosphere recirculation unit coolers function during normal operation. Air is drawn by the fan over the respective unit's cooling coils and then is discharged into, and distributed through, ductwork to the containment levels. Self-acting backdraft dampers are installed at the discharge of each fan to prevent reverse flow through an idle fan.

The cooling coils in each recirculation unit cooler assembly are served by a chilled water system (Section 9.2.2) during normal plant operation.

The electrical power is supplied from redundant emergency buses and is de-energized during an SI signal initiation, as described in Section 8.3.

9.4.7.1.3 Safety Evaluation

Two of the three containment atmosphere recirculation unit coolers are required to limit the containment bulk air temperature to 108°F during normal operation.

With loss of all cooling water, such as a LOOP, containment bulk temperature will not exceed 135 degrees F.

The containment atmosphere recirculation fans are NNS class, Seismic Category 2, and are provided with Class 1E power. The containment atmosphere recirculation system cooling coils are Non-Nuclear Safety, Seismic Class 2. The system components and ductwork are designed to Seismic Category I requirements. The containment atmosphere recirculation system is not required to operate during accident conditions.

The fans are stopped automatically by an SI signal and a high containment water level signal to protect the integrity of the emergency power source. The fan high-high vibration signal will trip the fan but is not required to protect the integrity of the emergency power source.

9.4.7.1.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operated correctly. The system is tested and balanced after installation.

Preliminary tests are performed as described in Section 14.2.12.

9.4.7.1.5 Instrumentation Requirements

Control switches with indicating lights for the containment air recirculation fans are provided in the main control room and on the emergency shutdown panel. Control of the fans is similar from both locations. Two of the three fans are running during normal plant operation.

The containment air recirculation fans are capable of being started manually in the event of a loss of plant power. The fans are stopped automatically by an SI signal, a high containment water level, or a containment air recirculation fan high-high vibration signal. The third (swing) fan can be racked into either emergency bus if one of the other two fans is out of service. Cooling water for the containment air recirculation fans cooling coils is provided by the chilled water system during normal operation.

The containment air recirculation cooling coils outlet flow and temperature are monitored by means of indicators in the main control room. Containment air recirculation fans auto stop is annunciated in the main control room and is also monitored by the plant computer.

The fan's vibration is monitored in the main control room by means of an indicator. High vibration is annunciated in the main control room and is also monitored by the plant computer.

9.4.7.2 Deleted

9.4.7.3 Containment Purge Air System

The containment purge air system is designed to reduce the airborne radioactivity in the containment after the plant has reached cold shutdown, and to provide outdoor air during extended periods of occupancy such as during refueling, when the containment may be maintained at a slightly negative pressure.

9.4.7.3.1 Design Bases

The design bases for the containment purge air system are the following:

1. The capacity of the containment purge air system provides approximately one change of containment free air volume every hour. Section 12.3.3 discusses activity levels in the containment following a purge of 8 hours.

2. The containment purge air is supplied at a rate consistent with reducing airborne activity to as low as reasonably achievable.

3. The containment purge supply air is heated or cooled as required.

4. The containment penetrations, the containment isolation valves, and the piping between the valves are Safety Class 2. The remainder of the system is NNS class. The ductwork within the containment building is seismically supported.

5. During refueling, the exhaust air flow may be reduced as indicated in Table 6.5-8.

9.4.7.3.2 System Description

The containment purge air system is shown on Figure 9.4-9. The performance characteristics are provided in Tables 9.4-7 and 6.5-7. The containment purge air system consists of supply and exhaust air subsystems.

An outdoor air pressure-equalizing line with a manually-operated valve is provided between the isolation valve outside the containment on the purge supply line and its containment penetration. This line is used to bring the containment to atmospheric pressure prior to purging. The purge system is actuated manually after containment is at atmospheric pressure.

The purge air is supplied from one of the auxiliary building air-conditioning units, as described in Section 9.4.3.2.

Purge exhaust is provided by the SLCRS, as described in Section 6.5.3.2. The exhaust fans have the capacity to handle approximately one containment air change per hour maintaining the containment under a slightly negative pressure.

The purge exhaust can be manually routed through filter units of the SLCRS ensuring that no radioactivity beyond allowable limits is released to the atmosphere.

A containment airborne monitor provides the plant operators with a high radioactivity alarm. Upon receipt of an alarm the purge exhaust can be manually rerouted through SLCRS filters. Monitors are provided in the purge exhaust ductwork which may be configured to automatically close the containment purge isolation valves upon detection of high radioactivity in the airstream.

Supply and exhaust ductwork are provided with containment butterfly isolation valves. During normal operation of the plant, the purge supply circuit is inoperative and the isolation valves are closed. Provisions are also made to direct a small quantity of the exhaust air to the BVPS-1 process vent filters and gaseous waste blowers for discharge at the top of the cooling tower, as described in Section 11.3.2.4.

9.4.7.3.3 Safety Evaluation

The isolation valves are closed during normal containment operation.

Mechanical locking devices are provided to prevent an inadvertent opening of these containment isolation valves.

To control discharge of radioactive air to the outside atmosphere, during operation with the containment at atmospheric pressure, air in the containment and in the purge exhaust duct is monitored for radioactivity. High radiation in the containment atmosphere initiates an alarm in the main control room. The operator, upon receipt of the alarm, can reroute the purge exhaust from normal to filtered exhaust and elevated release. Detection of high radioactivity in the purge exhaust airstream may automatically close the containment purge isolation valves.

During refueling activities in the containment, the purge may be routed through the filtered leak collection exhaust at reduced air flow rate as indicated in Table 6.5-8.

This system is not required to operate during accident conditions.

9.4.7.3.4 Inspection and Testing Requirements

The containment isolation valves for the containment purge air system are tested for air-tightness as part of the containment leak testing program (Chapter 16).

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly.

The system is tested and balanced after installation. System components are periodically tested to insure system operation.

9.4.7.3.5 Instrumentation Requirements

A control switch with indicating lights is provided for the leak collection normal exhaust fan on the building service control panel located in the main control room. This exhaust fan exhausts air from the containment to the atmosphere, maintaining a slightly negative pressure during the purge and refueling activity.

A two-position control switch with indicating lights is provided on the building service control panel for the motor-operated containment diverting dampers which divert supply air from the auxiliary building to the containment.

A three-position selector switch with indicating lights is provided on the building service control panel for the motor-operated containment diverting dampers which divert exhaust air to the leak collection normal exhaust or filtered exhaust.

Indicating lights are provided on the building service panel for the following manually-operated containment dampers: The damper (ball valve) located outside the containment on the pressure-equalizing line, which will be opened before initial purging starts; the dampers located inside the containment on the exhaust line, which will be closed during refueling to allow a small amount of air to be exhausted after being monitored for radiation.

Redundant radiation monitors are located in the containment exhaust ductwork. Upon detecting a predetermined high level of radiation during purging the motor-operated containment isolation valves may be configured to automatically close and the leak collection normal exhaust fan will stop running.

During refueling activities in the containment, the purge may be directed to the SLCRS filtered exhaust, and the normal exhaust fan will be isolated. Upon detection of a predetermined high level of radiation, the containment isolation valves may be configured to automatically close.

Control switches with indicating lights are provided on the building service control panel to indicate valve position for each of the motor-operated containment isolation valves.

Air flow indication is provided in the main control room.

Annunciation is provided in the main control room for reactor containment radiation high, reactor containment radiation high-high, and leak collection normal exhaust fan trip. These are also monitored by the plant computer system.

9.4.7.4 Control Rod Drive Mechanism Ventilation System

The control rod drive mechanism (CRDM) ventilation system is a forced air cooling system that provides for the removal of heat from the CRDM magnetic jack coil windings during normal operation.

The system is designated as NNS class.

9.4.7.4.1 Design Bases

The CRDM ventilation system is designed in accordance with the following criteria:

1. The CRDM ventilation system will maintain the temperature of the stationary and movable grippers and lift coil wiring insulation below 392°F during normal reactor operation.

2. The CRDM ventilation system has the capability of supplying a minimum air flow of 66,000 scfm cooling air when the normal power supply is interrupted and the reactor is to be maintained at hot standby.

3. General Design Criterion 2, as it relates to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3.

4. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designated as Seismic Category I. The CRDM ventilation system fans are Seismic Category II.

9.4.7.4.2 System Description

The CRDM ventilation system is a forced air cooling system that provides a reliable supply of cooling air to the CRDM magnetic jack coil windings during normal reactor operation.

Cooling is provided by three ventilation subsystems, each with two 33-percent design capacity fans. The CRDM ventilation system fans draw containment ambient air through the CRDM shroud and detachable ductwork. The six CRDM ventilation system fans discharge the air that is drawn from the CRDM shroud, through coils that are cooled by the primary component cooling water (CCW) system and through gravity dampers before discharging to the containment atmosphere. All six fans are provided with Class 1E power and are de-energized during an SI.

The CRDM ventilation system fans can be manually started from the main control room during all modes of plant operation except an SI.

The CRDM ventilation system is shown on Figure 9.4-9 and its performance characteristics are provided in Table 9.4-13.

9.4.7.4.3 Safety Evaluation

During normal operation, three fans, one from each of the three ventilation subsystems, will be operating to supply a total of 66,000 scfm airflow through the CRDM coil area. The remaining three fans are standby units which can be started manually from the main control room or automatically upon failure of an associated fan.

The CRDM ventilation system fans are NNS class, Seismic Category II, and are provided with Class 1E power. The CRDM ventilation system cooling coils are Safety Class 3, Seismic Class 1, and are provided with cooling water from the primary CCW system, as described in Section 9.2.2.1. The system components and ductwork are Seismic Category 1.

The CRDM ventilation system fans and coils are not required to operate during a DBA.

On a loss of power and a safety injection (SI) signal, the CRDM ventilation system fans are disconnected from the Class 1E power supply. The CRDM ventilation system fans may then be started manually, with power supplied from the Class 1E power supply, providing the following conditions are met:

1. Manual reset of SI signal,

2. Emergency diesel generator is operating properly, and

3. Emergency diesel generator is capable of accepting the electrical load.

It is considered highly unlikely that a complete loss of CRDM cooling could occur because of the system design and use of multiple fans. In the unlikely event of a complete loss of CRDM cooling air, a loss of insulation life to CRDM magnetic coil windings will occur when the reactor is at operating temperature. Continuous overheating will result in shorting of the coil windings and tripping of the rods. This is not a safety-related problem since the rod will trip and shut down the reactor.

9.4.7.4.4 Inspection and Testing Requirements

The CRDM system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.3.12.

The system is in continuous operation and, as such, periodic inspection is not required.

9.4.7.4.5 Instrumentation Requirements

Control switches with indicating lights are provided for the CRDM ventilation system fans on the building services control panel in the main control room.

Selector switches with indicating lights are provided in the main control room for operation of the CRDM cooling coils cooling water inlet valves.

A control switch with indicating lights is provided in the MCC for operation of the CRDM cooling coils cooling water isolation valve. Indicating lights are provided in the main control room for indication of CRDM cooling coils cooling water isolation valve position.

CRDM shroud fan coil inlet and outlet air temperatures are monitored by the plant computer system.

Alarms are provided on the building services control panel to indicate automatic start or stop of the CRDM shroud fans and these alarms are also monitored by the plant computer.

9.4.8 Intake Structure Ventilation System

The intake structure ventilation system consists of two subsystems: the primary intake structure ventilation system and the alternate intake structure ventilation system.

9.4.8.1 Primary Intake Structure Ventilation System

The primary intake structure ventilation system provides an environment suitable for personnel access and equipment operation during both normal and accident conditions. The system is safety-related and is designated Safety Class 3.

9.4.8.1.1 Design Bases

The design of the primary intake structure ventilation system is in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3.

2. General Design Criterion 4, as it relates to the system being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, in that no systems or system components are shared except the common structure.

4. General Design Criterion 17, as it relates to assuring proper functioning of the essential electric power system.

5. Regulatory Guide 1.117, as it relates to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

6. Regulatory Guide 1.26, as it relates to the quality group classification of system components. This system is classified as QA Category I, Safety Class 3 with the exception of the electric unit heaters which are classified QA Category II, Safety Class NNS.

7. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is classified as Seismic Category I.

8. Branch Technical Positions ASB 3 1 and MEB 3 1, as they relate to postulated breaks and failures in high and moderate energy piping systems outside the reactor containment.

9. Branch Technical Position CMEB 9.5-1, as it relates to the capability of the system to remove smoke.

10. The ambient temperature in the structure is maintained above 55°F during the winter by electric unit heaters and below 115°F during the summer, by a forced air ventilation system.

11. The primary intake structure ventilation system is safety-related and Seismic Category I, except for the unit heaters. The unit heaters, which are nonsafety-related nor seismically designed, are held in place by seismically designed supports so they do not interfere with the operation of other safety-related items during a seismic event.

9.4.8.1.2 System Description

The primary intake structure ventilation system is shown on Figure 9.4-11, and the principal components and design parameters are given in Table 9.4-14.

The intake structure is common to both BVPS-1 and BVPS-2. All BVPS-2 ventilation system active components will run independently of BVPS-1 components.

There are three separate, independent, and redundant intake pump cubicles utilized for BVPS-2, each with its own cubicle housingand ventilation system. Thus, the failure of one system will not interfere with the operation of the others.

The primary intake structure ventilation system consists of three axial flow, 7,500 cfm capacity ventilating fans, three outdoor air intake dampers, and three roof vents. Air is exhausted through roof vents provided with gravity-type dampers. These vents are also used for smoke removal.

Outdoor air is introduced through a tornado missile-protected opening with motor-operated damper and discharged into the structure by a supply fan.

Exhaust and intake openings are provided with missile hoods. Three roof vents with self-acting backdrop dampers are provided for the relief of static pressure in the building.

Heating is provided to the intake structure to maintain space temperature above 55°F. Heating of the intake structure is not safety-related or seismically designed. The unit heaters are seismically supported to prevent damage to safety-related equipment.

The electric unit heaters are connected to BVPS-1 nonsafety-related motor control centers and are controlled automatically by room thermostats. The electric heaters start on falling temperature and maintain the temperature by recirculating the room air.

During normal conditions, the fans are in the auto control mode. In the cubicles for pumps 2SWS*P21A and B, an increase in room temperature above the setting of the corresponding room thermostat will open the outdoor air damper. This will cause the supply fan to start, allowing the cubicle to be ventilated with outdoor air. In the cubicle for pump 2SWS*P21C, an increase in space temperature above the setting of the room thermostat will start the supply fan. This will cause the outdoor air damper to open, allowing the cubicle to be ventilated with outdoor air.

9.4.8.1.3 Safety Evaluation

The temperature in the pump cubicles is maintained within the design limits of safety related equipment in the cubicles for accident conditions (which bound normal operating conditions). Maximum design limits are based on a service water pump winding temperature of 266°F (nominal 122°F ambient). The minimum design limit is based on the temperature at which service water pump grease will flow adequately (20°F for typical lubricants).

Power is supplied to the ventilation system by the respective emergency bus supplying the associated service water pump, as described in Chapter 8. Two fans are powered from separate emergency power sources. The third fan has the capability of being powered from either emergency power source.

The ventilation system for the intake structure pump cubicle is Safety Class 3, QA Category I, and Seismic Category I except for the electric unit heaters, which are QA Category III and seismically supported, but not seismically designed.

There are three separate and redundant intake pump structure cubicles utilized for BVPS-2, each with its own ventilation system. The failure of one system will not interfere with the safe shutdown of the plant, and therefore meets the requirements of single failure criterion.

A FMEA to determine if the I&C and electric portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisfied, has been performed on the primary intake structure ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.4.8.1.4 Inspection and Testing Requirements

The primary intake structure ventilation system is inspected after installation to ensure that the equipment is properly installed. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

Periodic operations of the system in conjunction with routine observation and maintenance during operation ensure system availability.

9.4.8.1.5 Instrumentation Requirements

Control switches with indicating lights are provided locally in each cubicle, one switch each for the two separate source powered ventilation fans, and two switches for the third ventilation fan, which can be powered from either power source.

Temperature switches with adjustable settings are provided for automatic operation of the pump cubicle ventilation fans, and outdoor air supply dampers. These temperature switches are mounted locally.

Automatic trip of the ventilation fans, and high and low cubicle temperatures, are monitored by the BVPS-2 computer system.

Alarms are provided on the building services control panel that annunciate on an automatic trip of any of the ventilation fans and/or on a high or low cubicle temperature.

A locally mounted power transfer switch is provided to transfer control of one of the ventilation fans, which can be powered by one of the two power sources, to either power source.

Heating is provided by electric unit heaters controlled by wall-mounted room thermostats. The heaters will start on a decrease in room temperature and stop when the preset temperature on the thermostat is reached.

9.4.8.2 Alternate Intake Structure Ventilation System

The alternate intake structure ventilation system provides an environment suitable for personnel access and equipment operation during normal plant operation. This system is not required to operate under accident conditions and is NNS class.

9.4.8.2.1 Design Bases

The design bases of the alternate intake structure ventilation system are as follows:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of the system is shared.

3. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

4. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The alternate intake structure ventilation system is designed to Seismic Category II criteria.

5. Outdoor air is drawn in through a motorized damper, circulated through the structure, and exhausted to the atmosphere by propeller-type exhaust fans to maintain the area below 104°F, coincident with summer outdoor design temperatures. Electrical heating is provided to maintain the area above 40°F, coincident with winter outdoor design temperatures.

6. The electrical components of the two redundant ventilation units is powered from the emergency power supply.

9.4.8.2.2 System Description

The alternate intake structure ventilation system consists of two 100-percent capacity exhaust fans, each with their own motorized intake and exhaust dampers and related ductwork.

Outdoor air is drawn in through the motorized intake damper, circulated through the structure, and exhausted through the motorized exhaust damper by the exhaust fan.

When an increase in room temperature is detected by a room thermostat, the intake and exhaust dampers will open automatically. With a further increase in temperature, the exhaust fan will start automatically.

The electric heaters start on falling temperature and maintain the temperature by circulating the room air. The electric unit heaters are provided from normal power. The ventilation system is shown on Figure 9.4-11 and the principal components and design parameters are given in Table 9.4-15.

A furnace supplies heated air to the lower pump bays to prevent ice formation during extremely cold weather. The air handler blower will operate continuously on normal power when the unit is placed in service. The furnace burner will operate by thermostat on falling temperature.

9.4.8.2.3 Safety Evaluation

The system is nonsafety-related and is not required to operate during a DBA.

The temperature in the intake structure is maintained below 104°F to ensure the required environment for operation of the pumps and associated equipment.

Power is supplied to the damper actuators and fans from emergency buses. Although this is not a safety-related system, the equipment is designed to withstand historic seismic forces.

9.4.8.2.4 Inspection and Testing Requirements

The alternate intake structure ventilation system is inspected after installation to ensure that the equipment is properly installed. The system is also tested and balanced after installation. Preliminary testing is performed in accordance with Section 14.2.12.

Observation of the system and routine maintenance during the course of normal operation are sufficient to ensure system availability.

9.4.8.2.5 Instrumentation Requirements

Control switches with indicating lights for each of the alternate intake structure ventilation fans are provided locally (near each respective ventilation fan).

Thermostats are locally mounted for automatic control of the air exhaust dampers, outside air supply dampers, and ventilation fans.

In the event of an SIS signal, the alternate intake structure ventilation fans will be shunt tripped off the emergency buses. The fans may be administratively loaded on to the emergency diesel generators after the SIS signal has been reset.

An alarm is provided on the alternate intake structure annunciator panel located in the alternate intake structure for indication of a space high temperature and a space low temperature.

A trouble alarm is provided on the main control room annunciator panel for indication of trouble with the alternate intake structure ventilation system and is also monitored by the BVPS-2 computer.

The alternate intake structure is provided with thermostatically controlled electric unit heaters to ensure the minimum ambient temperature required for freeze protection and proper operation of equipment located within the space.

9.4.9 Main Steam and Feedwater Valve Area Ventilation System

Cooling in the main steam and feedwater valve area (MSFVA) is accomplished by the MSFVA ventilation system. The MSFVA ventilation system maintains a suitable environment for personnel access and equipment operation during all modes of plant operation except a high energy line break in the MSFVA.

The MSFVA ventilation system is comprised of Seismic Category I axial flow fans with ductwork and non-safety related Seismic Category II cooling system for main steam valve room coolers.

9.4.9.1 Design Bases

Design bases for the MSFVA systems are as follows:

1. General Design Criterion 2, as it relates to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Sections 2 and 3.

2. General Design Criterion 4, as it relates to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems. No portion of the system is shared.

4. Regulatory Guide 1.26, as it relates to the quality group classification of system components. This system is designated as Safety Class 3.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designated as Seismic Category I.

6. During normal plant operation, the MSFVA ventilation system maintains the ambient temperature in the MSFVA at 120°F or less, coincident with outdoor design temperatures.

7. During plant shutdown, the MSFVA is maintained at a minimum temperature of 55°F with electric unit heaters, coincident with outdoor design temperatures.

9.4.9.2 System Description

Two 100-percent capacity ventilation systems are provided in the MSFVA. Each system consists of a fan, a roll-type filter, dampers, cooling coils, temperature control valves, ductwork, and supply and return grills.

The MSFVA ventilation system maintains the ambient temperature in the MSFVA by recirculating 31,400 cfm of air through the MSFVA ventilation system cooling coils.

Air is drawn into the MSFVA by the axial flow fan through a motor-operated damper, a roll filter, and the cooling coils. The air is then discharged through a motor-operated damper and various distribution ductwork into the MSFVA.

The MSFVA ventilation system is shown on Figure 9.4-12 and the principal component performance characteristics are presented in Table 9.4-16.

9.4.9.3 Safety Evaluation

The MSFVA ventilation system consists of two 100-percent capacity separate and redundant ventilation systems. Each of the separate MSFVA ventilation systems consists of a Seismic Category I axial flow fan powered with Class 1E power. Each system also includes a Seismic Category II roll filter and non-safety related, Seismic Category II cooling coils that are cooled by chilled water. The Chilled Water System is described in Section 9.2.2.2.2.

The MSFVA system is provided with air-operated flow control valves which will fail open to ensure cooling water flow to the MSFVA ventilation system cooling coils.

Normally, one train of the MSFVA ventilation system is in operation while the other train is on standby. Upon detecting a loss of air flow, which may be caused by loss of an operating fan or a duct blockage, the redundant system will automatically start.

Chilled water cooling flow to the backup unit will normally be isolated and must be manually aligned when the redundant unit starts.

During a high energy line break, the MSFVA ventilation system's electric motors will fail on exposure to high temperatures for an extended period. The ventilation system is not required in the MSFVA to bring down the temperature.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisfied, has been performed on the MSFVA ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

The MSFVA system ductwork is Seismic Category I. Components related to the Chilled Water Cooling Coils are Seismic Category II.

9.4.9.4 Inspection and Testing Requirements

The MSFVA ventilation system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and periodic operation of the standby equipment in conjunction with routine observation and maintenance during normal operation are sufficient to ensure system availability.

9.4.9.5 Instrumentation Requirements

Control switches with indicating lights for the MSFVA ventilation and cooling supply fans are provided on the building service panel in the main control room. Local selector switches are provided for the chilled water flow control valves for manual open or modulating modes. The auto modulating mode is controlled by temperature controllers that monitor and maintain the fans' exhaust air temperature.

The ventilation and cooling system supply fans may be started manually or automatically. When a supply fan is placed in the start position, the unit isolation dampers go to the full open position. Upon reaching a predetermined position of their opening travel, limit switches, attached to the motor-operated dampers, will energize the ventilation supply fan and when this fan is started, the automatic roll filters are started.

During normal or emergency operating conditions, one supply fan runs continuously with the redundant supply fan on standby in the auto position. Upon sensing a low air flow, the standby fan will start automatically.

Discharge air temperature indicators for the supply fans are located on the local control panel.

The ventilation and cooling supply fans have annunciation provided in the main control room for fan auto trip, air temperature high, and high filter differential pressure. These conditions are also monitored by the BVPS-2 computer system.

9.4.10 Service Building Ventilation System

The service building ventilation system is comprised of four separate ventilation systems. They are: the normal switchgear and cable spreading area ventilation system; the battery room ventilation system; the emergency switchgear room ventilation system; and the service building equipment room ventilation system.

9.4.10.1 Normal Switchgear and Cable Spreading Area Ventilation System

The normal switchgear and cable spreading area ventilation system removes heat from this area and maintains a suitable environment for personnel access and equipment operation.

9.4.10.1.1 Design Bases

The normal switchgear and cable spreading area ventilation system is designed in accordance with the following criteria:

1. The system maintains an ambient temperature at or below 104°F during the summer and a minimum temperature of 55°F during the winter, coincident with outdoor design temperatures.

2. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

3. General Design Criterion 5, as it relates to shared systems. No portion of the normal switchgear and cable spreading area ventilation system is shared.

4. Regulatory Guide 1.26, as it relates to the quality group classification of the system components.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components.

9.4.10.1.2 System Description

The principal component design and performance characteristics are presented in Table 9.4-17. Outdoor air is used to ventilate and cool the area.

The system consists of one supply fan and one return-exhaust fan, distribution ductwork, fire dampers, roll-type filter, supply and return air grilles, and dampers. Outdoor air is supplied by the supply fan. The return-exhaust fan either exhausts the air to the outdoors or returns it to the supply air duct. The components and

ductwork, except ductwork at el 745 ft-6 in, are not supported seismically. The ductwork at el 745 ft-6 in is designed seismically and is designated Seismic Category I.

Return-exhaust and outdoor air dampers are modulated by a thermostat in the supply air duct to maintain the supply air above a desired minimum temperature.

Outdoor and/or return air is filtered through a roll-type filter before being supplied to the area.

Heating is provided by hot water and electric unit heaters controlled by room thermostats.

9.4.10.1.3 Safety Evaluation

The normal switchgear and cable spreading area ventilation system is nonsafety-related, and the system is not required to operate during or after a DBA.

9.4.10.1.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and, as such, periodic inspection is not required.

9.4.10.1.5 Instrumentation Requirements

Control switches with indicating lights are provided on the normal switchgear ventilation control panel, located in the normal switchgear room, for the supply air and exhaust air ventilation fans. The two ventilation fans are interlocked such that the starting or stopping of one ventilation fan will automatically initiate the starting or stopping of the other ventilation fan.

Temperature indicators are provided on the normal switchgear ventilation control panel to indicate supply air to and exhaust air from the normal switchgear and cable spreading areas.

Supply air and return-exhaust air dampers are controlled automatically by the supply air temperature sensors, provided the supply air fan is operating.

Automatic trip of either the supply air ventilation fan or return-exhaust air ventilation fan activates an alarm on the building services control panel in the main control room and is monitored by the BVPS 2 computer system.

The automatic roll-type filter is energized upon starting of the supply air ventilation fan.

9.4.10.2 Battery Room Ventilation System

The battery room ventilation system removes heat and maintains proper ventilation to preclude the buildup of hydrogen. The system is safety-related and designated Safety Class 3.

9.4.10.2.1 Design Bases

The battery room ventilation system is designed in accordance with the following criteria:

1. The system maintains the ambient temperature at or below 104°F during the summer and a minimum temperature of 55°F in the winter, coincident with outdoor design temperatures.

2. The ventilation rates are sufficient to limit the concentration of hydrogen below 2 percent by volume.

3. General Design Criterion 2, as it relates to structures housing the system, and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Sections 2 and 3.

4. General Design Criterion 4, with respect to structures housing the system, and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

5. General Design Criterion 5, as it relates to shared systems and components important to safety.

6. General Design Criterion 17, as it relates to assuring proper functioning of the essential electric power systems.

7. Regulatory Guide 1.26, as it relates to the quality group classification of systems and components. This system is designated as Safety Class 3.

8. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designated Seismic Category I.

9. Branch Technical Position CMEB 9.5-1, as it relates to the capability of the system to remove smoke.

9.4.10.2.2 System Description

The battery room ventilation system is shown on Figure 9.4-13 and the principal components design and performance characteristics are presented in Table 9.4-18. The ventilation system consists of two 100-percent capacity exhaust fans, fire dampers, ductwork, supply and return air grilles, and dampers.

Air is exhausted from the battery room by the exhaust fan. Transfer grilles in each room supply air to the room from the emergency switchgear areas.

9.4.10.2.3 Safety Evaluation

The battery room ventilation system has two 100-percent capacity fans, each powered from a separate emergency power bus; thus the failure of one fan or source of power does not leave the system inoperable.

The fans and components are QA Category I and supplied with emergency power to ensure their operation during all modes of BVPS-2 operation. The components and ductwork are supported to withstand seismic forces.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisfied, has been performed on the battery room ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.4.10.2.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and periodic operation of the standby equipment, in conjunction with routine observation and maintenance during normal operation, are sufficient to ensure system availability.

9.4.10.2.5 Instrumentation Requirements

Control switches with indicating lights are provided on the building services control panel in the main control room for the two battery room exhaust air ventilation fans.

No pressure differential across one exhaust air ventilation fan will automatically start the redundant fan.

Alarms are provided for automatic start or stop of either exhaust air ventilation fan on the building services control panel and are also monitored by the BVPS-2 computer system.

Loss of air flow from any battery room or total loss of air flow from the battery room ventilation system causes an alarm on the building services control panel and is monitored by the BVPS-2 computer system.

9.4.10.3 Emergency Switchgear Room Ventilation System

The emergency switchgear room ventilation system removes heat from this room and maintains a suitable environment for personnel access and equipment operation during all BVPS-2 operating conditions. The system is safety-related and designated Safety Class 3.

9.4.10.3.1 Design Bases

The emergency switchgear room ventilation system is designed in accordance with the following criteria:

1. The system maintains the ambient temperature at or below 104°F during the summer and a minimum temperature of 55°F in the winter, coincident with outdoor design temperatures.

2. General Design Criterion 2, as it relates to structures housing the system, and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Sections 2 and 3.

3. General Design Criterion 4, with respect to structures housing the system, and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

4. General Design Criterion 5, as it relates to shared systems and components important to safety.

5. General Design Criterion 17, as it relates to assuring proper functioning of the essential electric power system.

6. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

7. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designated as Seismic Category I.

8. Branch Technical Position CMEB 9.5-1, as it relates to the capability of the system to remove smoke.

9.4.10.3.2 System Description

The emergency switchgear room ventilation system is shown on Figure 9.4-13 and the principal components, design, and performance characteristics are presented in Table 9.4-19. Outdoor air is used for cooling and ventilating the area.

The system consists of two 100-percent capacity supply fans, two 100-percent capacity exhaust fans, a cartridge-type throwaway filter, distribution ductwork, and dampers. Each set of fans and associated motor-operated dampers is powered by an independent emergency bus.

Outdoor air is drawn in through a missile-protected opening, through a cartridge-type throwaway air filter, and into the emergency switchgear room by one of the supply fans. The room air is returned to the supply fan or exhausted by one of the exhaust fans to the outdoors through another missile-protected opening.

Outdoor air, return air, and exhaust air dampers are modulated by the temperature controller, located at the discharge of the supply fan, to maintain the supply air at a desired temperature.

A portion of the air supplied is drawn into the battery room and is exhausted by the battery room ventilation system.

Heating is provided by electric unit heaters controlled by room thermostats.

9.4.10.3.3 Safety Evaluation

The system is designed on the basis of 100-percent redundancy; thus the failure of one set of components or its separate emergency power supply would permit continued operation.

The system components are Seismic Category I design and are supplied with Class 1E power to ensure operation during all modes of BVPS-2

operation. The components and ductwork are supported to withstand seismic forces.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisifed, has been performed on the emergency switchgear room ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.4.10.3.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and periodic operation of the standby equipment, in conjunction with routine observation and maintenance during normal operation, are sufficient to ensure system availability.

9.4.10.3.5 Instrumentation Requirements

Control switches with indicating lights are provided on the building services control panel in the main control room to operate the supply and exhaust air fans for the emergency switchgear area. The exhaust air fans are interlocked so that the starting of one supply air fan will automatically start its respective exhaust air fan.

High or low temperature of the air coming from the supply air fan will automatically shut down both the supply and exhaust air fans.

Supply, exhaust, and return air dampers are controlled by the supply air temperature sensors.

Temperature indicators of the supply air temperature are provided on the building services control panel. Automatic start or stop of any of the emergency switchgear ventilation fans will cause an alarm on the building services control panel and is monitored by the BVPS-2 computer system. An alarm is provided for high differential pressure across the roll-type filter, which is also monitored by the BVPS-2 computer system. The BVPS-2 computer system also monitors high and low supply air temperatures. Automatic or manual control stations for adjusting the supply air temperature set point is mounted on the building services control panel in the main control room.

9.4.10.4 Service Building Equipment Room Ventilation System

The service building equipment room ventilation system removes heat from this room and maintains a suitable environment for personnel access and equipment operation. The system is nonsafety-related and is designated NNS class.

9.4.10.4.1 Design Bases

The service building equipment room ventilation system is designed in accordance with the following criteria:

1. The system maintains the ambient temperature at or below 104°F during the summer and a minimum temperature of 55°F during the winter, coincident with outdoor design temperatures.

2. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

3. General Design Criterion 5, as it relates to shared systems. No portion of this ventilation system is shared.

4. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The service building equipment room is nonseismic.

9.4.10.4.2 System Description

The principal component and design parameters are presented in Table 9.4-20. Outdoor air is used to ventilate and cool the area.

The system consists of two 50-percent capacity roof exhaust fans, intake hood, and dampers. Air is exhausted from the room by the two roof exhaust fans, which are controlled by room thermostats.

Air enters the room through the intake hood, which is common to both the service building equipment room ventilation and normal switchgear and cable spreading area ventilation systems. A motorized damper, interlocked with the exhaust fans, is tied with the intake hood ductwork.

Hot water unit heaters controlled by wall-mounted thermostats provide heat for the area in the winter.

9.4.10.4.3 Safety Evaluation

The service building equipment room ventilation system is nonsafety-related, is not required to operate during or after a DBA, and is nonseismic.

9.4.10.4.4 Inspection and Testing Requirements

The system is inspected and tested after installation to ensure that the equipment is properly installed and operates correctly. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and, as such, periodic inspection is not required.

9.4.10.4.5 Instrumentation Requirements

Control switches with indicating lights are provided on a local control panel for the service building equipment room powered roof ventilators. The motorized damper for outdoor air intake is controlled by the starting and stopping of the ventilators. Space heating/cooling thermostats are provided for controlling the operation of each ventilator.

Wall-mounted thermostats control the hot water unit heaters that are used to heat the area. Additionally, room heating is accomplished by the use of ventilators.

9.4.11 Safeguards Area Ventilation System

The safeguards area ventilation system maintains a suitable environment for equipment operation and personnel access. This ventilation system consists of two identical systems: south safeguards area ventilation system and north safeguards area ventilation system. The system is designed as Safety Class 3.

9.4.11.1 Design Bases

The design bases for the safeguards area ventilation system are in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3.

2. General Design Criterion 4, as it relates to the structures housing the system and the system itself being capable of withstanding the effects of externally and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems. No portion of this system is shared.

4. Regulatory Guide 1.26, as it relates to the quality group classification of systems and components. This system is designated as Safety Class 3, QA Category I.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. This system is designated as Seismic Category I.

6. The temperature of the area is maintained during the summer at a maximum of 104°F when there is no safeguards area equipment in operation (during normal plant operation). During normal plant operation, a minimum temperature of 55°F is maintained during the winter, coincident with outdoor design temperatures.

9.4.11.2 System Description

The safeguards area ventilation system is shown on Figure 9.4-12 (design basis analysis (DBA) flow rates are also provided). The design parameters of the principal components are provided in Table 9.4-21.

The safeguards area is divided into two identical areas - the south safeguards area and the north safeguards area. Identical ventilation systems are provided for each of the two areas.

Each ventilation system consists of an air-conditioning unit with a fan, service water cooling coils, volume control dampers, supply grilles, distribution ductwork, and electric unit heaters. Smoke detectors, located in the supply air ductwork downstream of the air-conditioning units, alarm locally and annunciate in the control room.

During the cooling mode of the system, the thermostat controls the operation of the fan, which draws air over the cooling coils and recirculates air in the area. Service water flows through the cooling coils at all times.

During the heating mode of the system, the thermostat controls the electric unit heaters and maintains area temperature above 55°F.

9.4.11.3 Safety Evaluation

The safeguards area ventilation system is designed to maintain an ambient temperature suitable for equipment operation and personnel access during normal plant operation.

During a DBA, temperature is maintained at an adequate level to support operation of emergency equipment in the area. The ventilation system is supplied from the Class 1E power buses to maintain operability during accident conditions. The safeguards area ventilation system is designed as Safety Class 3, Seismic Category I, and QA Category I.

Each of the separate safeguards areas is provided with an independent ventilation system. Failure of the ventilation system in one of the safeguards areas will not impair the operation of the ventilation system in the redundant safeguards area. Thus, protection against single failure is provided on a system-area basis.

Each area is also maintained under negative pressure, to prevent any airborne radioactive contamination from leaking out to the atmosphere, by the SLCRS described in Section 6.5.3.2.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisfied, has been performed on the safeguards area ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.4.11.4 Inspection and Testing Requirements

The safeguards area ventilation system is inspected after installation to ensure that the equipment is properly installed and operates correctly. The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The system is in continuous operation and periodic operation of the standby equipment, in conjunction with routine observation and maintenance during normal operation, are sufficient to ensure system availability.

9.4.11.5 Instrumentation Requirements

Control switches and indicating lights for each air-conditioning unit are provided in the main control room. The air-conditioning units can be operated manually, or automatically on rise and/or fall of space temperature.

The air-conditioning units' motor overload trip is annunciated in the main control room and is also monitored by the BVPS-2 computer.

9.4.12 Cable Vault and Rod Control Area Ventilation System and Alternate Shutdown Panel Room Ventilation System

The cable vault and rod control area ventilation system maintains a suitable environment for personnel access and equipment operation by providing cooling during normal plant conditions and heating during normal and accident conditions. The supplementary leak collection and release system (SLCRS, Section 6.5.3.2) provides safety related cooling during accident conditions. The primary system is safety-

related and designated as Safety Class 3. A secondary system, which supplements normal operation cooling, is nonsafety-related and is designated NNS class. The alternate shutdown panel (ASP) room ventilation system maintains a suitable environment for personnel occupancy and equipment operation, as well as room pressurization during a fire in the control building or cable tunnel area northwest of the auxiliary building. The system is safety-related and designated Safety Class 3.

9.4.12.1 Design Bases

The design bases for the cable vault and rod control area primary ventilation system are as follows:

1. The temperature of the area is maintained between 65°F and 104°F during normal plant operation and at a minimum of 65°F during accident conditions.

2. General Design Criterion 2, as it relates to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as described in Chapters 2 and 3.

3. General Design Criterion 4, with respect to structures housing the system, and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

4. General Design Criterion 5, as it relates to shared systems and components important to safety. No portion of the system is shared.

5. General Design Criterion 17, as it relates to assuring proper functioning of the essential electric power system.

6. General Design Criterion 60, as it relates to the system capability to suitably control release of gaseous radioactive effluents to the environment.

7. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

8. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The cable vault and rod control area primary ventilation system is designed to Seismic Category I criteria.

9. Regulatory Guide 1.52, as it relates to the design, testing, and maintenance criteria for post-accident ESF cleanup systems.

10. Branch Technical Position CMEB 9.5-1, as it relates to the design provisions given to implement the fire protection program in the removal of smoke.

The design bases of the ASP room ventilation system include the following:

1. General Design Criterion 2, as it relates to structures housing the system and the system itself to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as described in Chapters 2 and 3.

2. General Design Criterion 4, as it relates to structures housing the system and the system itself to withstand the effects of external missiles, internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems and components important to safety. No portion of the system is shared.

4. General Design Criterion 19, as relates to providing access and occupancy of spaces outside the control room housing equipment necessary for safe shutdown of the reactor.

5. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

6. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The alternate shutdown panel room ventilation system is designed to Seismic Category I criteria.

7. The capability of the nonsafety-related features (in-line electric heaters) to maintain their structural integrity in the event of a safe shutdown earthquake (SSE) in order not to compromise the capability of the system.

9.4.12.2 System Description

The cable vault and rod control area primary and secondary ventilation systems are shown on Figure 9.4-14 and the design parameters of the principal components are provided in Table 9.4-22.

The systems consists of two safety-related 100-percent capacity air-conditioning units, two nonsafety-related unit coolers, volume control dampers, supply and return air grills, and related ductwork.

Each safety-related air-conditioning unit contains a chilled water cooling coil, a service water cooling coil, a hot water heating coil, a roll-type filter, and a centrifugal fan. Service water flow to the service water cooling coil is normally isolated to conserve service water system flow margin.

The primary system operates on 100 percent recirculation mode. During normal operation, the chilled water cooling coil is used to cool the recirculated air. During emergency conditions, when chilled water may not be available, the Supplemental Leak Collection and Release System (SLCRS) performs the cooling function. Water flows to the heating and chilled water cooling coils are modulated by the return air thermostat.

Failure of one safety-related unit to start, as sensed by the area high temperature, automatically starts the standby unit.

The secondary ventilation system consists of two nonsafety-related unit coolers, one located in the cable vault and the other in the cable tunnel area, augment normal operation cooling for the relay room and various spaces at el 755 feet-6 inches. Each cooler operates continuously during normal plant operation with 100-percent recirculation using chilled water as a cooling medium. During Carbon Dioxide discharge in the area, the secondary ventilation system will shut off to prevent damage to the cooling coils.

The area is maintained under negative pressure by the SLCRS as described in Section 6.5.3.2.

The ASP room ventilation system is shown on Figure 9.4-14, and the design parameters are shown in Table 9.4-22.

The system consists of one self-contained air-conditioning unit, a motor-operated water-regulating valve, an electric duct heater, a motor-operated damper, volume control dampers, fire dampers, supply air diffuser, return air grille, and related duct work.

The air-conditioning unit employs a refrigerant compressor, a direct expansion cooling coil, a water-cooled condenser, a motor-operated water regulating valve, a cartridge-type air filter, and a centrifugal fan.

During normal plant operations this system will not run except during periodic testing. In the event of a fire in the cable tunnel area (CT-1), the instrumentation and relay room (CB-1), the cable spreading room (CB-2), or the west communications room (CB-6), operators will be occupying the alternate shutdown panel room and the ventilation system will be continuously operating. Once manually started, the system is controlled by room thermostats.

9.4.12.3 Safety Evaluation

The cable vault and rod control area primary ventilation system was originally designed to limit maximum ambient temperature to 120°F during loss of chilled water. Subsequently, the service water cooling medium which performed this function was isolated. Safety related cooling is now performed by SLCRS.

The safety-related air-conditioning units and associated controls are supplied with emergency power to ensure their operation during emergency conditions. The primary ventilation system is QA Category I, Safety Class 3, and Seismic Category I. The air-

conditioning units are redundant, such that failure of one unit does not incapacitate the system.

A FMEA to determine if the I&C and electrical portions meet the single failure criterion, and to demonstrate and verify how the GDC and IEEE Standard 279-1971 requirements are satisfied, has been performed on the cable vault and rod control area ventilation system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

The ASP room ventilation system is designed to maintain room-temperature at 75 degrees F in the event of a fire in the control building or cable tunnel area.

The air-conditioning unit and associated controls are supplied with emergency power to ensure their operation in the event of a loss-of-offsite power. The air-conditioning unit is QA Category I, Safety Class 3, and Seismic Category I. The system is not redundant because a fire in the control building or cable tunnel area and any other accident which might render all other means of safe shutdown inoperable are not postulated to occur simultaneously.

9.4.12.4 Inspection and Testing Requirements

The systems are inspected after installation to ensure that the equipment is properly installed and operates correctly. The systems are tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12. The cable vault and rod control area ventilation system is in continuous operation. Periodic operation of the standby equipment and the alternate shutdown panel room ventilation system, in conjunction with routine observation and the maintenance during normal operation, are sufficient to ensure system availability.

9.4.12.5 Instrumentation Requirements

The following paragraphs describe instrumentation provided for safety-related air-conditioning units.

Control switches with indicating lights for the cable vault and rod control area air-conditioning units are provided on the building services control panel in the main control room.

Temperature indication is provided locally (on the cable vault ventilation panel) for the air supply to, and the air exhaust from, both air-conditioning units.

Return air temperature to the cable vault and rod control area air-conditioning units is monitored, and, through temperature sensors, automatically operates the hot water coil water supply valve and the chilled water coil water supply valve to maintain the required space temperature.

Space temperature thermostats for sensing the cable vault and rod control area temperatures are located in the cable vault and rod control area. These thermostats will be used for automatic operation of the air-conditioning units.

An increase in space temperature above the high-high set point of the duty unit space thermostat will automatically stop the duty unit. The standby unit will start automatically when the space temperature exceeds the high-high set point of its respective space thermostat.

High pressure drop across the roll filter, serviced by a pressure differential switch, will automatically start the drive assembly which will advance clean media into the air stream. Run-out of filter media will be indicated by a warning light provided on the filter terminal box.

Indicating lights are provided on the building services control panel to indicate air supply damper position and air exhaust damper position for each air-conditioning unit. Indicating lights are also provided on the building services control panel to indicate the valve position of the service water supply valve to each air-conditioning unit.

The nonsafety-related unit coolers are started and stopped manually from local panels. Indicating "start" and "stop" lights are provided.

Annunciation is provided for automatic trip of either air-conditioning unit. Annunciation is also provided for the cable vault

and rod control area high temperature and high-high temperature. These conditions are also monitored by the BVPS-2 computer.

Control switches with indicating lights are provided locally for the alternate shutdown panel room air-conditioning unit. When the air-conditioning unit start pushbutton is depressed, first stage cooling is energized and the fan of the air-conditioning unit will run. As the temperature in the room increases above the high setpoint of the temperature switch, the second stage cooling is energized. When cooling is no longer required, the air-conditioning unit stop pushbutton is depressed and the fan control switch is placed in the on position. The fan will run for ventilation and when the temperature of the area drops below the low setpoint of the temperature switch, an electric duct heater located downstream of the air-conditioning unit will be energized. An airflow switch provided with the heater will prevent the heater from operating unless the fan is running.

Temperature of the entering and leaving air, and the pressure drop across the cartridge filter are provided by local indicators.

9.4.13 Decontamination Building Ventilation System

The decontamination building ventilation system ventilates, removes heat, and maintains a suitable environment for personnel access and equipment operation under normal conditions.

The system is nonsafety-related and is designated as NNS class.

9.4.13.1 Design Bases

The decontamination building ventilation system is designed in accordance with the following criteria:

1. The system maintains the ambient temperature below 104°F during the summer and above 60°F during the winter, coincident with outdoor design temperatures.

2. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

3. General Design Criterion 5, as it relates to shared systems. No portion of the system is shared.

4. General Design Criterion 60, as it relates to the capability to suitably control the release of gaseous radioactive effluents to the environment.

5. Regulatory Guide 1.140, as it relates to the design for normal ventilation exhaust system air filtration and adsorption units.

6. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

7. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The decontamination building ventilation system is nonseismic.

9.4.13.2 System Description

The decontamination building ventilation system is shown on Figure 9.4-15. The principal components and design parameters are given in Table 9.4-23.

The ventilation system consists of two subsystems, the normal roof exhaust ventilation subsystem and the filtration and exhaust subsystem.

The normal roof exhaust subsystem ventilates the decontamination building when operating. This subsystem consists of two powered roof ventilator exhaust fans, two associated backdraft dampers, a radiation monitor located in the duct common to both fans, and a motorized damper at the west wall fresh air intake. The roof fans and motorized damper are controlled manually, or by two room thermostats when operating.

The filtration and exhaust subsystem ventilates the gaseous waste storage tank (GWST) area and the cask washdown area. The subsystem consists of a filter assembly, an electrical duct heater, a filter assembly bypass, two parallel centrifugal flow exhaust fans with backdraft dampers, associated ductwork, and manually- and motor-operated dampers. Upstream of the parallel centrifugal fans is an interconnecting cross-over with a manually-operated damper. Downstream of the centrifugal fans is a common, radiation-monitored exhaust stack.

The filtration assembly includes one prefilter, one charcoal filter, and one HEPA. A motor-operated damper upstream of the filtration assembly modulates air flow to the filters in order to maintain proper air-residence condition for optimal filter utilization. An electric duct heater upstream of the filtration assembly heats the air stream to reduce the relative humidity to less than 70 percent before the air stream passes through the filter banks.

The filtration and exhaust subsystem receives air from four flexible hoses used for venting spent fuel casks, and from the GWST area which is adjacent to the decontamination building. The flexible hose connections are equipped with redundant manually-operated dampers. When the fuel cask ventilation system is not in operation, the manual isolation dampers for the flexible hose connections are maintained in a closed position. When operating, the roof fans ventilate the decontamination building, the filter bypass centrifugal fan ventilates the GWST area, and the filtration assembly and second centrifugal fan are available for spent fuel cask venting. In the event of radiation detection in the roof exhaust, the roof fans are automatically shut off. Radiation detection in the exhaust stack from exhaust originating in the GWST area will automatically close the filter bypass flow path and open the filtration assembly flow path.

The decontamination building and GWST area are cooled and ventilated by outside air. The decontamination building is heated by centrifugal fan air flow across hot water heaters. The GWST area is heated by explosion-proof, forced air electric heaters.

9.4.13.3 Safety Evaluation

The decontamination building and GWST area ventilation systems are nonsafety-related.

Exhaust air from the decontamination building is radiation-monitored at the roof exhaust. Exhaust air from the GWST area and from spent fuel cask venting is radiation-monitored in the exhaust stack.

Two redundant roof fans exhaust air from a common ductwork in the decontamination building. The filtration and exhaust subsystem is equipped with a cross-over between the two flow paths and centrifugal fans, thereby making the centrifugal fans redundant. The fans may each be utilized for either the filtration or the bypass flow path.

The required filtration assembly air-residence condition is maintained by an upstream modulating damper and a controlling flow element. Pressure differential indicators within the filtration assembly monitor filter buildup. Fire detectors within the filtration assembly monitor filter temperatures.

9.4.13.4 Inspection and Testing Requirements

The system is inspected after installation to ensure that the equipment is properly installed and operates correctly.

The system is tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

The ventilation system with the exception of the roof fans is in continuous operation and, as such, periodic inspection is not required. The roof fans are operated in conjunction with surveillance and calibration of the associated radiation monitor. Periodic routine surveillance and preventive maintenance are performed at regular intervals.

9.4.13.5 Instrumentation Requirements

Control switches with indicating lights are provided for the two powered roof ventilation fans, on the decontamination building temperature control panel located in the decontamination building.

An air intake damper opens when either of the powered roof ventilation fans are operating and closes when the powered roof ventilation fans are not operating.

Control switches are also provided on the decontamination building filtration and exhaust panel for the unfiltered and filtered exhaust from the GWST area and decontamination building ventilation fans.

Dampers on the intake of these fans will open while the respective ventilation fan is operating and close when the respective ventilation fan is not operating.

A damper on the intake of the filtration unit is operated automatically by flow controllers on the intake of the filtration unit.

Flow indicators are mounted on the air flow control panel in the decontamination building to monitor the exhaust ventilated by the power roof ventilation fans, and the filtered and unfiltered exhaust ventilation fans.

Radiation monitors are provided to monitor the exhaust flow of the powered roof ventilation fans and the filtered and unfiltered exhaust ventilation fans. The airborne concentrations are provided at the radiation monitoring cabinet in the main control room. A low radiation signal will cause the shutdown of the normal exhaust ventilation fan associated with the exhaust flow, and start the filter exhaust fan. A high radiation level is alarmed at the decontamination building temperature control panel, and will cause the filter exhaust fan to shutdown.

Annunciation is also provided at the building services control panel in the main control room to indicate high radiation in the decontamination building, dirty filters on the filtration unit, and high temperature and a high-high temperature in the charcoal filter bed.

Low air flow from the GWST area or no air flow from the filtered and unfiltered ventilation fans are alarmed at the building services control panel and are monitored by the BVPS-2 computer system.

9.4.14 Cooling Tower Pumphouse Ventilation System

The cooling tower pumphouse ventilation system maintains a suitable environment for proper equipment operation and personnel access under normal conditions. The system is not safety-related and is designated as NNS class.

9.4.14.1 Design Bases

The cooling tower pumphouse ventilation system design is based on the following:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of the system is shared.

3. Regulatory Guide 1.26, as it relates to the quality group classification system components.

4. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The cooling tower pumphouse ventilation system is nonseismic.

5. The system maintains an ambient temperature below 104°F during the summer and above 60°F in the winter, coincident with outdoor design temperatures.

9.4.14.2 System Description

The principal system component design parameters and performance characteristics are given in Table 9.4-24.

The cooling tower pumphouse ventilation system uses outdoor air for cooling the area.

The ventilation system consists of two 100-percent capacity supply fans, four power roof ventilators, motorized intake and return air dampers, and distribution ductwork. Return and intake air dampers are modulated to keep a constant supply air temperature. Supply fans are started manually and normally run continuously. Power roof ventilators are started and stopped automatically, according to the position of the dampers, such that the same amount of outside air supplied in the cooling tower pumphouse can be exhausted into the atmosphere.

Heating is provided by electric unit heaters installed in the area and controlled by wall-mounted thermostats.

9.4.14.3 Safety Evaluation

The cooling tower pumphouse ventilation system is nonsafety-related and is designated NSS class.

9.4.14.4 Inspection and Testing Requirements

The cooling tower pumphouse ventilation system is inspected, tested, and air-balanced after installation.

Since the system is continuously in use, periodic tests beyond the normal observations and inspections in a maintenance program are not required.

Preliminary testing requirements are contained in Section 14.2.12.

9.4.14.5 Instrumentation Requirements

Control switches with indicating lights for the cooling tower pumphouse ventilation system are located on a local panel. During normal operation, each supply fan runs continuously. The outdoor air and return air dampers are modulated by a supply air thermostat to maintain a constant supply air temperature. The power roof

ventilators start automatically as the outdoor air supply dampers reach predetermined positions. Cooling tower pumphouse ventilation system trouble alarms are provided in the main control room and are also monitored by the plant computer system.

9.4.15 Gland Seal Steam Exhaust Ventilation System

The gland seal steam exhaust ventilation system directs the air from the gland seal steam condenser for monitoring before releasing it to the atmosphere. This system is not safety-related and is designated as NNS class.

9.4.15.1 Design Bases

The gland seal steam exhaust system design is based on the following:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of the gland seal steam exhaust ventilation system is shared.

3. Deleted

4. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The discharge of the gland seal steam exhaust ventilation system is designed in accordance with Seismic Category II criteria.

9.4.15.2 System Description

The principal system components and design parameters are given in Table 9.4-25.

The system consists of two dampers and related ductwork. Air is supplied to the moisture separator-electric heating coil and is released to the atmosphere via the ventilation vent of the normal exhaust flow path of the SLCRS. An electric heating coil in each bank can raise the gland seal steam exhaust temperature by the amount required to lower the relative humidity to 70 percent or less. A moisture separator is located upstream of the electric heating coil to remove water particles from the air prior to being heated and filtered.

9.4.15.3 Safety Evaluation

This system is nonsafety-related and is not required to perform any safety-related function.

Since the gland seal steam exhaust system consists of two redundant 100 percent capacity systems, only half of the system is required to be in operation to accomplish its function.

Radiation monitors in the main stack vent of the SLCRS will detect any radioactive particulate or gaseous activity.

9.4.15.4 Inspection and Testing Requirements

The system is inspected, tested, and air balanced after installation.

The system is in continuous operation. Periodic operation of the standby equipment in conjunction with routine observation and maintenance during normal operation are sufficient to ensure system availability.

Preliminary tests are performed as described in Section 14.2.12.

9.4.15.5 Instrumentation Requirements

Electric heaters are provided upstream of the filter bank to control moisture content of the gland seal steam exhaust. The electric heaters are controlled automatically by means of a moisture switch located upstream in the ductwork.

Radiation monitors are provided in the main vent stack of the SLCRS as described in Section 6.5.3.2.

Electric heating coils will be energized by moisture switches when the moisture content of the air exceeds the setting of the moisture controllers, as sensed by moisture transmitters located in the ductworks upstream of the heating coil. The coil stays energized as long as the incoming air moisture exceeds the controller setting. Continuous readings of relative humidity are indicated by moisture indicating gauges.

9.4.16 Condensate Polishing Building Ventilation System

The condensate polishing building ventilation system ventilates, removes heat, and maintains a suitable environment for personnel access and equipment operation under normal conditions. The system also filters, before releasing to the atmosphere, air that may contain gaseous and particulate contaminants. The system is nonsafety-related and is designated as NNS class.

9.4.16.1 Design Basis

The condensate polishing building ventilation system is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the system being capable of withstanding the effects of natural phenomena, as established in Chapters 2 and 3.

2. General Design Criterion 5, as it relates to shared systems. No portion of this system is shared.

3. General Design Criterion 60, as it relates to the system's capability to suitably control release of gaseous radioactive effluent to the environment.

4. Regulatory Guide 1.26, as it relates to the quality group classification of system components.

5. Regulatory Guide 1.29, as it relates to the seismic design classification of systems and components. The condensate polishing building ventilation system is not seismically supported.

6. Regulatory Guide 1.140, as it relates to the design for normal ventilation exhaust system air filtration units. The operation of such systems, also under RG 1.140, is controlled manually as circumstances require.

7. The system will maintain the ambient temperature below 104°F during the summer and above 60°F during winter, in the general areas, and at 75°F in the condensate polishing building control room, coincident with outdoor design temperatures.

9.4.16.2 System Description

The principal system components and design parameters are given in Table 9.4-26.

The building is ventilated by a general areas ventilation system. In addition to this system, the equipment room and the elevator machinery room are provided with their own local ventilation systems. The condensate polishing building control room has a separate air- conditioning system.

The general areas ventilation system for the condensate polishing building consists of one supply subsystem and three exhaust subsystems: the normal exhaust, the cubicle exhaust, and the process air exhaust.

The supply subsystem provides all general areas of the building with outdoor air during summer, and a mixture of outdoor and return air during winter. The subsystem consists of one automatic roll filter, one face and bypass reheat coil, one centrifugal fan, associated ductwork, and modulating dampers.

The normal exhaust subsystem draws air from the noncontaminated cubicles and discharges it either to the atmosphere, via the main ventilation stack, or to the supply subsystem for recirculation. The mode of operation and the amount of return air are achieved by air- operated dampers which are thermostatically controlled. The subsystem consists of one axial fan, associated ductwork, and dampers.

The cubicle exhaust subsystem exhausts air from the cubicles that may contain contaminated particulates and filters it before discharging it to the main ventilation stack into the atmosphere. The subsystem consists of one centrifugal fan with variable inlet vanes, associated ductwork, controls, and one filtration assembly containing one pre- filter bank and one HEPA bank.

The process air exhaust subsystem filters and exhausts air that may contain gaseous contaminants. The air is released and drawn from the process equipment located in the building and from fume hoods located in the primary chemical laboratory. The subsystem consists of one centrifugal fan that draws the air through one filtration assembly and discharges it into the atmosphere via the ventilation stack. The filtration assembly consists of one moisture separator, one electric heating coil, one charcoal gasketless adsorber, and two HEPA banks, one upstream and one downstream of the charcoal bank. The electric heating coil raises the air temperature by the amount required to lower the relative humidity to 70 percent or less, to ensure maximum charcoal efficiency.

The elevator machinery room ventilation system consists of one propeller exhaust fan, one motor-operated outdoor air damper, and one motor-operated exhaust air damper, all mounted on the wall. The system operates (dampers open, fan starts) and stops (the reverse) as dictated by the thermostat located in the room.

The equipment room ventilation system consists of one motor-operated outdoor air intake damper and two roof exhaust fans with backdraft dampers, all thermostatically controlled. The roof exhaust fans will start in sequence on a rise in temperature, and the outdoor air damper will open when the first fan starts. On a decrease in the room temperature, the reverse occurs. The system can also be started and stopped manually.

The condensate polishing building control room will be air-conditioned by the 100 percent air-conditioning unit. This unit contains one fan, one roll filter, and one cooling coil using chilled water (Section 9.2.2.2). The unit supplies a mixture of outside and return air. During summer, the supply air is cooled by the chilled water cooling coil, which is thermostatically controlled by a temperature control valve. Air is heated during winter by the electric duct heater installed in the supply duct and controlled thermostatically.

9.4.16.3 Safety Evaluation

The condensate polishing building air-conditioning system is nonsafety-related and is not required to perform any safety-related function.

The areas which may contain radioactive contaminants are kept under a slightly negative pressure. Continuous infiltration is ensured from the noncontaminated areas toward the potentially contaminated areas. Areas that do not normally contain contamination may have their ventilation fans run intermittently if not credited for radionuclide filtration (e.g. Cubicle Exhaust Fans).

The required filtration assembly air residence time is maintained in the process air filtration assembly by controlling the air flow with an upstream modulating damper and flow element. Fire detectors within the filtration assembly monitor filter temperatures. Fire protection is provided for the charcoal filter bank, as described in Fire Safety Analysis, Volume 2-2.

In the cubicle filtration assembly, the proper residence time for filter utilization is achieved by the exhaust fan variable inlet vanes, controlled by a downstream flow element.

Condensate from filtration assemblies is collected in a seal tank in the condensate polishing building. The tank discharges into the equipment drains system, as described in Section 9.3.3.

Pressure differential indicators within each filtration assembly monitor filter buildup. Exhaust air from all three exhaust subsystems is monitored by off-line gas and particulate detectors prior to being released to the environment through the ventilation stack, as described in Section 11.5. All three exhaust fans will be interlocked to stop on high radiation signal. Additional monitoring for radiation is also provided in the ductwork that exhausts the recovery filter areas.

9.4.16.4 Inspection and Testing Requirements

The ventilation systems are inspected after installation to ensure that the equipment is properly installed and operates correctly. The systems are tested and balanced after installation. Preliminary tests are performed as described in Section 14.2.12.

9.4.16.5 Instrumentation Requirements

Control switches with indicating lights for the process air filtration exhaust fan are provided at the local airflow control panel.

The process air filtration exhaust fan can be operated manually or automatically. Automatically, the fan will start and its associated air operated damper will open, provided the supply subsystem fan is running, and will stop and close the damper when the supply subsystem fan is stopped. A moisture transmitter is provided to send a signal to the electric heating coil to maintain the relative humidity in the filtration assembly.

Annunciation is provided at the building service control panel in the main control room for process air filtration exhaust fan auto trip, process air filtration exhaust fan low airflow, process air filtration system high temperature charcoal filter, process air filtration system high/high temperature charcoal filter, high pressure differential across process air filtration system filters and moisture separator, and process air filtration system high humidity. All of the preceding are annunciated by a common trouble alarm, and are also monitored by the BVPS-2 computer.

Indicators are provided on the local air flow panel for process air discharge air flow.

Control switches with indicating lights for the cubicle exhaust air filtration fan are provided at the local airflow control panel. The cubicle exhaust fan is manually started and stopped from the local airflow control panel. Starting the fan will open its respective air-operated damper and stopping the fan will close the damper.

Annunciation is provided at the building service control panel in the main control room for cubicle exhaust fan auto trip, cubicle exhaust fan low air flow, and cubicle exhaust air filtration system filters high differential pressure. All of the preceding are annunciated by a common trouble alarm, and are also monitored by the BVPS-2 computer.

Indicators are provided on the local air flow panel for cubicle air discharge air flow.

Control switches with indicating lights for the normal air ventilation supply and exhaust fans are provided at the local normal air ventilation system temperature control panel.

The normal air ventilation supply and exhaust fans can be manually started and stopped from the local control panel. The respective air-operated dampers open and close when fans are started and stopped. The normal air ventilation exhaust fan can be operated automatically. The fan will start when the supply fan is started and stopped when the supply fan is stopped.

Annunciation is provided at the building service control panel in the main control room for normal air ventilation supply fan auto trip, normal air ventilation exhaust fan auto trip, normal air ventilation supply fan roll filter high differential pressure, and normal air ventilation supply fan freeze conditions. All of the preceding are annunciated by a common trouble alarm, and are also monitored by the BVPS-2 computer.

Indicators are provided on the normal air ventilation system temperature control panel for normal air ventilation discharge temperature and normal air ventilation mixed air temperature.

A control switch with indicating lights for the elevator machinery room propeller exhaust fan is provided locally. The elevator machinery room propeller exhaust fan can be operated manually or automatically. The associated dampers of this fan will open when the fan is started, and close when the fan is stopped. Automatically, the fan is started on a high temperature in the elevator machinery room and stopped on a low temperature in the elevator machinery room.

An annunciator is provided at the building service control panel in the main control room for elevator machinery room propeller exhaust fan auto trip. This condition is annunciated by a common trouble alarm and is monitored by the BVPS-2 computer.

Control switches with indicating lights for the equipment room roof exhaust fans are provided locally. The equipment room roof exhaust fans can be operated manually or automatically. The associated dampers of these fans will open when the fan is started, and close when the fan is stopped. Automatically, the fans are started on a high temperature in the equipment room and stopped on a low temperature in the equipment room.

An annunciator is provided at the building service control panel in the main control room for equipment room roof exhaust fans auto trip. This condition is annunciated by a common trouble alarm and monitored by the BVPS-2 computer.

A control switch with indicating lights for the condensate polishing building control room air-conditioning unit is provided. The air-conditioning unit is manually started and stopped.

Annunciation is provided at the building service control panel in the main control room for condensate polishing building control room air-conditioning unit auto trip and for control room filter dirty. These conditions are annunciated by a common trouble alarm. This air-conditioning unit's auto trip is also monitored by the BVPS-2 computer.

Indication is provided locally for condensate polishing building control room temperature.

Tables for Section 9.4

TABLE 9.4-1

PLANT VENTILATION SYSTEMS MODES OF OPERATION

Ventilation System	Figure	Normal	Reactor Hot Shutdown	Reactor Refueling	Fuel Handling Accident	LOOP	LOCA
		System in Operation During:					
Leak Collection	6.5-2	X	X	X	X	X	X
Control room area pressurization filtration	9.4-1				X		X
Control room area air-conditioning	9.4-1	X	X	X	X	X	X
Control building ventilation (cable tunnel, cable spreading, etc.)	9.4-2	X	X	X	X	X	X
Spent fuel pool ventilation	9.4-15	X	X	X	X	X	
Auxiliary building ventilation	9.4-4	X	X	X	X		
Turbine building ventilation	9.4-7	X	X	X	X		
Waste handling building ventilation	9.4-4	X	X	X	X		
Emergency diesel generator building ventilation	9.4-8					X	X
Containment atmosphere recirculation	9.4-9	X	X	X	X		
Containment atmosphere filtration	9.4-9	X	X				
Intake structure pump house ventilation	9.4-11	X	X	X	X	X	X
Main steam and feedwater valve area	9.4-12	X	X	X	X	X	X
Condensate polishing building ventilation	-	X	X	X	X		

TABLE 9.4-2

CONTROL BUILDING AREA
DESIGN TEMPERATURES

Room or Area	Summer Temperature* (°F)	Winter Temperature (°F)
Main control room area (el 735 ft 6 in)	75/75	75
Computer room (el 735 ft 6 in)	75/75	75
HVAC equipment room (el 735 ft 6 in)	104/104	75
MCC Room (el 707 ft 6 in)	104/120	65
Communication room (el 707 ft 6 in)	104/120	65
Cable tunnel (el 712 ft 6 in)	104/120	65
Cable spreading room (el 725 ft 6 in)	104/120	65
Instrumentation and relay room	104/120	65

NOTE:

*During normal plant operation/After DBA.

TABLE 9.4-3

CONTROL BUILDING AIR-CONDITIONING AND VENTILATING SYSTEMS
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

System	Number of Units	Capacity (cfm-each)	Head (in WG)	Motor (hp)	Total Load (Btu/hr-each)
Control room air-conditioning system					
Supply air, air-conditioning units	2	18,000	7.8(SP)*	40	693,600
Emergency supply fans	2	1,000	10.1(TP)**	5	________
Control building air-conditioning system					
Supply air fans	2	13,000	6(TP)**	20	________
Return air fans	2	13,000	5(TP)**	20	________
Cooling coil	1	13,000	________	__	581,000

NOTES:

*Static pressure.
**Total pressure.

TABLE 9.4-4

CONTROL ROOM AREA AIR-CONDITIONING SYSTEM
DESCRIPTION OF OPERATION

	Modes of System Operation	System	Initiation		Result	System Operation
			Action	Instrument		
1.	Normal operation	Main air-conditioning system	Manual	Switch on main control board	Supply fan starts up. Outdoor air damper opens. Refrigeration system starts up.	One air-conditioning unit and one refrigeration system in operation. The return air duct thermostats control the direct expansion cooling coil solenoid valve. Room thermostats control air reheat coils in steps to maintain constant room temperature. An averaging thermostat controls air temperature downstream of the preheaters, and is located inside the air conditioning units. Each train and its respective components are assigned to a separate electrical train.
2.	DBA with/without loss-of-offsite-power	Control room isolation system	Automatic	CIB or high area radiation signal	Control Room Outdoor air intake damper closes.	One air-conditioning unit, and one refrigeration system are in operation. Each train and its respective components are assigned to a separate electrical train. The return duct thermostats control the cooling coil solenoid valve. Lack of air flow in one air conditioning unit results in automatic startup of the standby unit.
		Control room emergency supply filtration system	Automatic	CIB or high area radiation signal	Control room emergency supply fan starts	
3.	Toxic gas release	Control room isolation system	Manual	Pushbutton on main control board	Outdoor air intake dampers closes.	One air-conditioning unit, and one refrigeration unit in operation. Each train and its respective components are assigned to a separate electrical train.

TABLE 9.4-4 (Cont.)

Modes of System Operation		System	Initiation Action	Initiation Instrument	Result	System Operation
4.	Smoke (plant fire)	Main air-conditioning system	Manual	Smoke detector (in the intake duct)	Control room isolation	One air-conditioning unit and one refrigeration unit in operation. Each train and its components are assigned to a separate electrical train. Lack of air flow in one air-conditioning unit results in automatic startup of the standby air-conditioning unit and the refrigeration system.
5.	Smoke purging	Main air-conditioning system	Manual	Switch on control board and chain-operated damper	Exhaust and intake air dampers open fully, recirculation air damper closes.	One air-conditioning unit, and one refrigeration unit in operation. System operates on 100 percent outdoor air and 100 percent exhaust air. Each train and its components are assigned to a separate electrical train. Lack of air flow in one unit results in automatic startup of the standby air-conditioning unit and the refrigeration system.

TABLE 9.4-5

CONTROL ROOM AREA VENTILATION SYSTEM
OUTSIDE AIR RATES IN TERMS OF AIR CHANGES PER HOUR

Room	Air Changes (per hour)
Control Room	0.31
Computer Room	0.48

TABLE 9.4-6

SPENT FUEL POOL AREA (FUEL BUILDING) VENTILATION SYSTEM PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Recirculation Air-Conditioning Unit	
Fan	
Quantity	1
Capacity (cfm)	20,000
Static pressure (inch WG)	4.25
Motor (hp)	30
Filter	
Quantity	1
Pressure drop, clean/dirty (inch W/G)	0.16/0.55
Cooling Coils	
Quantity (number of coils/ACU)	2
Capacity, total (MBH)	1,470
Maximum water flow (gpm)	440
Heating Coils	
Quantity (number of coils/ACU)	2
Capacity, total (MBH)	796
Maximum water flow (gpm)	30
Unit Heaters	
Quantity	13
Capacity, (MBH) each	1 @ 158 12 @ 70.5

TABLE 9.4-7

AUXILIARY BUILDING AND RADWASTE AREA VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components (Air Handling Units)	Design Parameters
Supply Fans	
Quantity	2
Capacity, (cfm) each	28,200
Static pressure (in WG)	8.5
Motor, (hp) each	60
Cooling Coils	
Quantity	2
Capacity, (MBH) total	1,410
Flow rate, (gpm) total	152
Heating Coils	
Quantity	2
Capacity, (MBH) total	730
Flow rate, (gpm) total	10
Radwaste Area Heating Coil	
Quantity	1
Capacity, (MBH)	367
Flow rate (gpm)	12
MCC Enclosure Fans	
Quantity	2
Capacity, (cfm) each	2,800
Static pressure (in WG)	1.0
Motor, (hp) each	3
MCC Enclosure Cooling Coils	
Quantity	2
Capacity, (MBH) each	26.7
Flow rate, (gpm) each	15
Air Ejector/Charcoal Delay Bed Recirculation Fans	
Quantity	2
Capacity, (cfm) each	5,700

TABLE 9.4-7 (Cont)

Components (Air Handling Units)	Design Parameters
Static pressure (in WG)	1.25
Motor, (hp) each	3
Air Ejector/Charcoal Delay Bed Recirculation Cooling Coils	
Quantity	2
Capacity, (MBH) each	40.7
Flow rate, (gpm) each	7
Auxiliary Building Elevator Machinery Room Fan	
Quantity	1
Capacity (cfm)	5,000
Static pressure (in WG)	0.48
Motor (hp)	1
Post Accident Sampling System Cubicle Self-Contained Air Conditioning Unit	
Quantity	1
Capacity (cfm)	1,000
Capacity (MBH)	22.0
Static Pressure (in WG)	0.59
Motor (hp)	1/5

TABLE 9.4-8

TURBINE BUILDING VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Component	Parameters	
Supply Fans	Turbine Room	Walkway
Quantity	2	1
Fan capacity, (cfm) each	125,000	2,533
Stator pressure (in WG)	5.5	0.125
Motor, (hp) each	150	1/4
Circulating Fans		
Quantity	2	-
Capacity, (cfm) each	90,000	-
Static pressure (in WG)	free delivery	-
Motor, (hp) each	25	-
Intake Dampers	Turbine Building Wall	
Quantity	Nine banks/2 each bank	
Hot Water Unit Heaters		
Quantity/capacity	11 @ 960 MBH each 4 @ 460 MBH each 1 @ 107.7 MBH each	

Exhaust Fans	Elevator Mchry Room	Turbine Bldg. Roof	Battery Room	Toilet Room	Walkway
Quantity	1	10	1	1	1
Capacity, (cfm) each	5,000	75,000	2,000	400	1,809
Static pressure (in WG)	0.48	free dlvy	2.0	2.0	free dlvy
Motor, (hp) each	1	20	3	3/4	1/4

TABLE 9.4-9

EMERGENCY DIESEL GENERATOR BUILDING VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Normal Exhaust Fans	
Quantity	2
Capacity, (cfm) each	3,100*
Total pressure (in WG)	0.43*
Motor, (hp) each	1
Primary Supply Fans	
Quantity	2
Capacity, (cfm) each	62,225*
Total pressure (in WG)	2.19*
Motor, (hp) each	50
Secondary Supply Fans	
Quantity	2
Capacity, (cfm) each	36,300*
Total pressure (in WG)	3.55*
Motor, (hp) each	50
Electric Unit Heaters (per room)	
Quantity/capacity	4 at 25 kW each
Quantity/capacity	1 at 5 kW each

* As Built Parameters

TABLE 9.4-10

CONTAINMENT ATMOSPHERE RECIRCULATION SYSTEM
PERFORMANCE CHARACTERISTICS

Function	Performance Characteristics
Maximum containment temperature allowed	108°F
Number of units in operation	2
Single unit capacity	
cfm	167,000
MBH	5,833
Total capacity	
cfm	334,000
MBH	11,666

TABLE 9.4-11

CONTAINMENT ATMOSPHERE RECIRCULATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Containment Atmosphere Recirculation Units	
Quantity	3
Number of cooling coils per unit	12
Number of fans per unit	1
Fan mode operation	150,000 cfm/fan
Cooling medium during normal operation	Chilled water
Fan	
Total Pressure head (in WG)	9.3
Motor, hp	300

TABLE 9.4-12

DELETED

TABLE 9.4-13

CRDM VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
CRDM Fans	
Type	Axial
Quantity	6
Capacity, (scfm) each	22,000
Total pressure (in WG)	14
Motor, (hp) each	75
Cooling Coils	
Quantity of coil banks	3
Quantity of coils per coil bank	2
Capacity, total heat load per coil bank (MBH)	1,066
Primary component cooling water flow rate per coil bank (gpm)	200
Entering air temperature (°F) dry bulb at 100°F entering water temperature	190

TABLE 9.4-14

PRIMARY INTAKE STRUCTURE VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Supply Fans	
Quantity	3
Capacity, (cfm) each	7,500
Static pressure (in WG)	1.4*
Motor, (hp) each	3
Unit Heaters	
Quantity	3
Capacity, (MBH)/(kW) each	2 @ 17.1/5 kW
	1 @ 51.2/15 kW

* As Built Parameters

TABLE 9.4-15

ALTERNATE INTAKE STRUCTURE VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Exhaust Fans	
Quantity	2
Capacity, (cfm) each	20,000
Static pressure (in WG)	1.0
Motor, (hp) each	10
Unit Heaters	
Quantity	2
Capacity, (MBH) each	34.1
Propane Furnace	
Quantity	1
Capacity (MBH)	1,000

TABLE 9.4-16

MAIN STEAM AND FEEDWATER VALVE AREA VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Supply Fans	
Quantity	2
Capacity, (cfm) each	31,400
Total pressure, (in WG) each	8.9
Motor, (hp) each	75
Cooling Coils	
Quantity	2
Capacity, (MBH) each	985.5
Cooling water flow rate, (gpm) each	85
Air entering temperature, (°F) dry bulb	120
Electric Unit Heaters	
Quantity	5
Capacity, (MBH/kW) each	76.7/25
Quantity	1
Capacity, (MBH/kW) each	21.1/7.5
Roll Filters	
Quantity	2
Capacity, (cfm) each	31,400

TABLE 9.4-17

NORMAL SWITCHGEAR AND CABLE SPREADING
AREA VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Supply Fan	
Quantity	1
Capacity (cfm)	117,000
Total pressure (in WG)	5.8
Motor, (hp)	150
Return-Exhaust Fan	
Quantity	1
Capacity (cfm)	114,300
Total pressure (in WG)	5.5
Motor (hp)	150
Auto Roll Filters	
Quantity	1
Media	Glass fiber
Electric Unit Heaters	
Quantity	4
Capacity, (MBH) each	2 @ 17 2 @ 34
Hot Water Unit Heaters	
Quantity	11
Capacity, (MBH) each	60

TABLE 9.4-18

BATTERY ROOM VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Exhaust Fans	
Quantity	2
Capacity, (cfm) each	7,500
Total pressure (in WG)	4
Motor, (hp) each	7 1/2

TABLE 9.4-19

EMERGENCY SWITCHGEAR ROOM VENTILATION SYSTEM PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Supply Fans	
Quantity	2
Capacity, (cfm) each	58,250*
Total pressure (in WG)	4.4*
Motor, (hp) each	75
Exhaust Fans	
Quantity	2
Capacity, (cfm) each	53,450*
Total pressure (in WG)	4.3*
Motor, (hp) each	60
Filters	
Quantity	1
Media	Pleated
Unit Heaters	
Quantity	8
Capacity, (MBH) each	2 @ 17 2 @ 34 4 @ 68
Coil type	Electric

* As Built Parameters

TABLE 9.4-20

SERVICE BUILDING EQUIPMENT ROOM
VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Roof Exhaust Fans	
Quantity	2
Capacity, (cfm) each	25,000
Static pressure, (in WG) each	0.25
Motor, (hp) each	7 1/2
Horizontal Unit Heaters	
Quantity	11
MBH (each)	60
Coil Type	Hot water

TABLE 9.4-21

SAFEGUARDS AREA VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Air Handling Units	
Quantity	2
Capacity, (cfm) each	16,000
Static pressure, (in WG)	3.9
Motor, (hp) each	20
Cooling Coils	
Capacity (MBH)	430
Face velocity (fpm)	801
Leaving air temp dry bulb (°F)	96.2
Water flow rate (gpm)	175
Electric Unit Heaters	
Quantity	12
Capacity, (MBH) each	4 @ 25.6 4 @ 34.1 2 @ 42.6 2 @ 51.2

TABLE 9.4-22

CABLE VAULT AND ROD CONTROL AREA VENTILATION SYSTEMS PRINCIPAL COMPONENTS AND APPROXIMATE DESIGN PARAMETERS

Components	Design Parameters
Primary Ventilation System	
Air-Conditioning Units	
Quantity	2
Capacity, (cfm) each	15,000
Static pressure (in WG)	6.5
Motor, (hp) each	25
Filter pressure drop Clean/Dirty (in WG)	0.2/0.5
Chilled Water Coil for Air-Conditioning Unit	
Capacity (MBH)	959.8
Chilled water flow (gpm)	295.3
Service Water Cooling Coil for Air Conditioning Unit	
Capacity (MBH)	414
Service water flow (gpm)	0
Heating Coil for Air-Conditioning Unit	
Capacity (MBH)	844
Hot water flow (gpm)	24.6
Secondary Ventilation System	
Cable Tunnel Unit Cooler	
Quantity	1
Capacity (cfm)	4,200
Static pressure (in WG)	1.5
Motor (hp)	2
Chilled Water Coil for Cable Tunnel Unit Cooler	
Capacity (MBH)	324
Chilled Water Flow (gpm)	57.5

TABLE 9.4-22 (Cont)

Components	Design Parameters
Cable Vault and Rod Control Area Unit Cooler	
Quantity	1
Capacity (cfm)	4,700
Static Pressure (in WG)	1.3
Motor (hp)	2
Chilled Water Coil for Cable Vault and Rod Control Area Unit Cooler	
Capacity (MBH)	360
Chilled Water Flow (gpm)	57.5
Alternate Shutdown Panel Room Ventilation System	
Self-Contained Air-Conditioning Unit	
Quantity	1
Capacity (cfm)	1,800
Static Pressure (in WG)	2
Fan motor (hp)	2
Compressor motor (hp)	7 1/2
Filter pressure drop clean/dirty (in WG)	0.2/0.5
Direct Expansion Coil	
Capacity (MBH)	46
Condenser	
Capacity (MBH)	57
Service water flow (gpm)	12

TABLE 9.4-23

DECONTAMINATION BUILDING VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Roof Ventilators Fans	
Quantity	2
Capacity, (cfm) each	4,350
Static pressure (in WG)	0.25
Motor, (hp) each	1.5
Centrifugal Exhaust Fans	
Quantity	2
Capacity, (cfm) each	1,000
Static pressure, (in WG)	11.75
Motor, (hp) each	5
Filtration Unit	
Quantity	1
Capacity (cfm)	1,000
Prefilter	
Quantity	1
Pressure drop, clean (in WG)	0.5
Pressure drop, dirty (in WG)	1.0
HEPA Filter	
Quantity	1
Pressure drop, clean (in WG)	1.0
Pressure drop, dirty (in WG)	1.5
Charcoal Filter	
Quantity	1
Pressure drop, clean (in WG)	1.0
Pressure drop, dirty (in WG)	1.0
Electric Duct Heater	
Quantity	1
Capacity (kW)	5.0

TABLE 9.4-24

COOLING TOWER PUMPHOUSE VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND APPROXIMATE DESIGN PARAMETERS

Components	Design Parameters
Supply Fans	
Quantity	2
Capacity, (cfm) each	72,000
Total pressure (in WG)	1.0
Motor, (hp) each	20
Roof Ventilators	
Quantity	4
Capacity, (cfm) each	36,000
Static pressure (in WG)	Minimal
Motor, (hp) each	5

TABLE 9.4-25

GLAND SEAL STEAM EXHAUST SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
(DELETED)	
Electric Heaters	
Quantity	2
kW (each)	4
Backdraft Dampers	
Quantity	2
Air Control Dampers	
Quantity	2
Moisture Separators	
Quantity	2
Centrifugal Water Separator with drain trap	1

TABLE 9.4-26

CONDENSATE POLISHING BUILDING VENTILATION SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Supply Subsystem:	
Supply Fan	
Quantity	1
Capacity (cfm)	18,540
Static pressure (in WG)	3.75
Motor (hp)	40
Roll Filter	
Quantity	1
Capacity (cfm)	25,300
Pressure drop, clean/dirty (in WG)	0.4/0.5
Preheat Coil	
Quantity	1
Capacity (MBH)	960.6
Normal Exhaust Subsystem:	
Exhaust Fan	
Quantity	1
Capacity (cfm)	12,205
Static pressure (in WG)	5.26
Motor (hp)	25
Cubicle Exhaust Subsystem:	
Exhaust Fan	
Quantity	1
Capacity (cfm)	8,140
Total pressure (in WG)	10.75
Motor (hp)	25

TABLE 9.4-26 (Cont)

Components	Design Parameters
Filter Assembly	
Quantity	1
Number of prefilters	9
Prefilter bank pressure drop, clean/dirty (in WG)	0.25/1.0
Number of HEPA	9
HEPA bank pressure drop, clean/dirty (in WG)	1.0/4.0
Process Air Exhaust Subsystem:	
Exhaust Fan	
Quantity	1
Capacity (cfm)	5,276
Static pressure (in WG)	14.50
Motor (hp)	30
Moisture Separator	
Quantity	1
Number of Moisture separators	6
Moisture separator bank pressure drop, clean/dirty (in WG)	1.0/2.0
Electric Heating Coil	
Quantity	1
Capacity (kW)	24
Number of stages	2
Number of HEPA upstream charcoal bank	6
HEPA bank pressure drop, clean/dirty (in WG)	1.0/4.0
Charcoal filtration bank, quantity	1
Type of charcoal absorber	Gasketless
Charcoal filter bank pressure drop, clean/dirty (in WG)	1.5/1.5
Number of HEPA downstream charcoal bank	6
HEPA filter bank pressure drop, clean/dirty (in WG)	1.0/4.0

TABLE 9.4-26 (Cont)

Components	Design Parameters
Elevator Machinery Room Ventilation System:	
Exhaust Fan	
Quantity	1
Capacity (cfm)	5,000
Total pressure (in WG)	0.48
Motor (hp)	1
Equipment Room Ventilation System:	
Exhaust Fan	
Quantity	2
Capacity (cfm) each	1,975
Total pressure (in WG)	0.5
Motor, (hp) each	0.75
Condensate Polishing Building Air-Conditioning System:	
Air-Conditioning Unit	
Quantity	1
Fan capacity (cfm)	11,000
Fan total pressure (in WG)	4.0
Auto roll filter pressure drop, clean/dirty (in WG)	0.17/0.55
Cooling coil quantity	1
Cooling coil capacity (MBH)	828
Electric Reheat Coil	
Quantity	1
Capacity (kW)	13.5
Number of stages	1

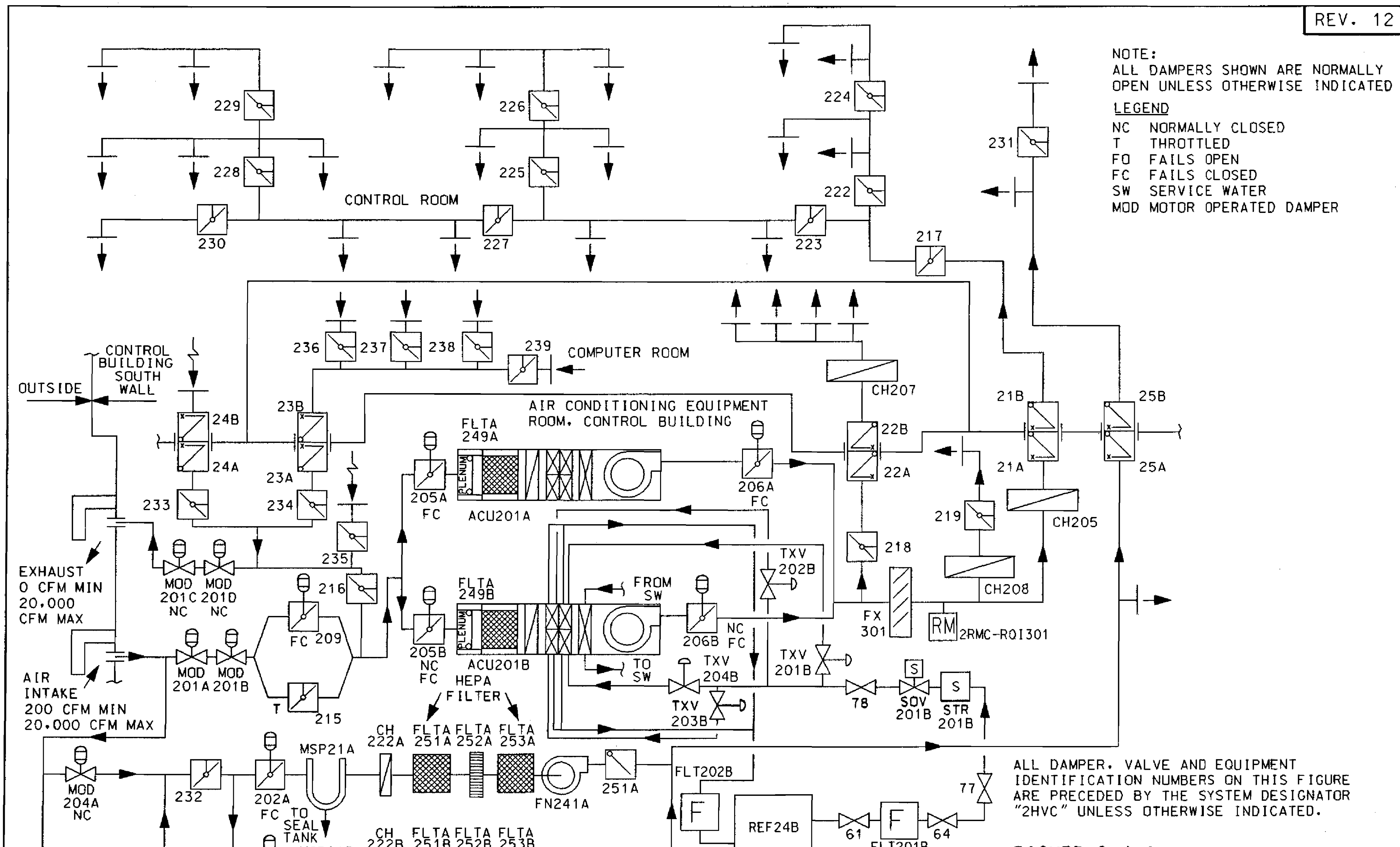
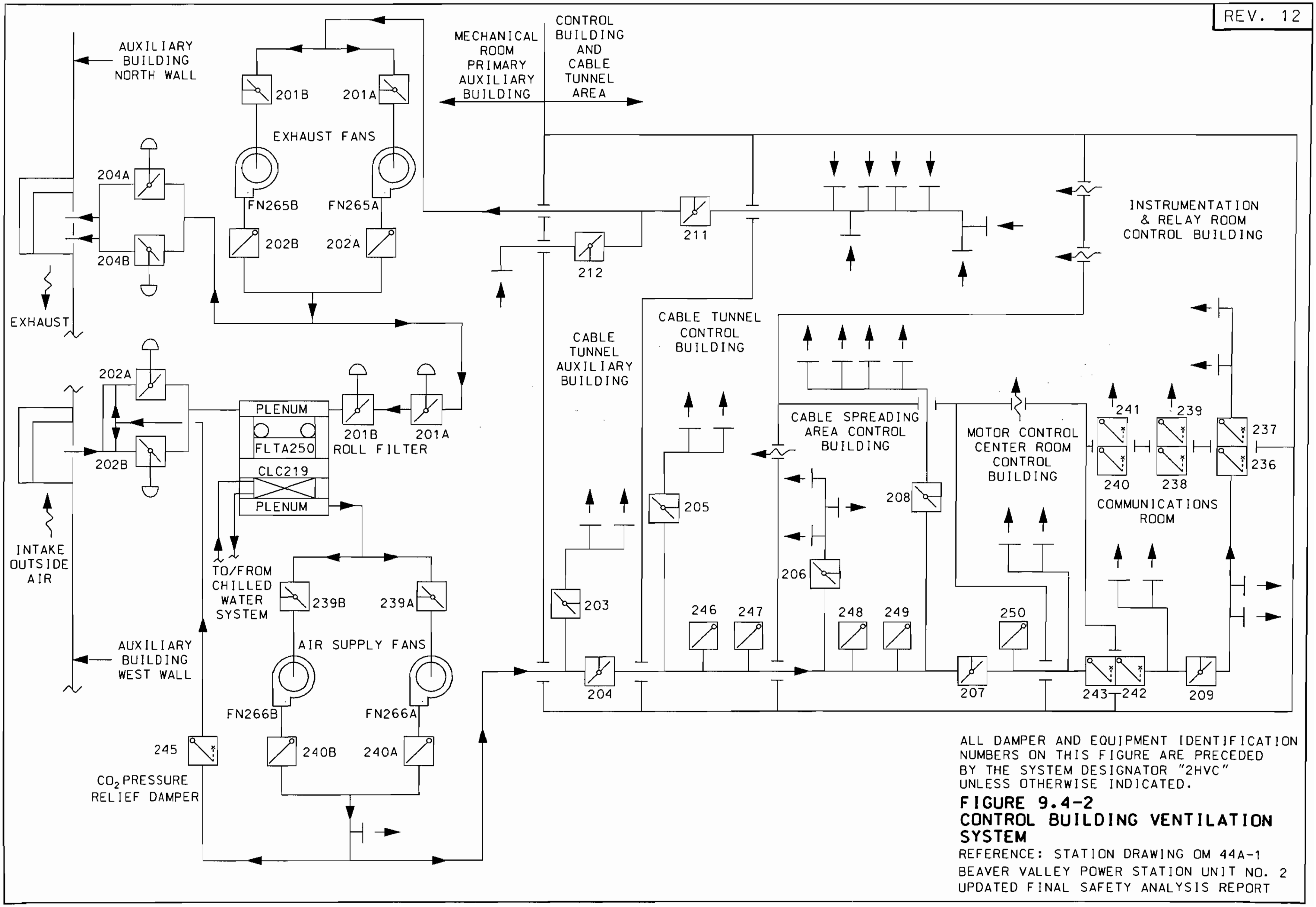


FIGURE 9.4-1
COMPUTER AND CONTROL ROOM AIR-CONDITIONING AND VENTILATION SYSTEM

REFERENCE: STATION DRAWINGS OM 44A-2 AND 3



ALL DAMPER AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVC" UNLESS OTHERWISE INDICATED.

FIGURE 9.4-2
CONTROL BUILDING VENTILATION SYSTEM

REFERENCE: STATION DRAWING OM 44A-1

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

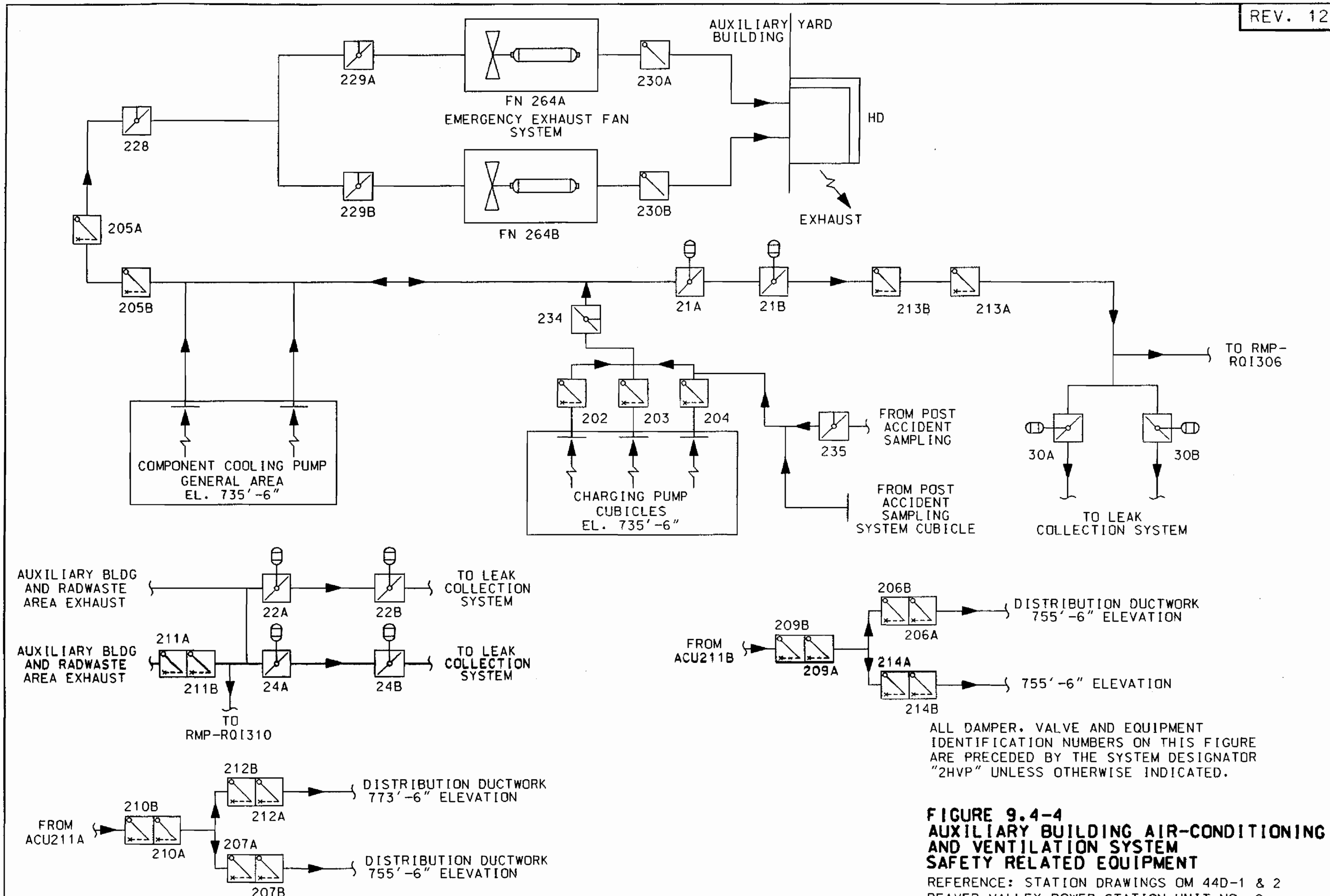


FIGURE 9.4-4
AUXILIARY BUILDING AIR-CONDITIONING AND VENTILATION SYSTEM SAFETY RELATED EQUIPMENT

REFERENCE: STATION DRAWINGS OM 44D-1 & 2

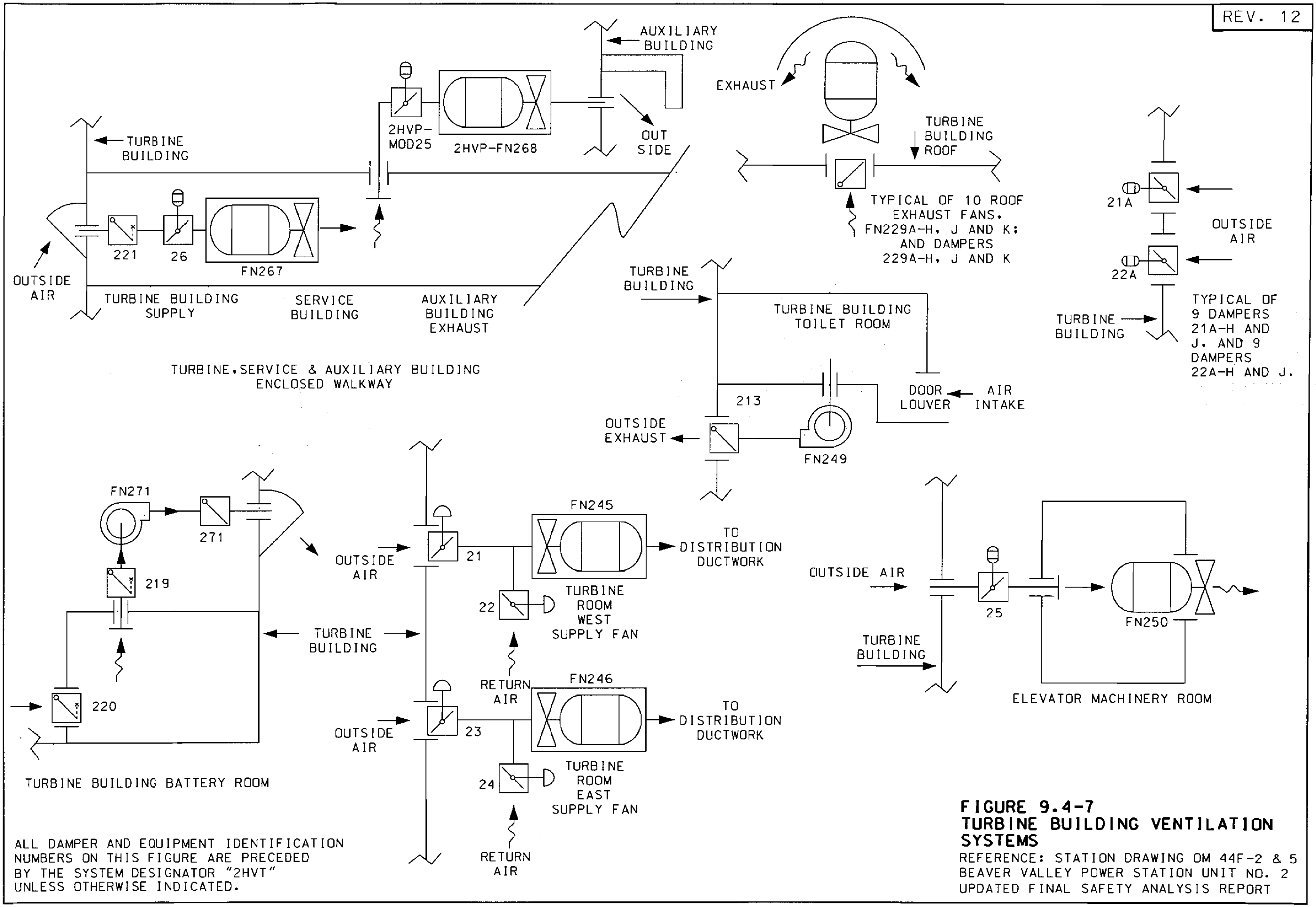
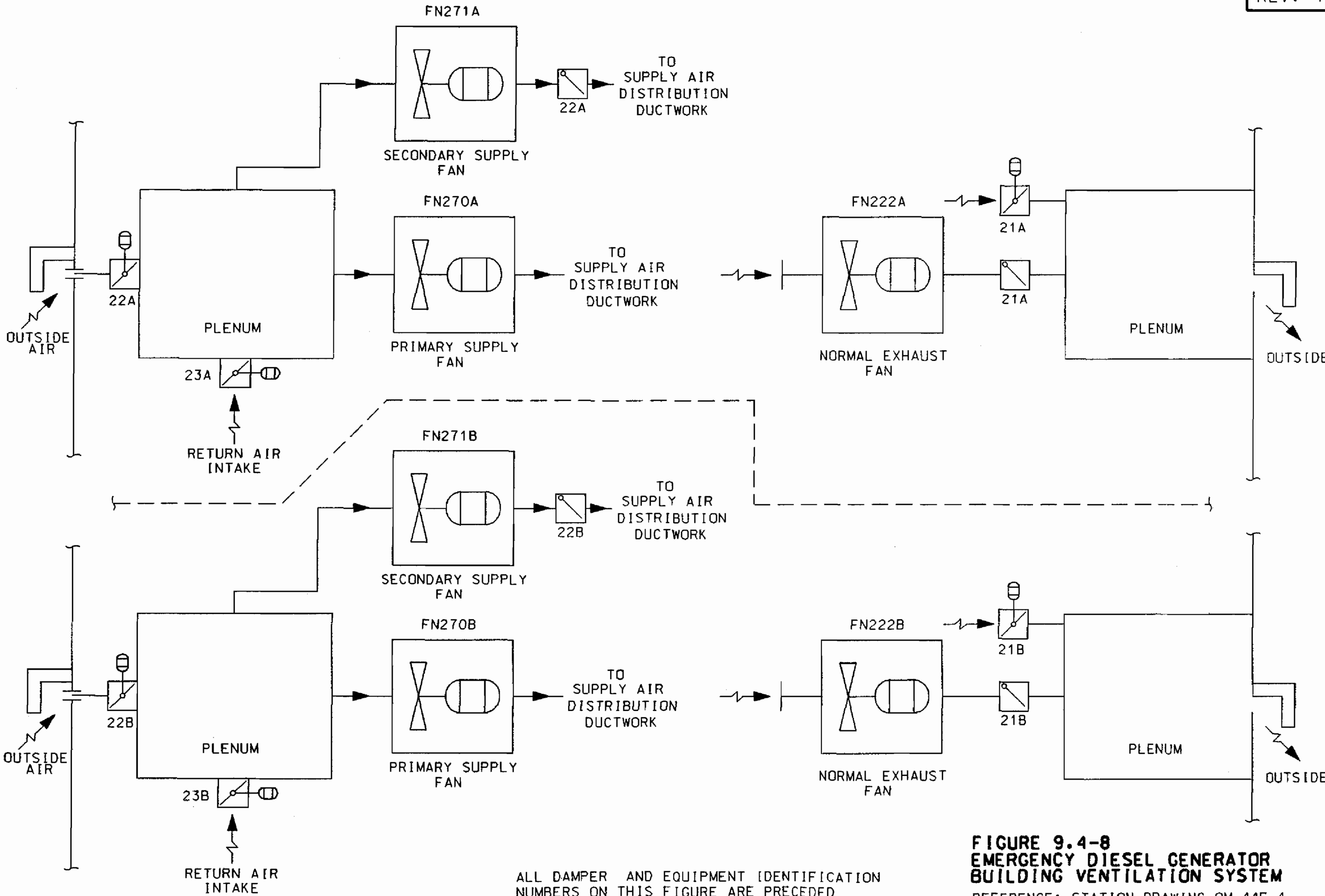


FIGURE 9.4-7
TURBINE BUILDING VENTILATION SYSTEMS
REFERENCE: STATION DRAWING OM 44F-2 & 5
BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

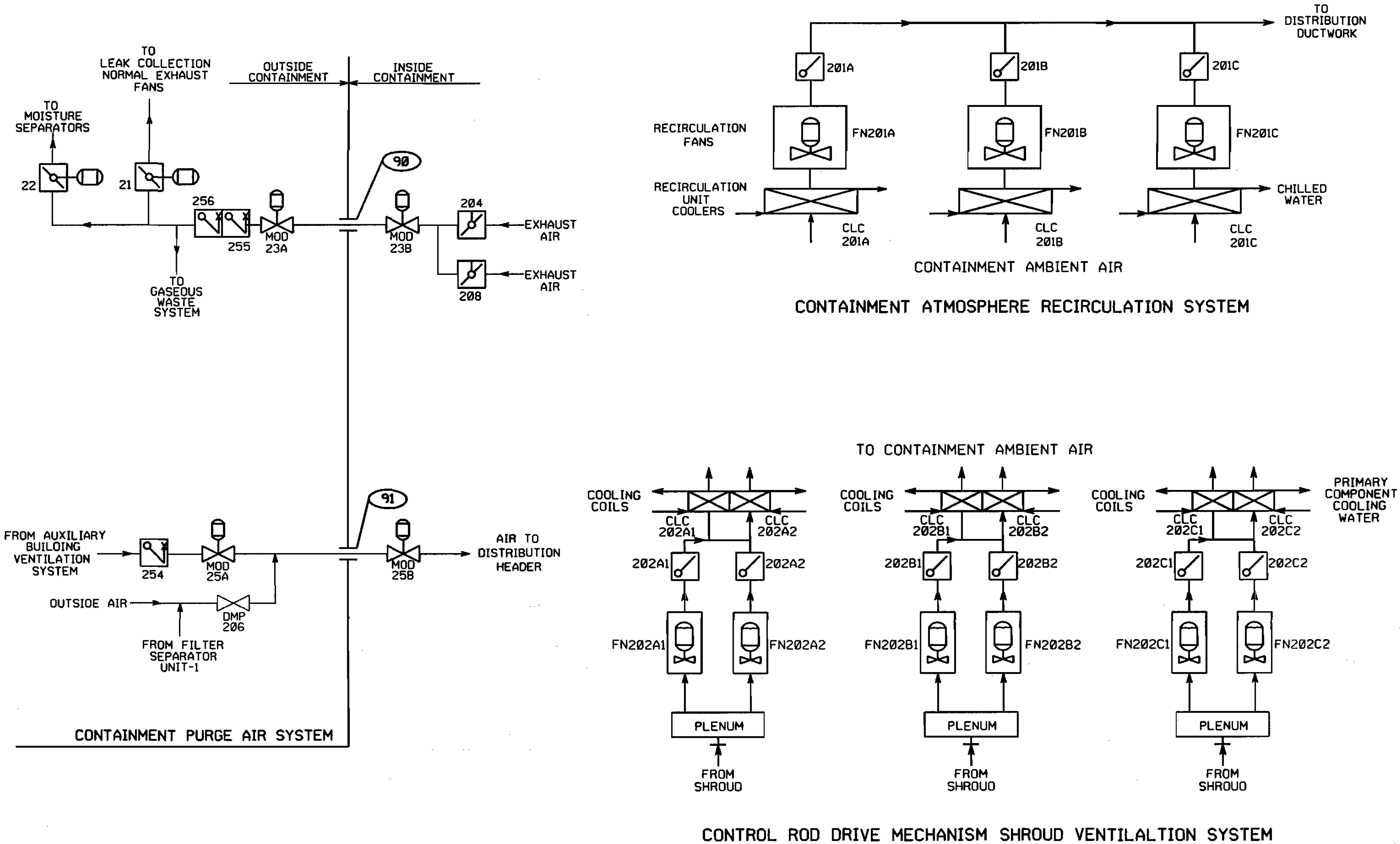


ALL DAMPER AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVD" UNLESS OTHERWISE INDICATED.

FIGURE 9.4-8
EMERGENCY DIESEL GENERATOR BUILDING VENTILATION SYSTEM

REFERENCE: STATION DRAWING OM 44F-4
BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

REV 17



ALL DAMPER, VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVR" UNLESS OTHERWISE INDICATED

FIGURE 9.4-9

CONTAINMENT AREA VENTILATION SYSTEM

REFERENCE: STATION DRAWINGS OM 44C-1 AND 2

BEAVER VALLEY POWER STATIION - UNIT No. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

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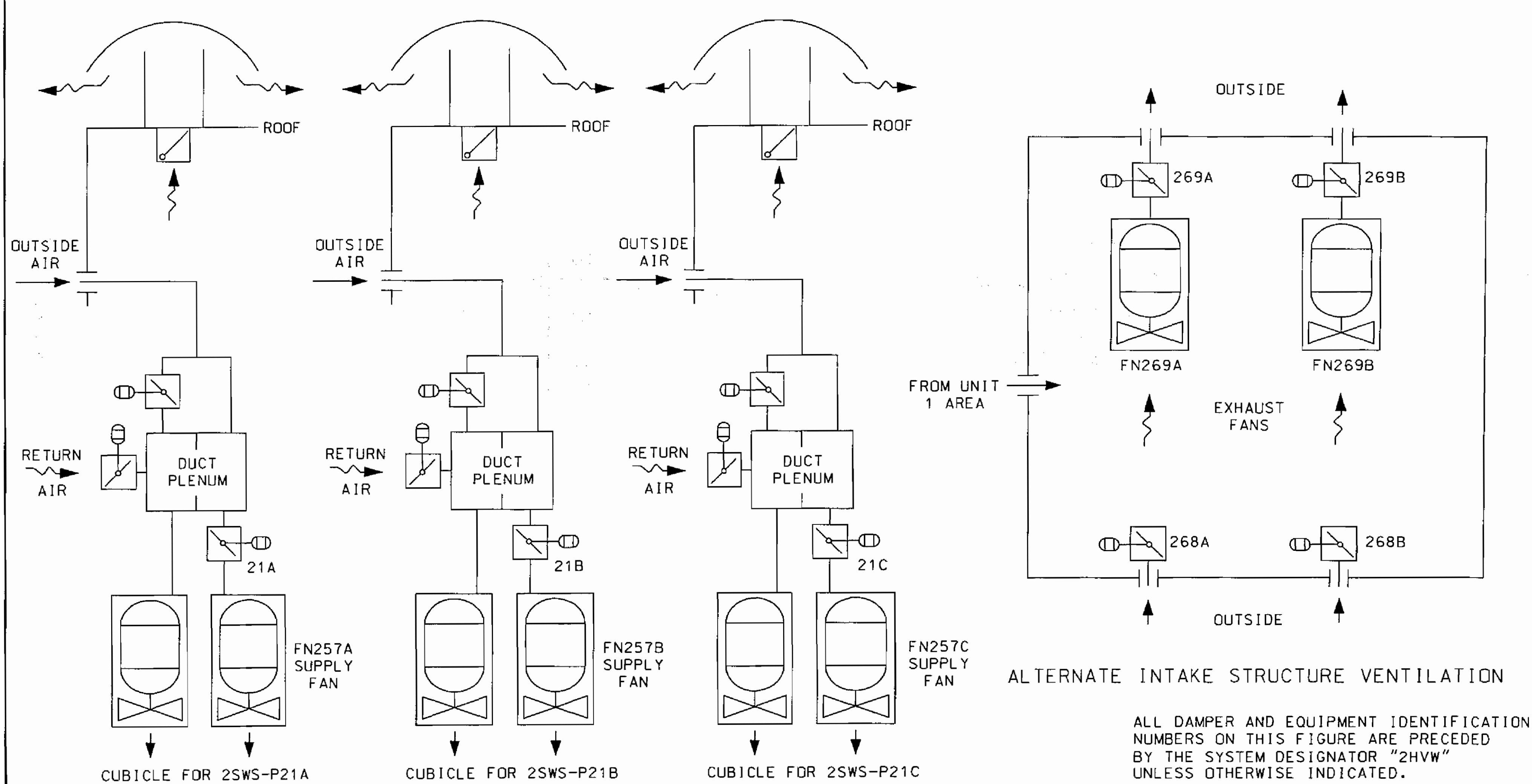


PRIMARY INTAKE STRUCTURE VENTILATION

ITEMS SHOWN WITHOUT MARK NUMBERS WERE FURNISHED WITH UNIT 1.

ALTERNATE INTAKE STRUCTURE VENTILATION

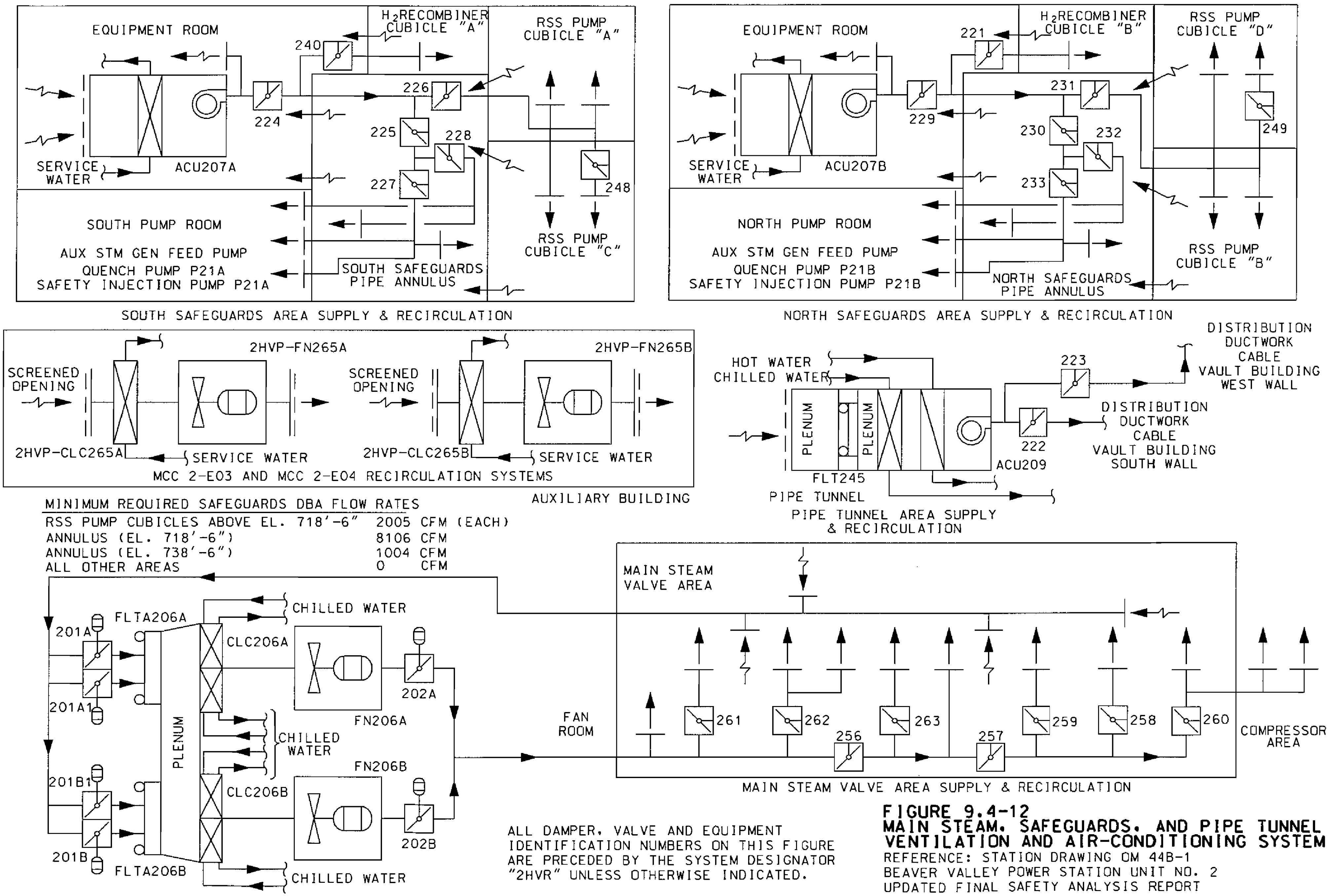
ALL DAMPER AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVW" UNLESS OTHERWISE INDICATED.

FIGURE 9.4-11
INTAKE STRUCTURE VENTILATION SYSTEMS

REFERENCE: STATION DRAWING OM 44F-1

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

REV. 12



MINIMUM REQUIRED SAFEGUARDS DBA FLOW RATES

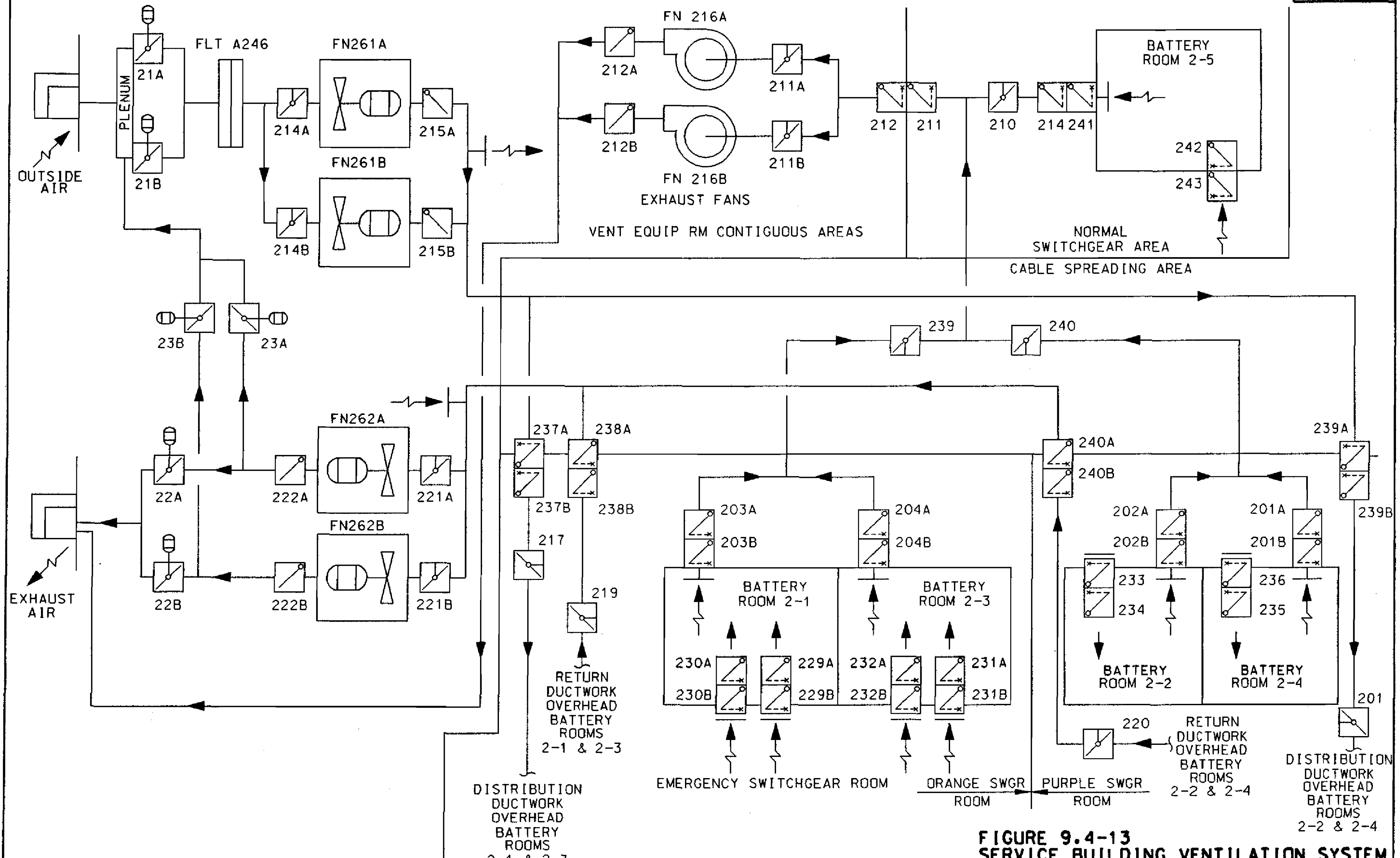
RSS PUMP CUBICLES ABOVE EL. 718'-6"	2005 CFM (EACH)
ANNULUS (EL. 718'-6")	8106 CFM
ANNULUS (EL. 738'-6")	1004 CFM
ALL OTHER AREAS	0 CFM

ALL DAMPER, VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVR" UNLESS OTHERWISE INDICATED.

FIGURE 9.4-12
MAIN STEAM, SAFEGUARDS, AND PIPE TUNNEL VENTILATION AND AIR-CONDITIONING SYSTEM

REFERENCE: STATION DRAWING OM 44B-1

REV. 12

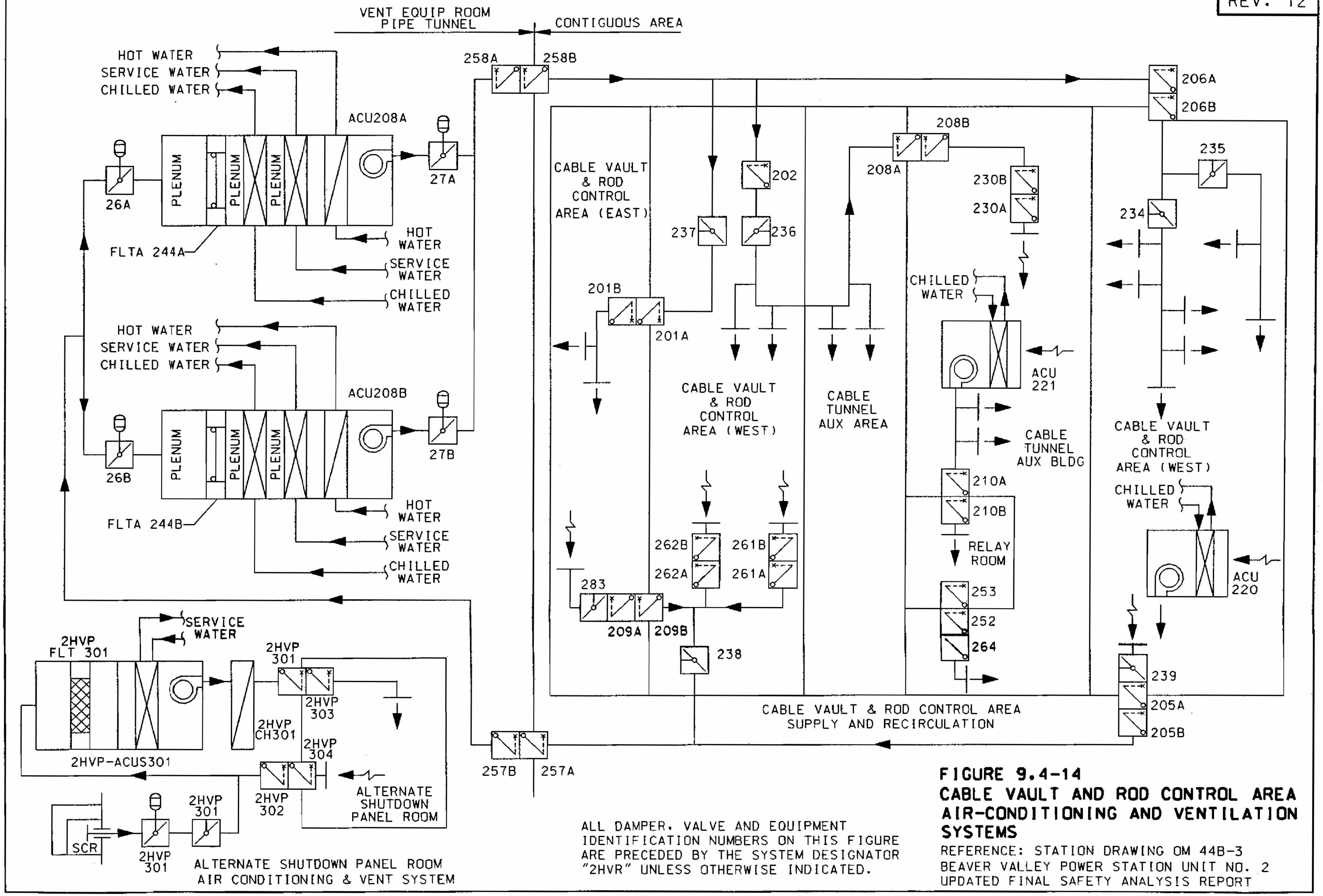


ALL DAMPER, VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVZ" UNLESS OTHERWISE INDICATED.

FIGURE 9.4-13
SERVICE BUILDING VENTILATION SYSTEM SAFETY RELATED EQUIPMENT

REFERENCE: STATION DRAWING OM 44F-3

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT



ALL DAMPER, VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2HVR" UNLESS OTHERWISE INDICATED.

FIGURE 9.4-14
CABLE VAULT AND ROD CONTROL AREA AIR-CONDITIONING AND VENTILATION SYSTEMS

REFERENCE: STATION DRAWING OM 44B-3

9.5 OTHER AUXILIARY SYSTEMS

9.5.1 Fire Protection

The fire protection program is based on the NRC requirements and guidelines, Nuclear Electric Insurance Limited (NEIL) Property Loss Prevention Standards and related industry standards. With regard to NRC criteria, the fire protection program meets the requirements of 10 CFR 50.48(c), which endorses, with exceptions, the National Fire Protection Association's (NFPA) 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants – 2001 Edition. BVPS-2 has further used the guidance of NEI 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c)" as endorsed by Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."

Adoption of NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants", 2001 Edition in accordance with 10 CFR 50.48(c) serves as the method of satisfying 10 CFR 50.48(a) and General Design Criterion 3. Prior to adoption of NFPA 805, General Design Criterion 3, "Fire Protection" of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," was followed in the design of safety and non-safety related structures, systems, and components, as required by 10 CFR 50.48(a).

NFPA 805 does not supersede the requirements of GDC 3, 10 CFR 50.48(a), or 10 CFR 50.48(f). Those regulatory requirements continue to apply. However, under NFPA 805, the means by which GDC 3 or 10 CFR 50.48(a) requirements are met may be different than under 10 CFR 50.48(b). Specifically, whereas GDC 3 refers to SSCs important to safety, NFPA 805 identifies fire protection systems and features required to meet the Chapter 1 performance criteria through the methodology in Chapter 4 of NFPA 805. Also, under NFPA 805, the 10 CFR 50.48(a)(2)(iii) requirement to limit fire damage to SSCs important to safety so that the capability to safely shut down the plant is satisfied by meeting the performance criteria in Section 1.5.1 of NFPA 805.

A safety evaluation was issued on January 22, 2018 by the NRC, that transitioned the existing fire protection program to a risk-informed, performance-based program based on NFPA 805, in accordance with 10 CFR 50.48(c).

9.5.1.1 Design Basis Summary

9.5.1.1.1 Defense-in-Depth

The fire protection program is focused on protecting the safety of the public, the environment, and plant personnel from a plant fire and its potential effect on safe reactor operations. The fire protection program is based on the concept of defense-in-depth. Defense-in-depth shall be achieved when an adequate balance of each of the following elements is provided:

1. Preventing fires from starting,

2. Rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage,

3. Providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

9.5.1.1.2 NFPA 805 Performance Criteria

The design basis for the fire protection program is based on the following nuclear safety and radiological release performance criteria contained in Section 1.5 of NFPA 805:

1. Nuclear Safety Performance Criteria. Fire protection features shall be capable of providing reasonable assurance that, in the event of a fire, the plant is not placed in an unrecoverable condition. To demonstrate this, the following performance criteria shall be met.

   a. Reactivity Control. Reactivity control shall be capable of inserting negative reactivity to achieve and maintain subcritical conditions. Negative reactivity inserting shall occur rapidly enough such that fuel design limits are not exceeded.

   b. Inventory and Pressure Control. With fuel in the reactor vessel, head on and tensioned, inventory and pressure control shall be capable of controlling coolant level such that subcooling is maintained such that fuel clad damage as a result of a fire is prevented for a PWR.

   c. Decay Heat Removal. Decay heat removal shall be capable of removing sufficient heat from the reactor core or spent fuel such that fuel is maintained in a safe and stable condition.

   d. Vital Auxiliaries. Vital auxiliaries shall be capable of providing the necessary auxiliary support equipment and systems to assure that the systems required under (a), (b), (c), and (e) are capable of performing their required nuclear safety function.

   e. Process Monitoring. Process monitoring shall be capable of providing the necessary indication to assure the criteria addressed in (a) through (d) have been achieved and are being maintained.

2. Radioactive Release Performance Criteria. Radiation release to any unrestricted area due to the direct effects of fire suppression activities (but not involving fuel damage) shall be as low as reasonably achievable and shall not exceed applicable 10 CFR, Part 20, limits.

Chapter 2 of NFPA 805 establishes the process for demonstrating compliance with NFPA 805.

Chapter 3 of NFPA 805 contains the fundamental elements of the fire protection program and specifies the minimum design requirements for fire protection systems and features.

Chapter 4 of NFPA 805 establishes the methodology to determine the fire protection systems and features required to achieve the nuclear safety performance criteria outlined above. The methodology shall be permitted to be either deterministic or performance-based. Deterministic requirements shall be “deemed to satisfy” the performance criteria, defense-in-depth, and safety margin and require no further engineering analysis. Once a determination has been made that a fire protection system or feature is required to achieve the nuclear safety performance criteria of Section 1.5, its design and qualification shall meet the applicable requirement of Chapter 3.

9.5.1.1.3 Codes of Record

The NFPA codes, standards and guidelines used for the design and installation of plant fire protection systems, as well as specific applications and evaluations of codes are described in BVPS Fire Safety Analysis (FSA), Volume 3, Enclosure 2, “NFPA 805 Codes of Record”.

9.5.1.2 Systems Description

9.5.1.2.1 Required Systems

9.5.1.2.1.1 Nuclear Safety Capability Systems, Equipment, and Cables

Section 2.4.2 of NFPA 805 defines the methodology for performing the nuclear safety capability assessment. The equipment required for the nuclear safety capability assessment is identified in FSA Volume 3, Enclosure 4, “Nuclear Safety Capability Assessment Equipment List”. Cables are identified in Enclosure 4, Reference 5.7, “Beaver Valley Unit 2 NFPA 805 Safe Shutdown, Non-Power Operation, and Fire PRA Cable Selection”.

9.5.1.2.1.2 Fire Protection Systems and Features

Chapter 3 of NFPA 805 contains the fundamental elements of the fire protection program and specifies the minimum design requirements for fire protection systems and features. Compliance with Chapter 3 is summarized in FSA Volume 1, Section 14.0, “Fundamental Fire Protection Program and Design Elements”.

Section 14.2, "NFPA 805 Chapter 3 Compliance Discussion Locations" identifies documents that provide supporting details.

Chapter 4 of NFPA 805 establishes the methodology and criteria to determine the fire protection systems and features required to achieve the nuclear safety performance criteria of Section 1.5 of NFPA 805. These fire protection systems and features shall meet the applicable requirements of NFPA 805 Chapter 3. These fire protection systems and features are documented in the FSA Volume 3, Enclosure 10, Table 4-3.

9.5.1.2.1.3 Radioactive Release

The NEI 04-02 guidance defines the analysis of the radioactive release performance criteria as evaluation of the direct effects of fire suppression activities. The BVPS evaluation did not credit any installed SSC's and relies strictly on the fire brigade's pre-fire plans and the fire brigade's mitigation instructions for guidance in monitoring and controlling potentially contaminated releases. FSA Volume 1, Section 10.0, "Radioactive Release" describes the evaluation methodology, summarizes the results and provides references to more detailed aspects of the evaluation.

9.5.1.2.2 Definition of "Power Block" Structures

Where used in NFPA 805 Chapter 3 the terms "Power Block" and "Plant" refer to structures that have equipment required for nuclear plant operations. For the purposes of establishing the structures included in the fire protection program in accordance with 10 CFR 50.48(c) and NFPA 805, the plant structures listed in FSA Volume 3, Enclosure 6 are considered to be part of the "power block".

9.5.1.3 Safety Evaluation

The FSA documents the achievement of the nuclear safety and radioactive release performance criteria of NFPA 805 as required by 10 CFR 50.48(c). This document fulfills the requirements of Section 2.7.1.2 "Fire Protection Program Design Basis Document" of NFPA 805. The document contains the following:

1. Identification of significant fire hazards in the fire area. This is based on NFPA 805 approach to analyze the plant from an ignition source and fuel package perspective.

2. Summary of the Nuclear Safety Capability Assessment (at power and non-power) compliance strategies.

    a. Deterministic compliance strategies

    b. Performance-based compliance strategies (including defense-in-depth and safety margin)

3. Summary of the Non-Power Operations Modes compliance strategies.

4. Summary of the Radioactive Release compliance strategies.

5. Summary of the Fire Probabilistic Risk Assessments.

6. Key analysis assumptions to be included in the NFPA 805 monitoring program.

9.5.1.4 Fire Protection Program Documentation, Configuration Control and Quality Assurance

In accordance with Chapter 3 of NFPA 805 a fire protection plan documented in Procedure 1/2-ADM-1900 defines the management policy and program direction and defines the responsibilities of those individuals responsible for the plan's implementation.

Procedure 1/2-ADM-1900:

1. Designates the senior management position with immediate authority and responsibility for the fire protection program.

2. Designates a position responsible for the daily administration and coordination of the fire protection program and its implementation.

3. Defines the fire protection interfaces with other organizations and assigns responsibilities for the coordination of activities. In addition, Procedure 1/2-ADM-1900 identifies the various plant positions having the authority for implementing the various areas of the fire protection program.

4. Identifies the appropriate authority having jurisdiction for the various areas of the fire protection program.

5. Identifies the procedures established for the implementation of the fire protection program, including the post-transition change process and the fire protection monitoring program.

BVPS administrative procedures identify the qualifications required for various fire protection program personnel.

The Augmented Quality Assurance Program, Appendix C, Fire Protection identifies the quality requirements of Chapter 2 of NFPA 805.

Detailed compliance with the programmatic requirements of Chapters 2 and 3 of NFPA 805 are contained in lower tier procedures and documents identified by Procedure 1/2-ADM-1900.

9.5.2 Communications Systems

9.5.2.1 Design Bases

The communications systems provide reliable, effective communications during normal operating and emergency conditions between essential areas of BVPS-2 (including the control room) and locations remote from BVPS-2. The communications systems are designed such that a failure of one system does not impair the reliability of any other system. This capability is accomplished by providing diverse types of communication systems.

9.5.2.2 System Description

9.5.2.2.1 Intra-plant Communications

The intra-plant communications consist of the following systems:

1. A page party system,
2. A calibration jack system,
3. A radio system, and
4. A private automatic exchange telephone system.

9.5.2.2.1.1 Page Party System

The five channel page party system (PPS) system provides communications from the main control room to all buildings and control areas within BVPS-2, and from one building or control area to any other. The PPS, powered from a reliable power source, is normally used during daily plant operation to allow individuals to communicate between PPS stations and to provide for public address within the plant.

In an emergency, the system is used to alert personnel on the site and to communicate messages between individuals. The evacuation/standby alarms are manually initiated from the communication console in the main control room or from the auxiliary communications station adjacent to the emergency shutdown panel (ESP). The alarms are carried on the PPS loud-speakers to ensure audibility throughout the plant. The main plant PPS obtains its power from the essential bus. Outlying buildings, such as the cooling tower pumphouse, obtain power for the PPS from normal ac distribution panels.

9.5.2.2.1.2 Calibration Jack System

A calibration jack system is installed in the plant. It is a two-channel system with a network of plug-in jacks. Headsets, consisting of earphones and a microphone, are connected through the plug-in jacks to permit direct communication between persons in different areas. The system obtains its power from a reliable source of ac power.

This system is normally used for maintenance, during instrument and equipment calibration, and during construction and start-up. During an emergency, the system can be used as an alternate means of communication between two or more areas of the plant.

9.5.2.2.1.3 Radio System

Hand-held portable radios are available for use during normal and emergency conditions. The radios operate on two VHF band frequencies and two 450 MHz band frequencies. The hand-held radios are powered by rechargeable batteries and, once charged, are not dependent on any electrical system until recharging is necessary. The VHF frequencies are used for normal maintenance and operating communications and can be used as an alternate means of relaying messages between areas of the plant during an emergency. The 450 MHz band frequencies will also be used by security for both normal and emergency operations.

The base stations are capable of communicating with hand-held portable radios within BVPS-2. Two VHF remote consoles for high band and one for low band operation are located in the plant. These consoles operate two base radios located in a remote radio building at a high point just off the site. The remote control consoles are powered from the essential bus. The base radios are powered from a 48 V dc battery/charger supply at the radio building.

High band VHF radio transceivers are available for use in vehicles by radiation monitoring teams.

Dedicated hand-held portable radios are provided to support post fire safe shutdown at BVPS-1 and BVPS-2.

9.5.2.2.1.4 Private Automatic Exchange Telephone System

A private automatic exchange (PAX) telephone system is installed in BVPS-2. Commercial-type telephone handsets are installed in various

areas that may be continuously or frequently manned. The power supply for the system is from an independent communications battery/charger system (shared with BVPS-1).

This system is tied to commercial telephone lines to allow for calls outside the plant but does not depend on them for intra-plant use.

9.5.2.2.1.5 Cable and Circuit Routing

Cables in the PPS, calibration jack system, and PAX communications systems are independent from those of other systems, and are isolated from power cables of other systems and any other sources of line noise which could adversely affect the audibility of the systems. The PPS, the calibration jack system, and the PAX telephone system are normally run in separate raceways. The PPS and the PAX telephone system are sometimes run in the same raceway in the yard area where a fire or other event would not threaten any safe shutdown systems. Loss of all communications in the yard area would have no impact on a safe shutdown.

All communications systems wiring in general plant areas is routed in rigid metal conduit, underground duct, or electrical metallic tubing (EMT), or meets the flame testing requirements specified in Section 8.3.3.

9.5.2.2.2 Plant-to-Offsite Communications

The plant-to-offsite communications consist of the following separate, independent, and diverse systems adaptable to in-plant and offsite locations:

1. Commercial telephone land line system,

2. Plant-to-offsite radio systems,

3. Microwave system, and

4. System operator telephone.

9.5.2.2.2.1 Commercial Telephone Land Line System

Telephone company voice circuits are provided from the plant to the telephone control office in the area. This enables appropriately designated telephone instruments within the plant to contact any outside telephone number. In addition, telephone tie lines connect the plant to the DLC telephone network. Diverse physical routing is provided to preclude a total interruption of service that might result from a single failure.

9.5.2.2.2.2 Plant-to-Offsite Radio System

Two VHF base radio stations provide communication with the local and state law enforcement authorities and other offsite facilities. The stations are also used for plant communications via fixed or portable units.

The radio transceivers are located in the radio building, adjacent to the site, with remote control consoles in the main control room and with a remote handset provided at the ESP. In addition, two mobile radio transceivers are provided in the plant. The system is designed to provide reliable radio communications.

9.5.2.3 Design Evaluation

A failure of one communication system does not affect the operation of the other types of communications systems since they are of diverse types and are independent of one another.

9.5.2.3.1 Intra-plant Communications

A loss of electric power does not cause a common code failure of intra-plant communications. The PPS and PAX systems are powered from separate reliable power supplies that ultimately derive power from the station or from communication batteries. The portable radio system is battery-powered and independent of plant electric power except for recharging of batteries. The calibration jack, PPS, and PAX systems generally do not share common raceways.

9.5.2.3.2 Plant-to-Offsite Communications

The plant-to-offsite communications systems provided use a diverse mix of the major types of approaches which are available (commercial telephone, radio, and system operator telephone) to ensure that under the most adverse circumstances, communications will be maintained.

9.5.2.4 Inspection and Testing Requirements

The design of the communications systems permits routine testing and inspection without disrupting normal communications. Degradation of any systems which are in daily use can be identified and corrected.

Periodic tests of the required unused circuits, plus tests of the associated handsets and headsets, prove their availability.

The evacuation alarm system is tested periodically in accordance with plant procedure. Preoperational tests are made to ensure adequate design sound pressure levels, in the case of audible evacuation alarms, or visibility of lights for visual evacuation alarms.

The communications systems (except for Bell Telephone equipment) are fully maintained by the licensee staff:

Preventative maintenance and operability checks are periodically performed. These checks are to ensure that essential equipment is operating properly, and to insure that the systems will operate when called upon.

9.5.3 Lighting Systems

The lighting system provides adequate illumination during all operating conditions, including transients, accident conditions, and the effect of the loss of normal and offsite power.

9.5.3.1 Design Bases

The system provides, as a minimum, lighting intensities at levels recommended by the Illuminating Engineering Society and state regulatory agencies, where applicable. The backup lighting system provides adequate illumination in all access areas and in all areas required for control of safety-related equipment. Power is supplied from normal ac and dc sources.

Backup lighting units, each with a minimum 8-hour individual battery power supply, may be provided in some areas.

Within the reactor containment, decontamination building, and fuel building, only incandescent or LED lamps are used to prevent potential contamination from lighting elements containing mercury.

Fluorescent or LED lamps are used for general lighting within the plant.

High intensity discharge (HID) or LED lamps are used for high bay lighting, medium height lighting, and for roadways and parking lots. Auxiliary lighting is provided in the indoor HID fixtures to provide a safe level of illumination during the time necessary for a restrike function to occur following a power interruption.

Lighting circuits are designed to avoid overloading and the subsequent tripping of breakers, which would affect lighting reliability. To prevent faults in one lighting system from rendering another system inoperative, separate conduits are used to feed lighting systems derived from different sources. Normal lighting circuit conductors and backup lighting circuit conductors are run in separate raceways to prevent a common mode failure.

The lighting in the main control room can be systematically switched for different illumination levels to suit the requirements of the operating staff.

Underwater lighting in the fuel pool provides sufficient illumination to enable the crane operator to accurately see the material being handled in the fuel pool. Additional underwater illumination is provided for use with closed circuit television. All fixture materials used are stainless steel.

Lighting wire used is type XHHW, which is radiation- and flame-resistant and is entirely enclosed in conduit.

Seismic conditions are considered in the placement of lighting equipment and the selection and installation of supports. Lighting transformers, panelboards, and light fixtures are seismically- supported in seismically designed areas.

9.5.3.2 System Description

Normal ac lighting is used throughout the plant. Backup ac lighting will be confined to the following areas:

1. Control room,

2. Emergency shutdown panel area,

3. Alternate shutdown panel area,

4. Class 1E switchgear rooms, and

5. Essential bus inverter and rectifier area in the rod control/cable vault building.

9.5.3.2.1 Normal AC Lighting

Normal ac lighting for the plant is supplied from the 480 V station service system through single-phase, 480-120/240 V, 3-wire grounded, dry-type transformers.

In most areas of the plant, normal ac lighting is provided from two different sources to enhance reliability. Alternating rows of fluorescent or LED fixtures are supplied from different lighting panels and transformers which, in turn, are supplied from separate 480 V motor control centers (MCCs) on separate 480 V unit substation buses.

Indoor areas illuminated primarily with mercury vapor (MV) sources have an auxiliary lighting system to provide illumination during the cooling and restrike time of MV lamps. This auxiliary lighting is fed from the same ac circuit as the MV lamp and is a quartz lamp built into the luminaire.

9.5.3.2.2 Backup DC Lighting

Backup dc lighting consists of 125 V dc incandescent fixtures supplied from the non-Class 1E station batteries. These fixtures are normally energized from nonsafety-related, diesel backed, 480 V unit substation through 480 V MCC and 480-120 V dry-type transformers. Automatic transfer switches connect the backup dc lighting to the station batteries upon a loss of normal ac supply and will then re-transfer back to the 120 V ac power when the diesel generator is supplying load or normal ac power returns. These switches have a 3-second time delay on transfer from normal to backup sources to prevent nuisance operation caused by momentary voltage dips. These switches have also been sized to withstand expected levels of fault current. Separate circuit-breaker-type panel boards are used for this lighting system.

9.5.3.2.3 Backup AC Lighting

The backup ac lighting subsystem is connected to non-Class lE 480 V MCCs through 480-120/240 V dry-type transformers. In the event of a loss of normal ac power, this subsystem receives power from the onsite, nonsafety diesel generator (Section 8.3.1.1.1). All lighting fixtures connected to this lighting subsystem are 120 V or 240 V fluorescent or LED and are continuously energized.

The backup ac lighting subsystem supplements the backup dc lighting subsystem in the following areas: main control room, ESP area in the control building, Class lE switchgear areas in the service building, and essential bus inverter and rectifier equipment areas in the rod control and cable vault building. Separate ac circuit breaker-type panelboards are used for this lighting subsystem.

The backup ac lighting subsystem is connected to a single non-Class 1E 480 V unit substation through a non-Class 1E, 480 V MCC and 480 - 120/240 V dry type transformers. In the event of a loss of normal ac power, this 480 V unit substation is automatically loaded onto the onsite, nonsafety diesel generator (Section 8.3.1.1.1).

9.5.3.2.4 Main Control Room Lighting

The main control room lighting is supplied from the normal ac buses. Alternating rows of fixtures are supplied from two separate MCC sources.

General lighting is from a louvered ceiling of the aluminum egg-crate type. Fixtures are fluorescent strips seismically-mounted above the louvers.

The system is capable of controlled illumination by use of switching from the panelboard circuit breakers. Lighting for the face of the main control board can also be switched.

The main control room also has backup dc incandescent fixtures powered from the non-Class 1E dc buses. Fixtures are located to provide adequate illumination for safe shutdown operation and egress.

Approximately 20 percent of the fluorescent fixtures in the main control room are connected to the backup ac lighting subsystem as a supplement to backup dc illumination during loss of normal ac power. This subsystem can also provide operation for long periods of time without offsite power, since it is powered from the onsite, nonsafety diesel generator upon loss of normal ac power.

9.5.3.2.5 Egress Lighting and Exit Signs

In order to comply with the rules and regulations of OSHA concerning exit signs and egress lighting, the following is provided:

1. Externally-illuminated Exit signs at all exits.

2. Adequate and reliable illumination for both vertical and horizontal exit facilities for clearly visible egress routes.

The external illumination for Exit signs, Direction to Exit signs, and egress lighting receives power from normal ac sources. During loss of normal ac power, these fixtures are fed from the non-Class 1E station batteries which are designed for a 2-hour duty cycle.

Backup lighting required for personnel safety in some areas is provided by local, self-contained, battery-powered, backup lighting units with a 1.5-hour minimum operation rating.

9.5.3.2.6 Safety-Related Areas

The safety-related area lighting is generally supplied from the normal ac buses. However, lighting required for the control of safety-related equipment, such as the Class 1E switchgear and the ESP, has sufficient fixtures powered from the backup ac and/or dc subsystems to operate them during loss of normal ac lighting.

9.5.3.2.7 Individual Sealed Beam or Fluorescent 8-hour Battery Pack Lighting

The lamp in a sealed beam/battery pack unit and the fluorescent/battery pack fixtures will not normally be illuminated and will be activated upon a loss of normal ac power. The units will receive the necessary power to trickle charge the battery packs and to provide indication of available normal ac power from local normal ac lighting circuits. A sealed beam/battery pack unit will therefore be activated upon the loss of normal ac lighting power in the area serviced by the unit. The individual power supplies assure that the failure of any one component will not affect the balance of the units.

9.5.3.3 Seismic Design

The installation of all lighting subsystems in safety-related areas, including lighting transformers, panelboards, raceway, and all support structures, is designed to meet the seismic requirements of the area in which they are located.

9.5.3.4 Safety Analysis

During normal plant operation, lighting is provided from normal buses. Upon loss of normal power, the backup dc and ac lighting subsystems automatically operate through sensing and controlling equipment. Each backup subsystem is backed up with power from the onsite, nonsafety diesel generator or station batteries and has separate panels, conduit, wiring, controls, and fixtures. This separation of lighting systems protects against a common mode failure.

9.5.3.5 Inspection and Testing Requirements

Design of the lighting system permits routine surveillance and testing without disrupting normal service. Proper functioning of normal ac lighting is verified by surveillance and inspection. All backup dc and ac lighting fixtures will operate from normal ac power, thus allowing for surveillance of all lamps for proper operation.

The automatic transfer switches on the backup dc lighting subsystem are provided with test switches to simulate loss of normal ac power. All automatic transfer switches on the backup dc subsystem are provided with main control room annunciation for loss of the dc backup source and for transfer to the backup source. All self-contained backup dc units are provided with local test switches to simulate loss of normal ac power.

9.5.4 Emergency Diesel Generator Fuel Oil Storage and Transfer System

The emergency diesel generator fuel oil storage and transfer system is a safety-related system which stores fuel oil for the emergency diesel generators during normal operation and supplies fuel oil to the diesel generator fuel oil pumps when they are required to operate.

9.5.4.1 Design Bases

The emergency diesel generator fuel oil storage and transfer system is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the ability of structures housing the system and the system itself to withstand the effects of natural phenomena (for example, earthquakes, tornadoes, hurricanes, and floods) as established in Chapters 2, 3, and Appendix Position 13 of Regulatory Guide 1.117.

2. General Design Criterion 4, with respect to structures housing the system, and the system itself, being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks, and Position C.1 of Regulatory Guide 1.115.

3. General Design Criterion 5, as it relates to the capability of shared systems and components important to safety to perform required safety functions.

4. General Design Criterion 17, as it relates to the capability of the fuel oil system to meet independence and redundancy criteria. Beaver Valley Power Station - Unit 2 has redundant emergency diesel generators which satisfy the single failure criterion for essential power. Each emergency diesel generator is provided with its own separate fuel oil storage and transfer system.

5. Regulatory Guide 1.54, as it relates to protective coatings applied to diesel fuel oil storage tanks.

6. Regulatory Guide 1.75, as it relates to physical independence of electrical systems.

7. Regulatory Guide 1.137, as it relates to the emergency diesel generator fuel oil systems, their design, fuel oil quality, and required tests.

8. ANSI Standard N195, with the exception of Section 6.3 which requires a duplex strainer for the transfer line from the storage tank to the day tank. Due to the unavailability of ASME Section III, Class 3, duplex strainers, redundant ASME Section III, Class 3, 'Y' type strainers are provided instead.

9. NUREG/CR-0660 (USNRC 1979), Enhancement of Onsite Emergency Diesel Generator Reliability.

10. Diesel Engine Manufacturers Association (DEMA), as it relates to the design of the diesel fuel oil system.

11. The storage capacity of the system provides sufficient fuel oil for each diesel generator to operate continuously at maximum load for 7 days.

12. The system is designed in accordance with ASME Section III, Class 3.

13. The system is designed to operate at an ambient temperature between 55° and 120°F and at ambient atmospheric pressure.

9.5.4.2 System Description

The emergency diesel generator fuel oil storage and transfer system (Figure 9.5-7) supplies fuel oil to the emergency diesel generators. Table 9.5-1 lists the design parameters of the components in this system. Figure 3.8-43 shows the general arrangement of the system.

The fuel oil accumulator tank, located on the diesel engine, ensures that the fuel headers are full at the time of initiating engine start. The tank capacity is approximately 0.9 gallons and is fabricated to the diesel engine manufacturer's standard design.

A separate, independent, emergency diesel generator fuel oil storage and transfer system is provided for each of the two emergency diesel generators. Each emergency diesel generator fuel oil storage and transfer system consists of a storage tank, a stick gauge, two transfer pumps, three strainers, a day tank, necessary piping, and valves.

The emergency diesel generator fuel oil storage tanks are sized to store sufficient fuel oil for 7 days of continuous operation of the associated diesel generator under maximum load conditions. Two full capacity, motor-driven, diesel generator fuel oil transfer pumps are used for each storage tank to transfer fuel oil to the fuel oil day tanks. The diesel generator building is a Seismic Category I designed tornado and missile-protected structure that is flood-protected to ground grade (Section 3.4). Each of the redundant fuel oil systems is located in a separate room within the diesel generator building. The fuel oil storage tanks are embedded in concrete below the diesel generator building (below grade elevation) where the fuel oil can be maintained at a fairly constant temperature.

Upon a loss of offsite power (LOOP), power is provided to each fuel oil transfer pump by its associated emergency diesel generator. The pumps operate in a lead-follow arrangement. On a low level signal from the day tank, the first pump starts. If this pump fails to maintain the level in the day tank, the second pump starts on a low-low level signal.

An orificed recirculation line in each pump discharge line back to the storage tank provides minimum flow through the pump. A 'Y' type strainer is installed in each pump discharge line to minimize the transfer of solids to the day tanks.

The system also provides protection against fuel oil overflowing from the day tank in the event that the transfer pump does not trip on a high level. This is accomplished by means of an overflow line from the top of the day tank to the storage tank. The integral accumulator tank also has a return line to the day tank for excess fuel.

The day tanks are sized to store a maximum of 1,100 gallons of fuel oil in accordance with NFPA Standard 37, Stationary Combustion Engines and Gas Turbines. The fuel oil day tank and fuel oil piping are located clear of any source of ignition such as open flames or hot surfaces. Open flames are not permitted in the diesel generator building except when associated with maintenance activities. During

these maintenance activities the appropriate station operating procedures will be followed. The fuel oil day tank and connecting piping are located a minimum distance of 10 feet from the emergency diesel generator engine, 10 feet from the emergency generator starting air compressors and insulated discharge piping, and 10 feet from the insulated diesel exhaust piping to preclude contact with these hot surfaces. Fuel oil piping to the diesel generator fuel oil pumps is directed to the opposite end of the diesel engine, away from the insulated exhaust piping. The day tanks are located in the diesel generator building at an elevation that will assure a positive pressure at the engine-driven fuel oil pumps. Each fuel oil day tank is mounted in a diked area. Within this area is a sump with a level switch and outlet drain piping. The volume of the dike area and sump is equal to the fuel oil day tank volume.

The outlet piping is used to remove oil and to ensure significant amounts of fluids will not remain in the dike or sump areas. Excess fuel oil is gravity-fed through the drainage system directly to the waste oil system. The level switch indicates a high level within the sump and alarms in the main control room. At that time appropriate station operating procedures will be followed.

Both the storage tanks and the day tanks are separately vented to the atmosphere and equipped with flame arrestors. The day tank vents are terminated outside the building in missile-protected areas.

The storage tank vents terminate at approximately elevation 740 feet - 6 inches. These diesel fuel oil tank vent pipes cannot be assured as they are protected on three sides and overhead by reinforced concrete but are vulnerable to a tornado missile from one direction. An alternate vent path exists through the 3” overflow line between the fuel oil storage tank and the day tank then out the day tank 2” vent pipe that is tornado missile protected.

The fill connections terminate outdoors 3 feet - 6 inches above grade at elevation 736 feet - 0 inches. This connection is provided with a locked closed valve and a threaded cap to prevent entrance of water into the fuel oil storage tank. These fill lines are not tornado missile protected. Alternate methods of filling the fuel oil tank are provided through the sample connection or the vent flame arrestor connection which are located in an area protected from tornado missiles on three sides. Each fuel oil storage tank can also be filled through separate manholes covered by a concrete plug cover located inside the building entrance labyrinth.

The fuel oil storage tank fill connection terminates at the bottom of the fuel oil storage tank. The fill connections are located a sufficient distance from the fuel oil transfer pump suction bells to enhance settling of sediment away from the fuel oil transfer pump suction bells.

To preclude the need for cathodic protection, all fuel oil storage tanks, day tanks, and piping are adequately protected

from external corrosion by their enclosure in a heated building or by encasement in concrete. Interior and exterior surfaces of the fuel oil storage tanks are protected by coatings applied in accordance with Regulatory Guide 1.54, as described in Section 1.8, and in accordance with Steel Structures Painting Council Standards PA1, Paint Application Guide for Shop, Field, and Maintenance Painting. The interior surfaces of the fuel oil storage tanks are coated with a prime and finish coat of a high build epoxy paint. The exterior surfaces of the fuel oil storage tanks are coated with a zinc-rich epoxy polyamide.

Strainers are placed in the fill lines of the storage tanks and in the discharge piping of the fuel oil transfer pumps. The strainers, storage tanks, and day tanks have drain lines and provisions for periodic checks for water, sediment, etc., to minimize the possibility of contamination or deterioration of the fuel oil supply. Provisions are available on each tank for removal of excess water.

9.5.4.3 Safety Evaluation

The emergency diesel generator fuel oil storage and transfer system is designed to remain operable assuming a single failure during a LOOP. This system is safety-related, QA Category I, and is designed in accordance with ASME Section III, Class 3, and Seismic Category I requirements.

Each of the emergency diesel generator fuel oil systems is capable of providing for 7 days of operation at rated load per Regulatory Guide 1.137 and ANSI N-195. Sufficient additional capacity is also available to allow approximately 10 hours of diesel generator running time for test purposes before the fuel oil tanks must be topped off to maintain capacity. Each diesel generator fuel oil transfer pump receives power from its associated diesel generator.

There are five major oil distributors within 40 miles of the site. Their normal diesel fuel stocks on hand and their delivery capabilities are presented in Table 9.5-2.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I & C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Std 279-1971 requirements are satisfied, has been performed on the emergency diesel generator fuel oil storage and transfer system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.5.4.4 Inspection and Testing Requirements

The emergency diesel generator fuel oil supply piping is pressure-tested during construction and all active system components are functionally tested during start-up, as described in Section 14.2.12. The fuel oil for the diesel generator is monitored for water accumulation, and periodic samples are

analyzed. Fuel oil used in the engines will meet the standards stated in the BVPS-2 Technical Specifications.

The fuel oil transfer pumps and all system valves will be in-service tested, as specified in Section 6.6. A manhole is provided for the inspection of the fuel oil storage tanks.

9.5.4.5 Instrumentation Requirements

Each diesel generator fuel oil day tank is provided with two transfer pumps that have local selector switches with indicating lights for manual or automatic control. Each of the two lead pumps, when in auto, start on a low level in the day tank. The two standby pumps, when in auto, start on a low-low level in the day tank. The four pumps take their suction from the fuel oil storage tanks. The pumps stop on a high level in the day tank.

Local alarms are provided for fuel oil transfer pump discharge strainer differential pressure high, diesel generator fuel oil day tank level high and low, diesel generator fuel oil storage tank level high and low, and day tank fuel oil sump level high. These all annunciate on a common alarm in the main control room. These conditions are also monitored by the BVPS-2 computer.

9.5.5 Emergency Diesel Generator Cooling Water System

9.5.5.1 Design Bases

The emergency diesel generator cooling water system is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena (earthquakes, tornadoes, hurricanes, and floods) as established in Chapters 2 and 3, and defined in Regulatory Guide 1.102 and 1.117.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external and internally

generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to the capability of shared systems and components important to safety being capable of performing required safety functions. Each emergency diesel generator is provided with its own separate cooling water system.

4. General Design Criterion 17, as it relates to the capability of the cooling water system to meet independence and redundancy criteria, and General Design Criterion 44 to assure:

    a. The system is capable of transferring heat from essential diesel generator components to a heat sink under transient or accident conditions,

    b. Redundant emergency diesel generators are provided, which satisfy the single failure criterion for standby onsite ac power sources, and

    c. Separate cooling water lines are provided for each emergency diesel generator which satisfies the capability to isolate components of a system or piping to maintain system safety function.

5. General Design Criterion 45, as it relates to design provisions to permit periodic inspection of safety-related components and equipment of the system.

6. General Design Criterion 46, as it relates to design provisions to permit appropriate functional testing of safety-related systems or components to assure structural integrity and leaktightness, operability and performance of active components, and the capability of the system to function as intended under accident conditions.

7. IEEE Standard 387-1972 and Regulatory Guide 1.9, as they relate to the design of the emergency diesel generator cooling water system for qualification to a mild environment as referenced in Section 3.11.

8. Regulatory Guide 1.26, as it relates to the quality group classification of system components. This system is QA Category I, Safety Class 3. The engine-driven circulating pumps, the keep-warm pumps, and the engine itself are built to the manufacturer's standards. All components such as piping, fittings, tanks, valves, pumps, etc up to the engine, conform to all the requirements of ASME Section III, Class 3.

9. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designed in accordance with Seismic Category I requirements.

10. Branch Technical Position ICSB-17 (PSB), as it relates to engine cooling water protective interlocks during accident conditions.

11. Diesel Engine Manufacturers Association Standard, as it relates to the design of the engine Cooling Water System.

12. NUREG/CR-0660 (USNRC 1979), Enhancement of Onsite Emergency Diesel Generator Reliability, as it relates to the design of the cooling water system.

13. The emergency diesel generator cooling water heat exchangers are designed for a service water temperature of 90°F.

9.5.5.2 System Description

The emergency diesel generator cooling water system, Figures 9.5-8 and 9.5-9 and Table 9.5-3, is an integral part of the diesel generator package.

Each diesel engine cooling system consists of a jacket water cooling system and an intercooler water system. The jacket water cooling system consists of an engine-driven jacket water circulating pump, water temperature regulating valve, water expansion tank, electric heater, ac motor-driven keep-warm circulating pump, and jacket water cooling heat exchanger. The intercooler water system consists of a direct engine-driven circulating pump, water temperature regulating valve, water expansion tank (both the intercooler system and the jacket water system share the same expansion tank and a three-way thermostatic mixing valve), and heat exchanger. With the exception of the engine-driven circulating pumps and keep-warm pumps, all piping, fittings, tanks, valves, pumps, etc up to the engine, conform to all the requirements of ASME III, Class 3.

The jacket water cooling system provides cooling to the cylinder lines, cylinder heads, lube oil cooler, governor oil cooler, and turbo charger cooling spaces. The system is designed and tested by the diesel engine manufacturer to ensure proper cooling. The heat rejection and capacity of the jacket water cooling system is shown on Table 9.5-3.

The intercooler water system provides cooling to the turbo charged air intercooler and the alternator outboard bearing. The system is designed and tested by the diesel engine manufacturer to ensure proper cooling. The heat rejection and capacity of the intercooler water system is shown on Table 9.5-3.

The emergency diesel generator cooling water system heat exchangers are cooled with water from the SWS (Section 9.2.1). Each diesel generator is supplied with service water from a service water pump powered from the emergency buses associated with that generator. The motor-operated service water inlet valves to the diesel generator cooling system heat exchangers are opened on a safety injection signal or diesel generator running signal. The service water pumps are started on Start Step 3 of the diesel generator loading sequence (refer to Table 8.3-3). The service water inlet gate valves to the emergency diesel generators are started on Start Step 2 of the diesel generator loading sequence (refer to Table 8.3-3), and cycle to full open in 60 seconds to insure adequate cooling to the diesel generators. The portion of the SWS for the diesel generator appears on Figure 9.2-1.

The cooling water system maintains water in the diesel engine jacket within the manufacturer's specified limits of 95°F to 170°F for average temperature and temperature rise through the jacket. The cooling water can bypass the heat exchanger for fast engine warmup.

The jacket water expansion tank is located to ensure the required NPSH is provided on the circulating pumps, in accordance with the diesel engine manufacturer's recommended location. The jacket water expansion tank is sized by the diesel engine manufacturer to accommodate predicted system-leakage (Tables 9.5-3 and 9.5-7) and to maintain the required NPSH on the circulation pumps for 7 days of engine operation.

The thermostatically-controlled electric water heater is suitable for maintaining the engine jacket cooling water at 125°F in a minimum ambient temperature of 10°F when the engine is not running. An ac motor-driven cooling water circulating pump is provided for moving the water through the jacket water cooling system when the engine is not running.

Each emergency diesel generator cooling water system provides cooling to the respective Diesel Generator lubrication oil cooler (Section 9.5.7).

Table 9.5-3 delineates design parameters of the emergency diesel generator cooling water system.

Makeup water to the cooling water system is added to the jacket water expansion tank from the nonsafety-related demineralized water system, which is normally isolated from the cooling water system. The 100-gallon jacket water expansion tank is the highest point of the emergency diesel generator cooling system to ensure that all components and piping are filled with water. Vent valves are provided to insure adequate draining and filling of the system.

A corrosion inhibitor is added to the system via a chemical addition connection. This inhibitor is compatible with the materials of the system and maintains water chemistry in conformance with the engine manufacturer's recommendations. Chemical addition is provided on the service water side of the heat exchangers to allow wet layup of the cooling system. A biodegradable chemical will be used so as not to adversely affect the service water chemistry requirements.

The engine coolers are designed to reject the engine heat loads with an inlet service water temperature of 90°F. Maximum expected service water temperature is 89°F.

9.5.5.3 Safety Evaluation

The emergency diesel generator cooling water system is designed to remain operable during a LOOP. Each emergency diesel generator cooling water system is independent, and is an integral part of the diesel engine.

There is no sharing of cooling water subsystems or components between the two emergency diesel generators. Each diesel generator has its own cooling water subsystems which are cooled by redundant service water trains. Section 9.2.1 and Figure 9.2-1 describe the interface to, and the analysis of, the service water system.

No single failure or piping interconnections between the engine water jacket, lube oil cooler, governor lube oil cooler, and the engine air

intercooler can cause degradation of both emergency diesel generator engines.

This system is safety-related, QA Category I, is designed in accordance with Seismic Category I requirements, and is protected from pipe break effects, as described in Section 3.6. A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I & C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Standard 279-1971 requirements are satisfied, has been performed on the emergency diesel generator cooling water system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis, can be found in the separate FMEA document (Section 1.7).

9.5.5.4 Inspection and Testing Requirements

The emergency diesel generator cooling water system piping is pressure tested during construction, and system components, pumps, valves, and controls are tested and operationally checked when the diesel generator is tested (Section 8.3). Pre-operational tests are performed as described in Section 14.2.12. After operating the diesel engine for extended periods of time (over 24 hours) from no-load up to 20 percent of rated load, the diesel generator will be run at above 50 percent load for at least 1 hour for each 24 hour period no-load operation, as recommended by the diesel engine manufacturer. The diesel generator can be run at loads greater than 20 percent of rated load continuously with no adverse affect on any of the operating parameters.

9.5.5.5 Instrumentation Requirements

Selector switches with indicating lights are provided locally for the diesel generator jacket water keep-warm pumps. These pumps may be operated manually or automatically. Automatic operation is available to start the pumps when the diesel generator engine speed is below synchronous speed and the diesel generator jacket cooling water pressure is below a predetermined set-point, and the pumps will stop when the diesel generator engine speed is above synchronous speed or the diesel generator jacket cooling water pressure is above a predetermined set-point.

Selector switches with indicating lights are provided for the diesel generator jacket water heaters. These heaters may be operated manually or automatically. When these heaters are in the automatic mode, the respective keep-warm pump running in conjunction with its respective diesel generator jacket cooling water temperature (below a predetermined point) will energize the water heater.

Jacket cooling water temperature control valves are provided for each diesel generator. These valves are automatically operated by means

of a temperature controller. These valves will modulate when their respective diesel generator engine speed is above a predetermined point or when their respective diesel generator jacket cooling water pressure is above a predetermined point.

Control switches with indicating lights are provided for the diesel generator heat exchanger service water header valves. Refer to Section 9.2.1.1.5 for additional control information for these valves.

Annunciation is provided locally for the jacket water expansion tanks low water levels. Demineralized water may be added manually to the jacket water expansion tanks if a low water level exists. Alarms are also provided locally for high and low cooling water temperature and cooling water low pressure. These local annunciators are monitored in the main control room by a common trouble alarm. They are also monitored by the BVPS-2 computer system.

9.5.6 Emergency Diesel Generator Air-Starting System

Each emergency diesel generator is air-started by a dedicated air-starting system. Redundant components are provided for each emergency diesel generator to enhance starting reliability. Each air compressor in a system has sufficient capacity to recharge the air storage system in 30 minutes from minimum to maximum starting air pressure.

9.5.6.1 Design Bases

The emergency diesel generator air-starting system is designed in accordance with the following criteria:

1. General Design Criterion No. 2, as it relates to the ability of structures housing the system to withstand the effects of natural phenomena (for example, earthquakes, tornadoes, hurricanes, and floods) as established in Chapters 2 and 3.

2. General Design Criterion No. 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion No. 5, as it relates to the capability of shared systems and components important to safety to perform required safety functions. Each emergency diesel generator is provided with its own separate redundant air-starting system.

4. General Design Criterion 17, as it relates to the capability of the emergency diesel generator air-starting system to

meet the independence and redundancy criteria. Specific criteria and guidance necessary to meet these requirements are addressed in the Diesel Engine Manufacturers Association Standard, as it relates to the emergency diesel generator air-starting system.

5. Regulatory Guide 1.9, as it relates to the design of the emergency diesel generator air-starting system.

6. Regulatory Guide 1.26, as it relates to quality group classification of the system components. This system is QA Category I, Safety Class 3.

7. Regulatory Guide 1.29, as it relates to seismic design classification. This system is designed in accordance with Seismic Category I requirements.

8. Regulatory Guide 1.68, as it relates to preoperational and start-up testing of the air-starting system.

9. IEEE Standard 387-1972, as it relates to the design of the emergency diesel generator air-starting system for qualification to a mild environment as referenced in Section 3.11.

10. Branch Technical Position ICSB-17, as it relates to emergency diesel generator protective trips.

11. The emergency diesel generator air-starting system also meets the following specific criteria:

    a. Each emergency diesel generator is provided with a dedicated starting system, each consisting of two air compressors, two air receivers, an air dryer, injection lines and valves, and devices to crank the engine. Redundant components are provided for each emergency diesel generator to enhance starting reliability.

    b. Each of the redundant air-starting systems is designed to provide the manufacturer's requirement for five starting cycles from an initial pressure of 425 psig without recharging the starting air receivers. Table 9.5-11 shows the manufacturer’s test data, which demonstrated the capability of the starting air system to start the engine five times, each attempt within 10 seconds, without recharging of the receiver.

    c. Periodic surveillance testing is performed on the emergency diesel generator air start system. In accordance with Technical Specification 3.8.3, the emergency diesel generator air start system’s capability is verified by determining that at least one air start receiver is at the minimum pressure to support five starting cycles. This periodic verification determines that sufficient air volume is available to support five engine start cycles without recharging.

The emergency diesel generator start system (including the air start subsystem and supporting electronic circuitry) is designed to crank the diesel engine to the manufacturer's recommended rpm to support the generator's design capability to reach its rated voltage and frequency, and to begin load sequencing within 10 seconds. The Technical Specification 3.8.1 surveillance requirements demonstrate the ability of each emergency diesel generator to reach its rated voltage and frequency and to begin load sequencing within 10 seconds for one start demand (as required by accident analyses).

d. Alarms are provided which will alert operating personnel if the air receiver pressure falls below the minimum allowable value.

e. Refrigerant air dryers and filters are provided to remove moisture and any foreign material from the starting air.

9.5.6.2 System Description

The emergency diesel generator engine starting system is shown on Figure 9.5-10 and the principal components are listed in Table 9.5-10. The system is located in the diesel generator building, which is a Seismic Category I, tornado and missile-protected structure. Each emergency diesel generator is provided with a dedicated starting system, which is capable of starting the engine without offsite power. Each starting system includes two ac motor-driven air compressors, two air storage tanks, an air dryer, all necessary valves and fittings, and complete instrumentation and control systems. All system components downstream of the inline plug valve between the dryer and receiver are designed in accordance with ASME Section III, Class 3.

All piping and components from the dryer discharge plug valves to the diesel engine air start solenoid, inclusive, are designed in accordance with ASME III. Engine-mounted components and the starting air compressors which are not covered in the rules of ASME III, Code Class 3, are designed in accordance with the diesel manufacturer's latest standards for reliability. These components include the following:

1. Engine-mounted air start distributors,

2. Engine-mounted air start valves,

3. Engine-mounted starting booster air valve, and

4. Engine-mounted fuel rack shutdown and starting booster servo.

A skid-mounted, 450-psig design pressure, 0.2-cubic foot, ASME III Class 3 air tank is provided in the air supply line to the servo fuel rack shutdown and fuel rack booster sources. A check valve isolates the tank from the starting air system. The air tank is designed by the diesel manufacturer to ensure a source of air for positive fuel shutoff in the event of a loss of all starting air pressure in the

main starting air system. Approximately five such stops can be achieved with the tank volume provided.

The air start system is not required to control engine operation after an emergency start. The air start solenoid valves, 2EGA*SOV202-1, 2 and 2EGA-SOV203-1, 2, are normally closed and both valves are opened on a diesel start signal to admit air to the air admission valves in each of the inlet lines to the engine. The air admission valves allow the starting air to enter the engine under control of the air start distributor.

During an engine start, air pressure from the air start header is applied to the auxiliary start control device of the fuel rack booster, which forces the piston in the device to move inward. This action causes the control linkage and the fuel injector pump racks to move to the starting fuel position. Energization of the shutdown solenoid valve, 2EGA*SOV201-1, 2, opens the valve to allow starting air pressure to be applied to the opposite side of the piston in the auxiliary start control device, forcing the piston to move outward. This suction causes the control linkage and the fuel injection pump rack to move to the "no fuel" position.

Four shuttle valves in series are incorporated to control the rack boost function of the fuel rack servo cylinder. The operation of each valve is as follows:

1. The first shuttle valve in the series selects the starting air header that will supply the rack boost pressure. The B header is ordinarily selected unless the pressure falls such that it cannot overcome the shuttle valve spring, in which case the valve selects the other header.

2. The second shuttle valve in series vents the boost pressure in case of overspeed governor actuation due to cranking.

3. The third shuttle valve vents the boost pressure if a shutdown signal from any source other than the overspeed governor and actuates the shutdown solenoid during cranking.

4. The fourth shuttle valve vents the boost pressure when the engine has built up sufficient lube oil to move the shuttle against the spring pressure.

Each diesel engine is equipped with a 3-way shutdown solenoid valve that is normally closed. Opening this valve will actuate the fuel

rack servo shutdown cylinder to shut down the engine. It will remain open until after the engine has come to a complete rest. A check valve upstream of the tank is installed to ensure a source of air for positive shutdown in the event of a loss of starting air pressure in the main air receiver.

Air compressor cross-connect lines are provided between redundant diesel generators. Cross-connect valves, which are normally closed, permit the supply air compressor from one emergency diesel generator to be used to restore air pressure in the second emergency diesel generator air starting system air receiver tanks (Figure 9.5-10). The air receivers between the two emergency diesel generator trains are prevented from being cross-connected due to check valves in the inlet lines; only the air compressor discharge can be cross-connected. These cross-connect valves will be controlled by existing BVPS-2 administrative procedures. Appropriate precautions will be included in the operating manual for the diesel generators to permit their use only as described in Section 9.5.6.2. When both compressors for the same train are inoperable, a compressor will be used to supply air pressure as required.

The refrigerant air dryers are cycling, heat sink type dryers. They are thermostatically controlled and have automatic water separators and drains. A high heat sink temperature alarm is provided to alert operating personnel of a high dew point temperature.

Included with the air dryers is an aftercooler, two coalescing filters, a particulate filter and pressure and temperature gauges. A flow switch on the aftercooler is provided to give a permissive for the compressor to start if there is adequate cooling air flow through the aftercooler.

The air storage tanks are equipped with pressure gauges, pressure relief valves, and other fittings for connection of the air-starting systems to the emergency diesel generators. Tank bottom drains are provided for periodic blowdown of accumulated moisture.

The design pressure and the normal operating supply pressure of the air storage tanks are specified by the emergency diesel generator manufacturer. The ac compressor motor is furnished with automatic and manual start and stop control.

9.5.6.3 Safety Evaluation

The emergency diesel generator starting system is designed to remain operable during a loss of offsite power. Redundant components are provided to enhance the starting reliability of each emergency diesel generator.

Without the air compressor operating, the air receivers in each train of each diesel engine air-starting system are capable of supplying five starting cycles per train. The manual feature of the emergency diesel generator starting system is provided in addition to the automatic starting mode, in compliance with IEEE Standard 387-1972. The system is QA Category I, Safety Class 3, and is protected from pipe break effects, as described in Section 3.6.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I & C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Standard 279-1971 requirements are satisfied, has been performed on the emergency diesel generator air-starting system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.5.6.4 Inspection and Testing Requirements

The emergency diesel generator air-starting system is inspected during construction to ensure the quality of the air-starting system, and to ensure that all components of the system operate properly. Periodic blowdown of the air receivers is performed to check for any moisture or foreign material. The system is routinely observed during periodic testing as prescribed in the Technical Specifications (Chapter 16). Preoperational tests are performed as described in Section 14.2.12.

9.5.6.5 Instrumentation Requirements

Selector switches with indicating lights are provided locally for the emergency diesel generator air-starting air compressors and the air dryers. The air-starting air compressors can be operated manually or automatically. Automatic actuation of the air compressors is governed by the air receiver pressure. Low air-starting air receiver pressure is annunciated locally, and is also monitored by the BVPS-2 computer. The local annunciator actuates a common diesel generator trouble alarm in the main control room.

A temperature switch maintains the proper heat sink temperature in the diesel air dryers. High heat sink temperature is annunciated locally and monitored by the BVPS-2 computer. The local annunciator actuates a common diesel generator trouble alarm in the control room. A flow switch on the aftercoolers gives a permissive for the compressors to start on a positive cooling air flow signal.

Diesel generator air start solenoids are provided for each diesel generator. The air start solenoids will energize to open on a diesel generator start signal or on a diesel generator low speed signal provided all of the following conditions exist: diesel generator barring device No. 1 and No. 2 have been disengaged, diesel generator engine trouble signal has been reset, and the diesel generator electrical protection signal has been reset. The air start solenoids will be de-energized to close provided any of the above conditions do not exist.

9.5.7 Emergency Diesel Generator Lubrication System

9.5.7.1 Design Bases

The emergency diesel generator lubrication system is designed in accordance with the following criteria:

1. General Design Criterion 2 and Regulatory Guides 1.117 and 1.102, as they relate to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena (earthquakes, tornadoes, hurricanes, and floods) as established in Chapters 2 and 3.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems and components important to safety being capable of performing required safety functions. Each emergency diesel generator provided with its own separate lubrication system.

4. General Design Criterion 17, as it relates to the emergency diesel generator lubrication system to meet independence and redundancy criteria.

5. Regulatory Guide 1.9, as it relates to selection, design, and qualification of emergency diesel generator units.

6. Regulatory Guide 1.26, as it relates to quality group classification of system components. This system is QA Category I, Safety Class 3.

1. General Design Criterion 2 and Regulatory Guides 1.117 and 1.102, as they relate to structures housing the system and the system itself being capable of withstanding the effects of natural phenomena (earthquakes, tornadoes, hurricanes, and floods) as established in Chapters 2 and 3.

2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems and components important to safety being capable of performing required safety functions. Each emergency diesel generator provided with its own separate lubrication system.

4. General Design Criterion 17, as it relates to the emergency diesel generator lubrication system to meet independence and redundancy criteria.

5. Regulatory Guide 1.9, as it relates to selection, design, and qualification of emergency diesel generator units.

7. IEEE Standard 387-1972, as it relates to the emergency diesel generator lubrication system for qualification to a mild environment as referenced in Section 3.11.

8. NUREG/CR-0660 (USNRC 1979), as it relates to the design of the emergency diesel generator lubrication system.

9. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designed in accordance with Seismic Category I requirements.

10. Diesel Engine Manufacturers Association Standard, as it relates to the design of the emergency diesel generator lubrication system.

11. The emergency diesel generator lubrication system also meets the following specific criteria:

    a. The operating pressure, temperature differentials, flow rate of the engine-driven lubricating oil, and heat removal rate for the cooler of this system are in accordance with recommendations of the emergency diesel generator manufacturer.

    b. The temperature of the lubricating oil is automatically maintained above a minimum value by means of an independent recirculation loop, including its own pump and heater, to enhance the first try starting reliability of the emergency diesel generator when in the standby condition.

    c. The system is equipped with filters and strainers to remove impurities from the oil during engine operation.

    d. The diesel engine is equipped with a vapor extraction system and crankcase blow-out pots to mitigate the consequences of a crankcase explosion.

9.5.7.2 System Description

The emergency diesel generator lubrication system (Figure 9.5-11) provides essential lubrication to the components of the emergency diesel generator. The engine lubrication system is integral with the engine. Included in the lubrication oil system for each engine is an engine-driven lube oil pump, an ac motor-driven keep-warm and pre-lube pump, an electric lube oil keep-warm heater, a separate rocker arm lube oil system with an ac motor-driven rocker arm pre-lube pump and engine-driven rocker arm lube pump, a crankcase vapor extraction

system with an oil separator (Figure 9.5-12), filters and strainers, heat exchangers, thermostatic control valves, piping, and fittings.

The crankcase vacuum system (Figure 9.5-12) includes a crankcase vacuum pump, oil separator, piping and fittings. Table 9.5-9 lists the design parameters for the crankcase vacuum system. The crankcase vacuum system removes oil vapors from the diesel engine crankcase. The operation of the crankcase vacuum system is either manual or automatic. The vacuum pump is powered from the Class lE source of power. The crankcase vacuum system operates during all modes of diesel operation, however, it is not essential to the safe, reliable operation of the diesel engine and therefore the system is designated nonnuclear safety-related (NNS). The diesel crankcase is provided with relief ports to mitigate the consequences of a crankcase explosion.

The engine-driven lubricating oil pump has sufficient capacity to ensure adequate lubrication of the main bearings, crank pins, camshaft bearings, and other oil-lubricated wearing parts, as required. The engine-driven rocker arm lube oil pump ensures adequate lubrication of the rocker arms and valve gear while the emergency diesel generator is operating.

Operation of the rocker arm and pre-lube system, as recommended by the diesel engine manufacturer , will establish a sufficient oil film and on the rocker arm wearing parts to preclude the requirement for operation of the electric-driven rocker arm and pre-lube pump during emergency engine start.

The keep-warm and pre-lube pump operates continuously during the standby condition of operation to circulate oil through the electric keep-warm heater to the bearings, rods, and other essential parts, except the rocker arm assembly. The rocker arm pre-lube pump is manually operated on an as-needed basis to provide oil to the rocker arm assembly. The lubricating oil filters and strainers are multiple element, bypass type, capable of filtering out 5 micron size particles. The three lubrication oil strainers per engine are of the continuous, full-flow type utilizing suitable filtering and straining media to filter out 35 micron size particles.

Operation of the diesel engine keep-warm and pre-lube system is continuous in accordance with the diesel engine manufacturer recommendations. Lube oil from parts supplied by the keep-warm and pre-lube system drain back to the engine oil sump and therefore will not result in dangerous accumulations of lube oil that could ignite.

Manual operation of the diesel engine rocker arm pre-lube system is in accordance with the manufacturer's recommendation of 5 to 30 minutes of pump operation prior to all starts except emergency starts. The unlikely accumulation of lube oil that could ignite is eliminated by operation of the systems in accordance with

manufacturer recommendations coincident with proper maintenance and surveillance of the lube oil system.

The diesel engine keep-warm and pre-lube pump, rocker arm pre-lube pump, rocker arm lube oil pump, keep-warm heater, and engine driven lube oil pump design parameters are shown in Table 9.5-8.

The lubricating oil cooler is a shell and tube type (Figures 9.5-8, 9.5-9, and 9.5-11) and is suitable for the temperatures and pressures encountered in service. The oil cooler is capable of controlling the lubricating oil temperature at the required values by using the emergency diesel generator cooling water. The coolers are designed in accordance with the mechanical standards for Tubular Exchanger Manufacturers Association (TEMA) Class R coolers, and conform to the ASME Boiler and Pressure Vessel Code, Section III, Class 3. The total heat removal rates and system parameters for lube oil cooling are shown on Table 9.5-3 and are in accordance with manufacturer recommendations.

Oil pressure is monitored by four pressure switches, which will trip the emergency diesel generator upon receipt of a low pressure signal (approximately 60 psig) by any two of the four switches. Trip will occur during testing mode only, not during emergency mode. Operation of any lube oil pressure switch will sound an alarm during test or emergency mode of operation. The lubricating oil level in the engine oil sump is monitored for low and high level. Actuation of either the low or high level switch will sound an alarm. The rocker arm lube oil reservoir level is monitored for high level, and the level is maintained by a level control valve.

Addition of lube oil to the engine lube oil sump, if required, shall be via the sump fill connection. The rise in sump oil level shall be verified by comparing the amount of oil added and the indicated rise in level as shown on the sump dip stick. The point of lube oil addition is clearly identified on the emergency diesel engine.

9.5.7.3 Safety Evaluation

The emergency diesel generator lubrication system provides a completely separate and independent engine lubrication system for each diesel generator.

The lube oil keep-warm and pre-lube pump runs continuously to ensure that the lubricating oil is maintained at the desired temperature, even while the engine is not running. Lubrication oil is kept warm

by using a thermostatically-controlled electric heater. The lubricating oil pump discharge is constantly monitored for pressure.

The system is QA Category I, is designed in accordance with Seismic Category I requirements, and is protected from pipe break effects, as described in Section 3.6. A locked-closed administratively-controlled valve at the fill connection prevents deleterious material from entering the system. Qualified personnel will add lubricating oil to the system using procedures developed and proven satisfactory during the preoperational and start-up testing program.

A failure modes and effects analysis (FMEA) to determine if the instrumentation and controls (I & C) and electrical portions meet the single failure criterion, and to demonstrate and verify how the General Design Criteria and IEEE Standard 279-1971 requirements are satisfied, has been performed on the emergency diesel generator lubrication system. The FMEA methodology is discussed in Section 7.3.2. The results of this analysis can be found in the separate FMEA document (Section 1.7).

9.5.7.4 Inspection and Testing Requirements

The emergency diesel generator lubrication system piping is inspected during construction. Pre-operational tests are performed in accordance with Section 14.2.12. All system components are tested when the diesel generator is tested (Section 8.3). The system is checked periodically for leakage, lube oil deterioration, and water accumulation.

9.5.7.5 Instrumentation Requirements

Control switches with indication are provided locally for the desired operation of the emergency diesel generator rocker arm pre-lube pump, keep-warm and pre-lube pump, and pre-lube oil heater. The rocker arm pre-lube pump can be run manually or automatically. The automatic operation is controlled by a emergency diesel generator speed interlock start of pump on low speed, and stopping of pump on high speed diesel generator. The keep-warm and pre-lube pump can be run continuously (manually) and will be shunt tripped upon energizing diesel generator start circuit 1 or 2. The pre-lube oil heater is a thermostatically-controlled heater that can be energized manually if the keep-warm and pre-lube pump is running. The heater can be operated automatically and is energized provided the keep-warm and pre-lube pump is running, the emergency diesel generator lube oil temperature is not high, and the emergency diesel generator speed is not high.

Annunciation is provided locally and actuates a common trouble annunciator in the main control room for the following conditions: lube oil pressure low, low-low, and extreme low, lube oil temperature high and low, rocker arm lube oil reservoir level high, lube oil sump level high and low, and emergency diesel generator crank case

pressure high. The previously mentioned conditions are also monitored by the BVPS-2 computer. Lube oil temperature and pressure interlocks will automatically shut down the emergency diesel generator only during the test mode of operation. The other conditions mentioned are for annunciation only and are not associated with the emergency diesel generator trip circuit in any mode of operation.

9.5.8 Emergency Diesel Generator Combustion Air Intake and Exhaust System

9.5.8.1 Design Bases

The emergency diesel generator combustion air intake and exhaust system is designed in accordance with the following criteria:

1. General Design Criterion 2, as it relates to the ability of structures housing the system and system components to withstand the effects of natural phenomena (for example, earthquakes, tornadoes, hurricanes, and floods).

2. General Design Criterion 4, with respect to structures housing the systems and the system components being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.

3. General Design Criterion 5, as it relates to shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 17, as it relates to the capability of the emergency diesel generator combustion air intake and exhaust system to meet independence and redundancy criteria.

5. Regulatory Guide 1.26, as it relates to quality group classification of the system components. This system is QA Category I, Safety Class 3.

6. Regulatory Guide 1.29, as it relates to the seismic design classification of system components. This system is designed in accordance with Seismic Category I requirements.

7. IEEE Standard 387-1972, as it relates to the design of the emergency diesel generator combustion air intake and exhaust system for qualification to a mild environment as referenced in Section 3.11.

8. Regulatory Guide 1.9, as it relates to the design of the emergency diesel generator combustion air intake and exhaust system.

9. Regulatory Guide 1.115, as it relates to the protection of structures, systems, and components important to safety from the effects of turbine missiles.

10. Regulatory Guide 1.117, as it relates to the protection of structures, systems, and components important to safety from the effects of tornado missiles.

11. Branch Technical Position ASB 3-1 and MEB 3-1, as they relate to protection against postulated piping failures, breaks, and leakage locations inside and outside the containment.

12. Each emergency diesel generator is provided with an independent and reliable combustion air intake and exhaust system. The system is sized and physically arranged such that no degradation of engine function is experienced when the diesel generator set is required to operate continuously at the maximum power output.

13. The combustion air intake system is provided with an air filter capable of reducing airborne particulate material over the entire time period that emergency power is required. The combustion air is taken directly from outside the building with the air inlet 27 feet above ground level.

14. Suitable design precautions are taken to preclude degradation of the diesel engine power output due to exhaust gases and other diluents that could reduce the oxygen content below acceptable levels.

15. The total air intake and exhaust system pressure losses shall not exceed the maximum pressure losses specified by the diesel generator manufacturer.

16. NUREG/CR-0660 (USNRC 1979), Enhancement of Onsite Emergency Diesel Generator Reliability.

17. Diesel Engine Manufacturers Association (DEMA) Standards, as it relates to the design of the combustion air intake and exhaust system.

9.5.8.2 System Description

The emergency diesel generator combustion air intake and exhaust system is shown on Figure 9.5-12.

The emergency diesel generator combustion air intake and exhaust system is located in the diesel generator building, as shown on Figure 3.8-43. The building is Seismic Category I, missile-protected, and above the probable maximum flood level.

Each emergency diesel generator is provided with an air filter of the dry type, an air intake silencer (of the in-line type), and an exhaust silencer. The pressure losses through the emergency diesel generator combustion air intake and exhaust system do not exceed the manufacturer's recommendation, taking into consideration the piping, silencers, and intake and exhaust structures. Combustion air intake for each diesel engine is from outside the diesel engine generator building and is separated from the exhaust such that intake air will not be diluted or contaminated by exhaust products (Figure 3.8-43). This arrangement precludes the potential of fire extinguishing gases and combustion products from being drawn into the combustion air intake system.

The emergency diesel generator combustion air intake is provided with a downward oriented low velocity air inlet plenum equipped with a screened opening. This precludes direct entrainment of precipitation into the combustion air intake during either standby or operating conditions. Dust is prevented from accumulating within the combustion air intake during standby conditions by the same oriented intake plenum. During diesel operation under conditions of high atmospheric dust concentrations, the dry media intake filter intercepts particulate matter before it reaches the diesel combustion chambers. Surveillance will be performed during diesel monthly availability testing (Section 8.3) to ensure diesel generator availability on demand.

The emergency diesel generator exhaust is equipped with a normally open low point drain. The exhaust outlet is at the roof level of the diesel generator building and is protected by a concrete hood (Figure 3.8-43). This design will protect the exhaust from abnormal climatic conditions. Running of the diesel generator for availability testing will blow collected dust out of the exhaust.

9.5.8.3 Safety Evaluation

The emergency diesel generator combustion air intake and exhaust system provides the required air to the diesel engine for combustion and an acceptable method of expelling the gaseous exhaust products to the atmosphere.

The emergency diesel generator will be operated in accordance with the recommendations of NUREG/CR-0660 (USNRC 1979) as it pertains to the combustion air intake and exhaust system.

The emergency diesel generator exhaust ductwork terminates outside the diesel generator building in a missile-protected area. The piping which is exposed to atmospheric conditions is protected from clogging due to ice and snow.

The emergency diesel generator combustion air intake and exhaust system is designed to remain operable during a LOOP (Section 8.3). The system is QA Category I and is designed in accordance with

Seismic Category I requirements. There are no active components in the system.

The emergency diesel generator combustion air intake and exhaust system is designed so that failure of any one component will not result in the loss of function of more than one diesel generator. The loss of one diesel generator and its associated load group does not prevent safe shutdown of the plant (Section 8.3). Thus, failure of any one component of the emergency diesel generator combustion air intake and exhaust system does not preclude safe shutdown of the plant following a LOCA and a LOOP.

9.5.8.4 Inspection and Testing Requirements

The emergency diesel generator combustion air intake and exhaust system is inspected for leaks and blockage during construction, with pre-operational testing and periodical testing thereafter to ensure that components of the system operate properly. These inspections are normally accomplished during test runs for the diesel engines. Air filters are replaced periodically. Details of in-service inspections are given in Section 6.6. Pre-operational tests are performed as described in Section 14.2.12.

9.5.8.5 Instrumentation Requirements

A pyrometer with a selector switch is provided at the engine to indicate cylinder and turbocharger exhaust temperatures. In addition, a manometer is supplied in the intake system downstream of the air filter to enable periodic monitoring of filter pressure drop.

9.5.9 Reactor Plant Gas Supply System

The reactor plant gas supply system consists of a high pressure and a low pressure nitrogen supply system.

9.5.9.1 Design Bases

The reactor plant gas supply system (Table 9.5-4) design is based on the following:

1. To supply nitrogen to plant systems for the purpose of pressurization, gas content control, or providing a purge and/or diluent medium. The BVPS-2 plant requirements are shown in Table 9.5-5.

2. The portion of the high pressure nitrogen header from and including the outer containment penetration isolation valve to the safety injection accumulators is designed to ASME Section III, Class 2. The portion of the high pressure header from the BVPS-1 connection to the outer containment penetration isolating valve and the entire low pressure N_2 header are designed as NNS class.

9.5.9.2 System Description

Nitrogen is supplied to manifolds that distribute the gas to the components described as follows. Nitrogen is supplied from a nitrogen tank truck located at any tube trailer station. Stations are provided at both BVPS-1 and BVPS-2. The nitrogen tank truck which can supply high pressure gaseous nitrogen to both BVPS-1 and BVPS-2 also provides low pressure gaseous nitrogen through a pressure regulating valve.

The nitrogen system is comprised of two subsystems, a high pressure system and a low pressure system. They are designed to provide an adequate supply of nitrogen, of suitable quality and pressure, for normal nitrogen requirements to various components (Table 9.5-5).

High pressure nitrogen is supplied at approximately 1,500 psig from the nitrogen tank truck. A pressure control valve in the BVPS-2 header maintains downstream system pressure at 640 psig. The nitrogen is supplied at this pressure to the safety injection accumulators to maintain the pressure necessary for accumulator operation. Two redundant, Class 1E solenoid-operated isolation valves are located in the high pressure header. These valves are remotely operable for pressurizing the accumulators, as required. Redundant venting capability is also provided for the accumulators by use of safety grade valves and piping, as described in Sections 9.5.9.3 and 6.3, which are used during safety grade cold shutdown conditions. The high

pressure nitrogen line penetrating the containment structure contains an air-operated containment isolation valve outside and inside the containment structure. The system Safety Class 2 boundary begins at the outer containment isolation valve. This portion of the system meets the containment isolation requirements of Section 6.2.4 and is described in detail in that section.

The low pressure nitrogen header is supplied through a pressure regulating valve from the high pressure nitrogen header at 150 psig. Low pressure nitrogen is supplied to the steam generators via the blowdown lines through a flow measuring instrument for the purpose of chemical mixing during wet layup. Nitrogen is also supplied at low pressure to the steam generators to provide a nitrogen blanket during dry layup conditions. A steam generator evacuation pump is provided to produce a vacuum in the steam generators before the nitrogen injection. Nitrogen is also supplied to the volume control tank, the pressurizer relief tank, and the primary drains transfer tank for pressure control. In addition, low pressure nitrogen is supplied to BVPS-1.

9.5.9.3 Safety Evaluation

All nitrogen gas storage is located at the tube trailer stations, with the gas being provided via piping connections. The only safety-related portions of the system are the containment penetration piping and valves, which are designed in accordance with Safety Class 2, Seismic Category I requirements, and the nitrogen piping connecting to the safety injection accumulators, which are used for supply during normal operation and safety grade venting for cold shutdown capability. The supply lines to the accumulators are Safety Class 2, Seismic Category I, from the containment isolation valves to the accumulators. There are redundant, normally closed valves on the supply line to each accumulator plus two redundant vent lines to the containment atmosphere with fail closed valves. These valves are normally closed to protect and maintain the pressure in the accumulators for emergency core cooling system injection. The valves are safety grade, Class lE, and environmentally qualified, as described in Section 3.11, to allow opening of the supply line and vent path for depressurizing the accumulators prior to cold shutdown operations. The piping and valve arrangement is such that all three accumulators can be vented following any postulated single failure.

All other portions of the nitrogen system are NNS class. Relief valves are provided in the high and low pressure headers with set pressure below the design pressure of the system.

9.5.9.4 Inspection and Testing Requirements

Pressure indication on the gas supply system and periodic checks of the gas available ensure adequacy and availability of these gases to the required systems. Pre-operational tests are performed as described in Chapter 14.

9.5.9.5 Instrumentation Requirements

Pressure regulating valves, pressure indicators, and relief valves are provided locally for the nitrogen system.

Annunciation is provided in the main control room for low pressure in the high pressure nitrogen supply header and this alarm is monitored by the BVPS-2 computer system.

9.5.10 Containment Vacuum System

The containment vacuum system establishes and maintains the reactor containment internal pressure during normal operations. The system is nonsafety-related, except for the suction lines inside containment, the piping and valves required for containment isolation, and the piping related to the containment atmosphere radiation monitor (Section 11.5).

9.5.10.1 Design Bases

The containment vacuum system is designed to perform the following functions:

1. Reduction of the containment atmosphere pressure prior to plant start up (Mode 4 entry).

2. Removal of air from the containment atmosphere, which compensates for containment structure air inleakage during normal operation.

3. Provide piping connections to the containment for the containment atmosphere radioactivity monitor and the combustible gas control system.

Portions of the containment vacuum system which are safety-related (piping, valves, and controls for inside containment suction, containment penetrations, and the radiation monitor) are designed to Safety Class 2 or 3 and Seismic Category I requirements. The balance of the system, which is designated NNS class and located in Seismic Category I areas, is designed to Seismic Category II requirements.

9.5.10.2 System Description

The containment vacuum system consists of a containment vacuum ejector, two containment vacuum pumps, a containment atmosphere radiation monitor (Section 12.3), piping, valves, and instrumentation. The design parameters for the principal system components are described in Table 9.5-6.

The containment vacuum ejector removes air from the containment structure prior to initial plant operation and after subsequent refueling operations. Operation of the ejector continues until the desired containment operating pressure is reached, as indicated in the control room on the main board. The motive medium for the ejector is 150 psig saturated steam, which is supplied at 5,700 lb/hr from the auxiliary steam system (Section 10.4.10). The containment vacuum ejector discharges directly to the atmosphere. No discharge radiation monitoring is required as air ejector containment isolation valves will be closed during power operation. The containment vacuum ejector will be secured with administratively controlled, locked closed, manual valves prior to raising the reactor cooling system temperature above 200°F.

During normal operation the containment pressure is maintained by periodically operating one of the containment vacuum pumps, each of which has a capacity of approximately 45 SCFM. The vacuum pumps are manually operated from the main control room by control switches with indicating lights from the main control room. The common discharge of the two containment vacuum pumps is directed to the BVPS-1 gaseous waste disposal (GWD) system via the BVPS-2 GWD sweep gas subsystem discharge header. Redundant charcoal and high efficiency particulate air (HEPA) filters and GWD blowers vent to the atmosphere through the process vent on top of the BVPS-1 cooling tower. Each containment vacuum pump is capable of removing containment structure air inleakage during normal operation and of maintaining containment atmosphere pressure in the operating range (Section 6.2.1).

The suction piping inside the containment, and the containment penetration piping and isolation valves up to the second valve outside containment, are also used as part of the post-accident combustible gas control system (Section 6.2.5). The design of the containment penetration piping and valves is described in Section 6.2.4. The containment atmosphere radiation monitor is described in Section 11.5.

9.5.10.3 Safety Evaluation

The maximum and minimum containment atmosphere pressures achieved during plant operation varies as a function of service water temperature and ambient air temperature in the containment structure. The containment vacuum pumps are operated, remote-manually from the main control room, to maintain containment atmosphere pressure within the Technical Specifications, as set by the post-accident containment analysis described in Chapter 6.

Excessive depressurization of the containment structure by misoperation or failure of the containment vacuum system is not considered credible. The containment vacuum pumps have a relatively small capacity when compared to the containment structure free volume. Uninterrupted operation of a containment vacuum pump for greater than 4 days would be required to lower

the containment atmosphere pressure to the minimum design pressure of 8.0 psia, assuming no air temperature change. A low suction pressure signal will stop the pumps by 9.0 psia. Continuous containment pressure monitoring is available in the main control room using pressure transmitters.

The air ejector is used for reducing the containment atmosphere pressure during start-up operations. Plant start-up is performed in accordance with detailed written procedures, which include operation of the steam ejector system. The establishment of containment pressure is governed by administrative procedures and is closely supervised by personnel responsible for plant start-up.

This close supervision and monitoring assures that the normal operating pressure is not reduced below that permitted by the Technical Specifications (Chapter 16). In the unlikely event containment pressure is reduced below the value defined by the Technical Specifications, a low pressure alarm will annunciate in the main control room, notifying the operator that the low pressure condition exists. Because of the slow rate of depressurizing the containment, there will be sufficient time to take corrective action (take the ejector out of service). When the normal containment operating pressure is reached, the steam jet ejector will be secured with locked-closed manual valves under administrative control and will not be used during normal plant operation.

The containment vacuum ejector is shut down when the containment atmosphere pressure operating range is reached and a containment vacuum pump is started. At this time, the inside containment isolation valve on the containment vacuum ejector suction line and the outside containment isolation valve will be locked closed. Excessive depressurization during initial operating of the ejector and inadvertent ejector operation during normal plant operation would be possible only with a violation of operation procedures, disregard of the low containment air atmosphere pressure alarm, and removal of the locking devices on the ejector suction valves. In addition, a long period of inadvertent operation is required before any significant pressure reduction is seen. The discharge of the containment vacuum pumps is directed to BVPS-1, where redundant pumps and filters are used such that no single failure of BVPS-1 equipment will prevent the use of the BVPS-2 containment vacuum system.

9.5.10.4 Inspection and Testing Requirements

The containment vacuum ejector is not required during plant operation. Because it is a passive mechanical device having no moving parts, periodic testing of the ejector is not required.

The containment vacuum pumps are operated prior to fuel loading to demonstrate adequate capacity to remove inleakage. During normal plant operation, routine surveillance is performed to ensure operability of the pumps on the applicable start signal. Testing of the containment penetration isolation valves is discussed in Section 6.2.4. Pre-operational tests are performed as described in Chapter 14.

9.5.10.5 Instrumentation Requirements

Control switches with indicating lights are provided in the main control room for the manual operation of the containment vacuum pumps. These pumps stop automatically from a low suction pressure signal.

Control switches with indicating lights are provided in the main control room for the containment vacuum system isolation valves. These valves close automatically on a containment isolation signal phase A (CIA).

A control switch with indicating lights is provided in the main control room for the steam isolation valve to the containment vacuum ejector.

Indication is provided in the main control room for reactor containment pressure, reactor containment moisture, and reactor containment temperature.

A flow totalizer indicator is provided in the main control room for the containment vacuum pumps discharge flow. This indicator is used in the containment structure leakage rate monitoring system.

Annunciation is provided in the main control room for the containment vacuum pumps auto-stop, containment air pressure high/low, and containment air temperature high/low. These are also monitored by the BVPS-2 computer system.

Control switches with indicating lights are provided in the main control room for the reactor containment pressure isolation valves. A pressure recorder is provided in the main control room for the reactor containment pressure.

Tables for Section 9.5

TABLE 9.5-1

EMERGENCY DIESEL GENERATOR
FUEL OIL STORAGE AND TRANSFER SYSTEM
COMPONENT DESIGN PARAMETERS

Component	Design Parameters
Storage Tank	
Quantity	1
Capacity (gal)	58,000
Day Tank	
Quantity	1
Capacity (gal.)	1,100
Fuel Transfer Pumps	
Quantity	2
Head (ft)	40
Flow (gpm)	40
"Y" Type Strainers	
Quantity	2
Mesh Size	200 mesh per ASTM E437 0.0021 dia wire 0.0029 average opening plain square weave
Engine-Mounted Fuel Oil Pumps	
Engine-Driven	
Quantity Per Engine	1
Mark Numbers	2EGF*P23A,B
Capacity (gpm)	Approximately 13.4
System Pressure (psig)	Approximately 30

TABLE 9.5-1 (Cont)

Component	Design Parameters
Motor-Driven	
Quantity Per Engine	1
Mark Numbers	2EGF*P22A,B
Capacity (gpm)	Approximately 13
System Pressure (psig)	Approximately 30
Motor Characteristics	2 HP 125 V dc
Source of Power	2EGF*P22A, PNL*DC2-07
	2EGF*P22B, PNL*DC2-06

TABLE 9.5-2

EMERGENCY DIESEL GENERATOR
FUEL OIL STORAGE AND TRANSFER SYSTEM
MAJOR OIL DISTRIBUTORS WITHIN 40 MILES OF SITE

Supplier	Distance from Site (mi)	Normal Supply on Hand (gal)	Tank Truck Capacity (gal)	Time Required To Make Initial Delivery (hr)
Ashland	8	200,000 to 2,000,000	8,000 to 9,200 (6,800 max due to weight limit)	1
Texaco	18	945,000 (min)	7,300	1-1/4
Gulf	40	6,000,000 (min)	7,200	2
Universal	25	50,000	8,000 (7,300 max due to weight limit)	8 to 10
Mobil	4	1,300,000 (min)	7,000	3/4

TABLE 9.5-3

EMERGENCY DIESEL GENERATOR INTERCOOLER AND JACKET WATER COOLING SYSTEMS PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Component	Design Parameter
Cooling water system capacity (gal)	600
Expansion tank capacity (gal)	100
Heat exchangers per engine:	
Jacket water heat exchanger	1
Intercooler water heat exchanger	1
Cooling water system temperature:	
Maximum (°F)	170
Minimum (°F)	95
Service water	
Minimum raw water flow required at 89°F water temperature to each engine (gpm)	625
Service water temperature rise at 625 gpm	
Jacket water (°F)	15.5
Intercooler water (°F)	7.3
Total rise (°F)	22.8
Intercooler water cooling system	
Engine-driven cooling water pump capacity (gpm)	950
Intercooler water heat exchanger	
Inlet temperature (°F)	112.6
Outlet temperature(°F)	103.0
Heat exchanger design capacity (Btu/hr)	4,545,000
Heat exchanger operating capacity (Btu/hr)*	3,359,000
Jacket water cooling system	
Engine-driven cooling water pump capacity (gpm)	850

TABLE 9.5-3 (Cont)

Component	Design Parameter
Jacket water heat exchanger	
Inlet temperature (°F)	152.7
Outlet temperature (°F)	135.0
Heat exchanger design capacity (Btu/hr)	7,365,000
Heat exchanger operating capacity* (Btu/hr)	6,518,000
Jacket water keep-warm system	
Keep-warm pump capacity (gpm)	50
Keep-warm electric heater capacity	30 kW, 460 V, 3 phase
Keep-warm pump motor	1 1/2 hp, 60 Hz, 460 V, 3 phase
Lube oil heat exchanger	
Flow (gpm)	400
Shell side	
Lube oil temperature in (°F)	160.0
Lube oil temperature out (°F)	143.5
Tube side	
Jacket water temperature in (°F)	135
Jacket water temperature in (°F)	138.5
Heat exchanger design capacity (Btu/hr)	1,395,000
Heat exchanger operating capacity* (Btu/hr)	1,268,000
Governor lube oil cooler	Negligible

NOTE:

*With engine operating at rated load

TABLE 9.5-4

REACTOR PLANT GAS SUPPLY SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Component	Design Parameters
Steam generator evacuation pump	
Capacity	150 scfm at 2.0 psia and 60°F
Discharge temperature	80°F
Motor	460 V, 3-phase, 60 Hz, totally enclosed, fan-cooled

TABLE 9.5-5

REACTOR PLANT GAS SUPPLY SYSTEM
SUMMARY OF NITROGEN REQUIREMENTS

Nitrogen Header Pressure	Supplied to	Supply Requirements (scf)	Requirement Basis
Low	Steam generator blanketing - dry layup	8,350	Placing one steam generator in dry layup at 5 psig (does not include subsequent leakage)
Low	Auxiliary building hose connections - gas waste system purge	600	One purge of gaseous system performed approximatley once each year. One purge = 3 volumes (system volume = 200 ft^3)
Low	Primary drains transfer tank	120	Floating tank with nitrogen blanket at 1/2 full level to a pressure of 15 psi
Low	Pressurizer relief tank	964	Purge and fill tank
Low	Volume control tank	780	Refueling operation
Low	Steam generator blowdown for chemical mixing	1,344	Mixing of chemicals in one steam generator wet layup
Low	Hydrogen analyers	100	Monthly purge for calibration
High	Safety injection accumulators	120,000	Initial charge of three accumulators and any subsequent charge
		544	Makeup at low level alarm

TABLE 9.5-6

CONTAINMENT VACUUM SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Component	Design Parameters
Containment Vacuum Pumps	
Quantity	2
Capacity (each)	45 cfm
Operating pressure	12.8 - 14.2 psia
Design pressure	14.7 psia (maximum) 8.0 psia (maximum)
Operating temperature	65 - 104°F
Design temperature	140°F
Containment Vacuum Ejector	
Quantity	1
Capacity	15,000 cfm at 14.7 psia
Operating pressure (air suction)	12.8 - 14.7 psia
Operating pressure (steam)	140 psig
Design pressure	150 psig
Operating temperature (air)	65 - 104°F
Operating temperature (steam)	360°F

TABLE 9.5-7

EMERGENCY DIESEL GENERATOR COOLING WATER SYSTEM
LEAKAGE SUMMARY PER DIESEL ENGINE*

	Jacket Water System	
	gph	gal/7 days
Piping and valves	0.02	3.36
Pump seals	0.06	10.08
Orifices, gasket (both sides)	0.00	0.00
Instrumentation	0.00	0.00
Turbocharger and piping	0.01	1.68
Subtotals	0.09	15.12

	Intercooler Water System	
	gph	gal/7 days
Piping and valves	0.03	5.04
Pump seal	0.06	10.08
Injectors and flow gauges	0.02	3.36
Instrumentation	0.00	0.00
Subtotals	0.11	18.48
Total Leakage	0.20	33.6

NOTE:

*Leakages provided by diesel engine manufacturer.

TABLE 9.5-8

EMERGENCY DIESEL GENERATOR LUBE OIL SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Component	Design Parameter
Rocker Arm Lube Oil System	
Engine-Driven Pump	
Capacity	2.2 gpm at 20 psi
Motor-Driven Pump	
Capacity (Approx.)	2-3 gpm at 20 psi
Motor	1/2 hp, 3-phase, 60 Hz 460 V ac Class 1E Power
Keep-Warm and Pre-Lube System	
Motor Driven Pump	
Capacity	50 gpm with built-in relief at 120 psi
Motor	7 1/2 hp, 3-phase, 60 Hz 460 V ac Class 1E Power
Keep-Warm Heater	15 kW, 3-phase, 60 Hz 460 V ac Class 1E Power
Engine-Driven Lube Oil Pump	
Capacity	50-55 gpm with relief set at 110/115 psi

TABLE 9.5-9

CRANKCASE VACUUM PUMPS
DESIGN PARAMETERS

Component	Design Parameters
Quantity	2
Capacity (each)	600 cfm @ 3″ H_2O
Motor	1 hp, 3 phase, 60 Hz, 460 volts, Class 1E power
Mark Numbers	2EDG*P21A&B

TABLE 9.5-10

EMERGENCY DIESEL GENERATOR AIR STARTING SYSTEM
PRINCIPAL COMPONENTS AND DESIGN PARAMETERS

Components	Design Parameters
Air Compressors	
Quantity per diesel	2
Start pressure (psig)	395
Stop pressure (psig)	425
Capacity, free air (cfm)	31.3
Motor (hp)	15
Power	460 V, 3 phase, 60 Hz Class 1E power
Air Tanks	
Quantity per diesel	2
Design pressure (psig)	450
Volume (each, ft^3)	74.2
Relief Valves	
Compressor discharge (psig)	450
Air tank (psig)	450
Alarms	
High air temperature alarm (°F)	50

TABLE 9.5-10 (Cont)

Components	Design Parameters
Dryers	
Quantity per diesel	1
Dew point temperature	40°F
Capacity, free air (cfm)	50
Aftercooler	
Quantity per diesel	1
Capacity, free air (cfm)	Later
Filters	
Aftercooler discharge, particulate	3 micron
Aftercooler discharge, coalescing	.7 micron
Dryer discharge, particulate	.3 micron

TABLE 9.5-11

DIESEL ENGINE
AIR START TEST DATA*

Start	2EGS*EG2-1				2EGS*EG2-2			
	Left Bank Air Start South Air Tank		Right Bank Air Start North Air Tank		Left Bank Air Start South Air Tank		Right Bank Air Start North Air Tank	
	Pressure (psig)	Time (sec)	Pressure (psig)	Time (sec)	Pressure (psig)	Time (sec)	Pressure (psig)	Time (sec)
1	430	9.1	428	8.67	429	8.9	428	8.5
2	390	8.99	390	8.62	394	9.0	396	8.7
3	355	9.3	360	9.0	362	9.15	369	8.9
4	330	9.11	330	9.41	336	9.6	345	9.0
5	305	9.5	305	9.52	311	9.6	321	9.1
6	280	9.89	280	9.62	288	9.7	300	9.5
7	260	10.2	258	10.19	267	10.2	280	9.6
8	238	10.55	235	10.32	245	10.4	262	9.7
9	220	11.13	215	10.9	226	11.1	243	10.0
10	202	12.26	195	12.72	208	11.2	225	10.5
Last Start	Start No. 12 168	16.1	Start No. 12 157	16.3	Start No. 12 177	12.6	Start No. 14 165	11.8

*Tests were performed using one bank of cylinders and one tank. A start is defined as a one bank start with one tank. Inasmuch as both tanks are equal inside, twice as many starts can be achieved.

NOTE:

Reference Source: Contract Test Reports First and Second Diesel Generator Units 11-206147A and B.

REV. 21

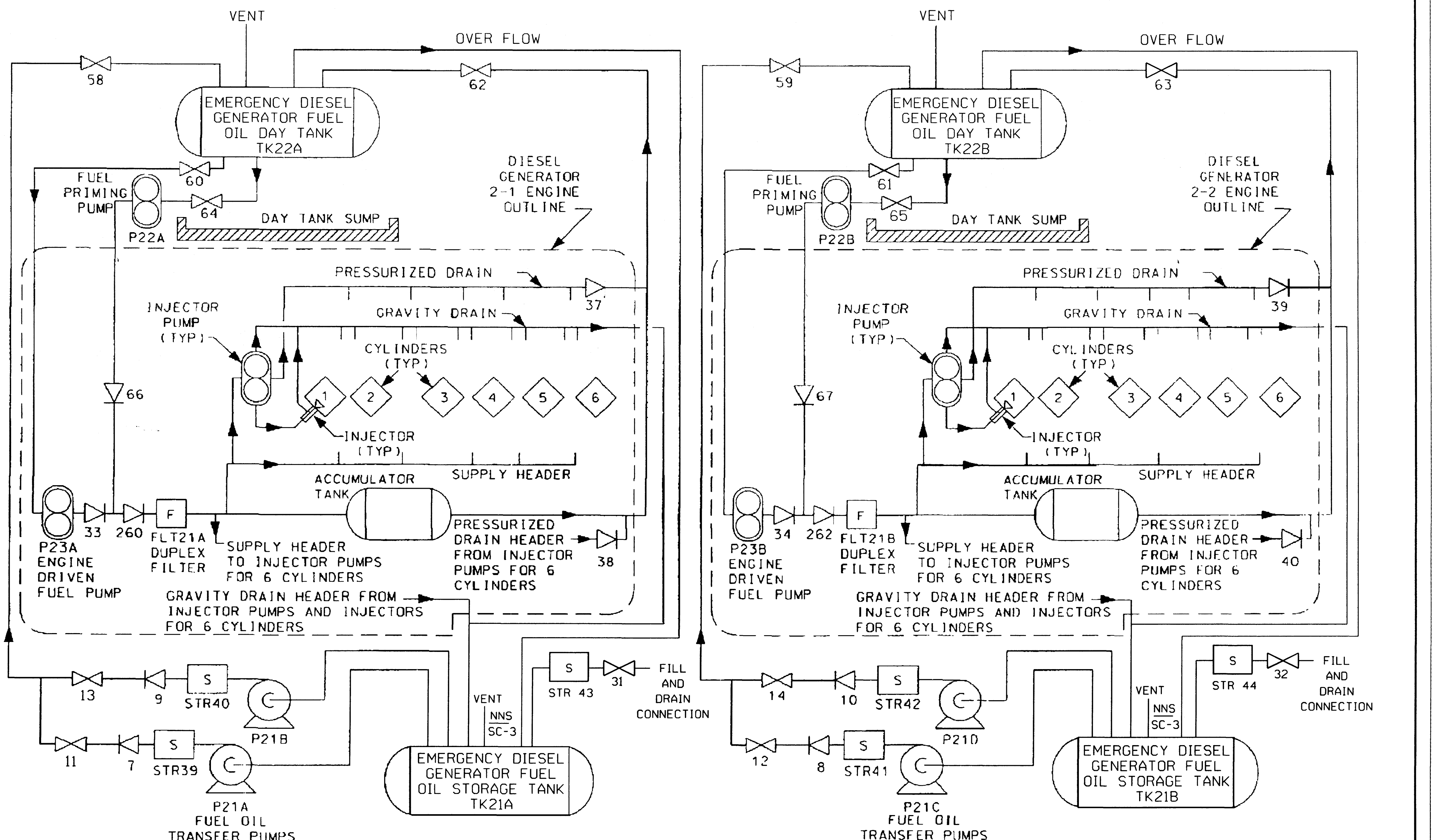


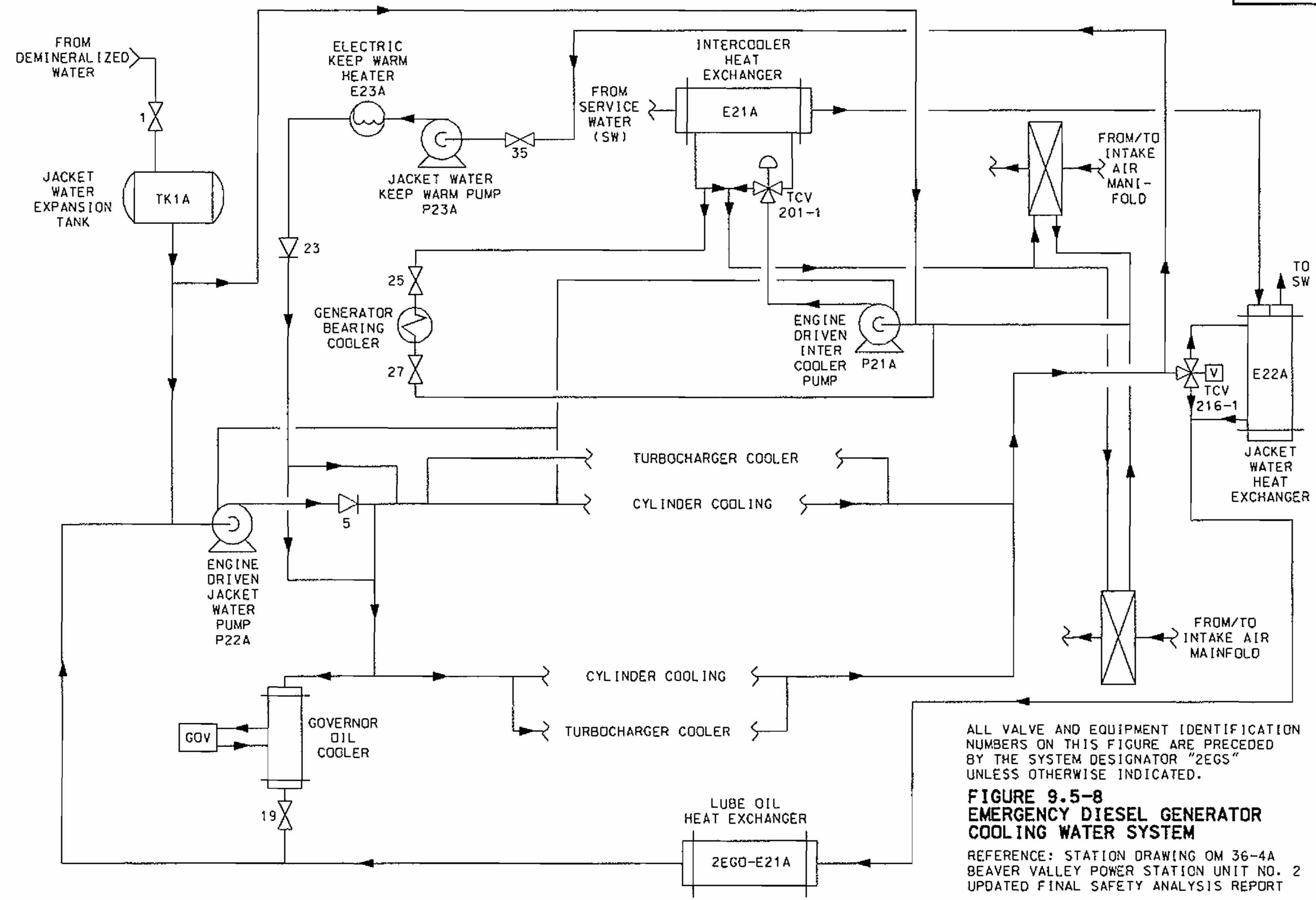
FIGURE 9.5-7

EMERGENCY DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

REFERENCE: STATION DRAWING OM 36-1

ALL PIPING SHOWN IS ASME III EXCEPT PIPING SHOWN WITHIN THE ENGINE OUTLINES OR UNLESS OTHERWISE INDICATED

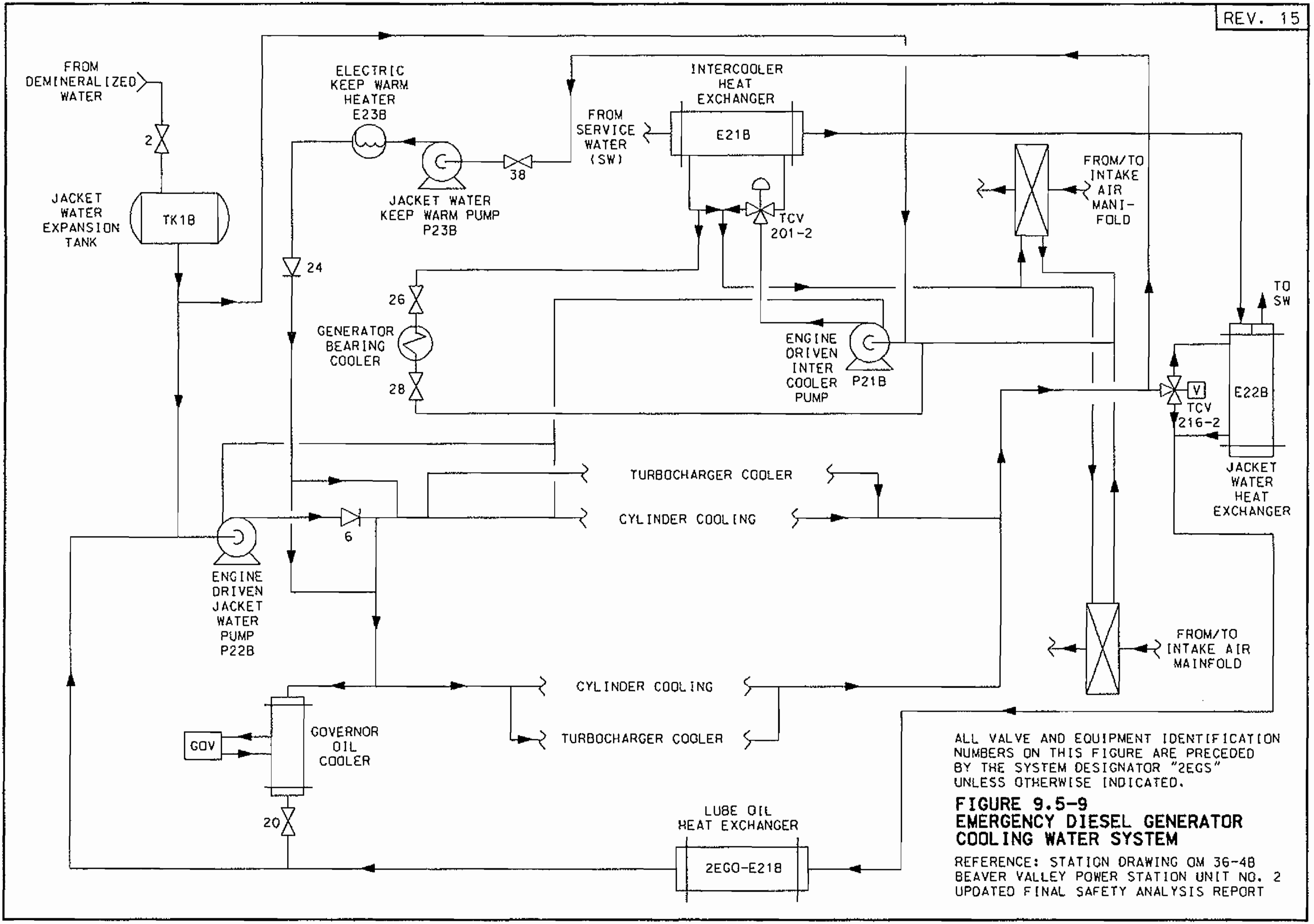
ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2EGF" UNLESS OTHERWISE INDICATED.



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2EGS" UNLESS OTHERWISE INDICATED.

FIGURE 9.5-8
EMERGENCY DIESEL GENERATOR COOLING WATER SYSTEM

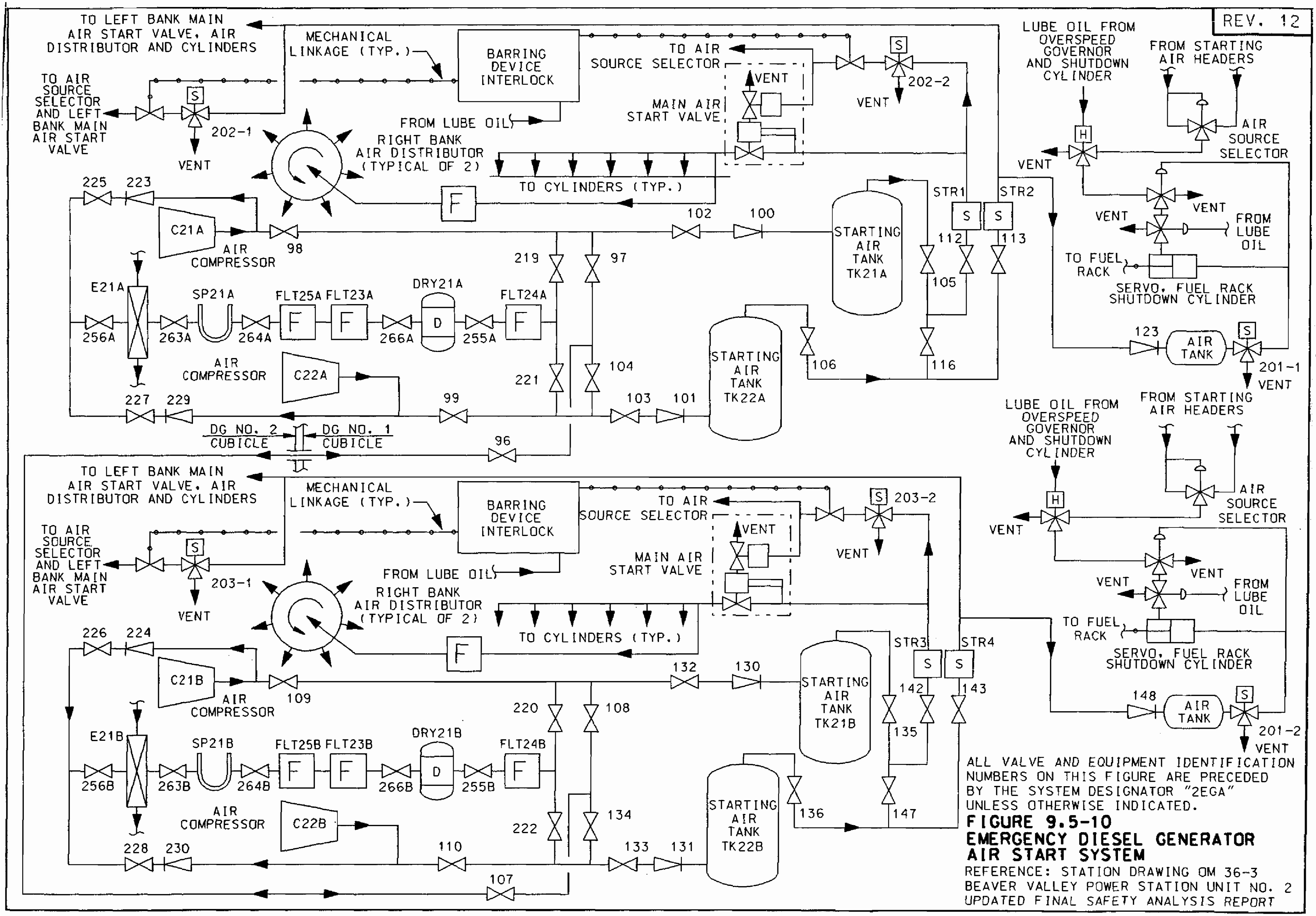
REFERENCE: STATION DRAWING OM 36-4A
BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2EGS" UNLESS OTHERWISE INDICATED.

FIGURE 9.5-9
EMERGENCY DIESEL GENERATOR COOLING WATER SYSTEM

REFERENCE: STATION DRAWING OM 36-4B
BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT



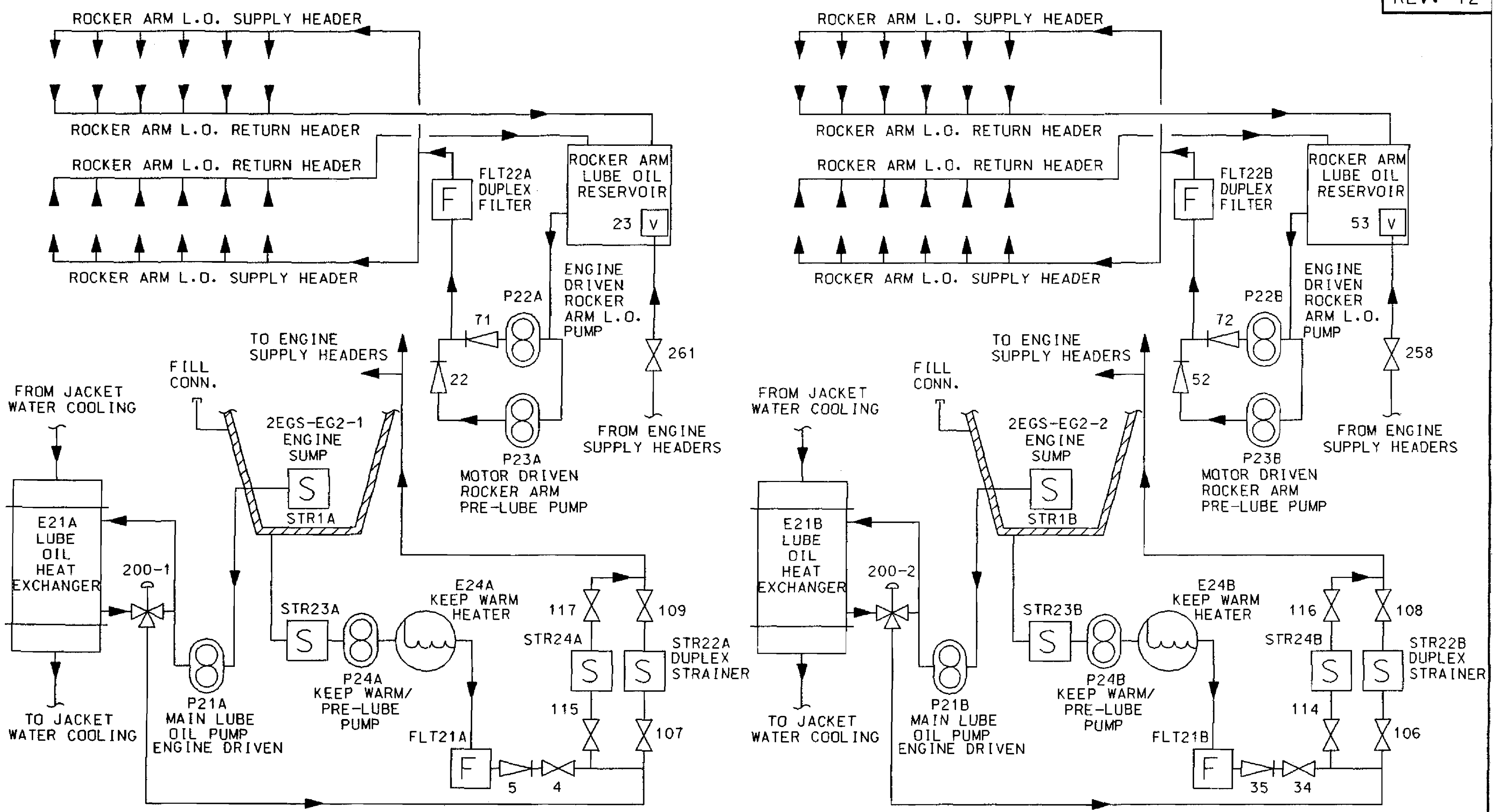
ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2EGA" UNLESS OTHERWISE INDICATED.

FIGURE 9.5-10
EMERGENCY DIESEL GENERATOR AIR START SYSTEM

REFERENCE: STATION DRAWING OM 36-3

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT

REV. 12



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2EGO" UNLESS OTHERWISE INDICATED.

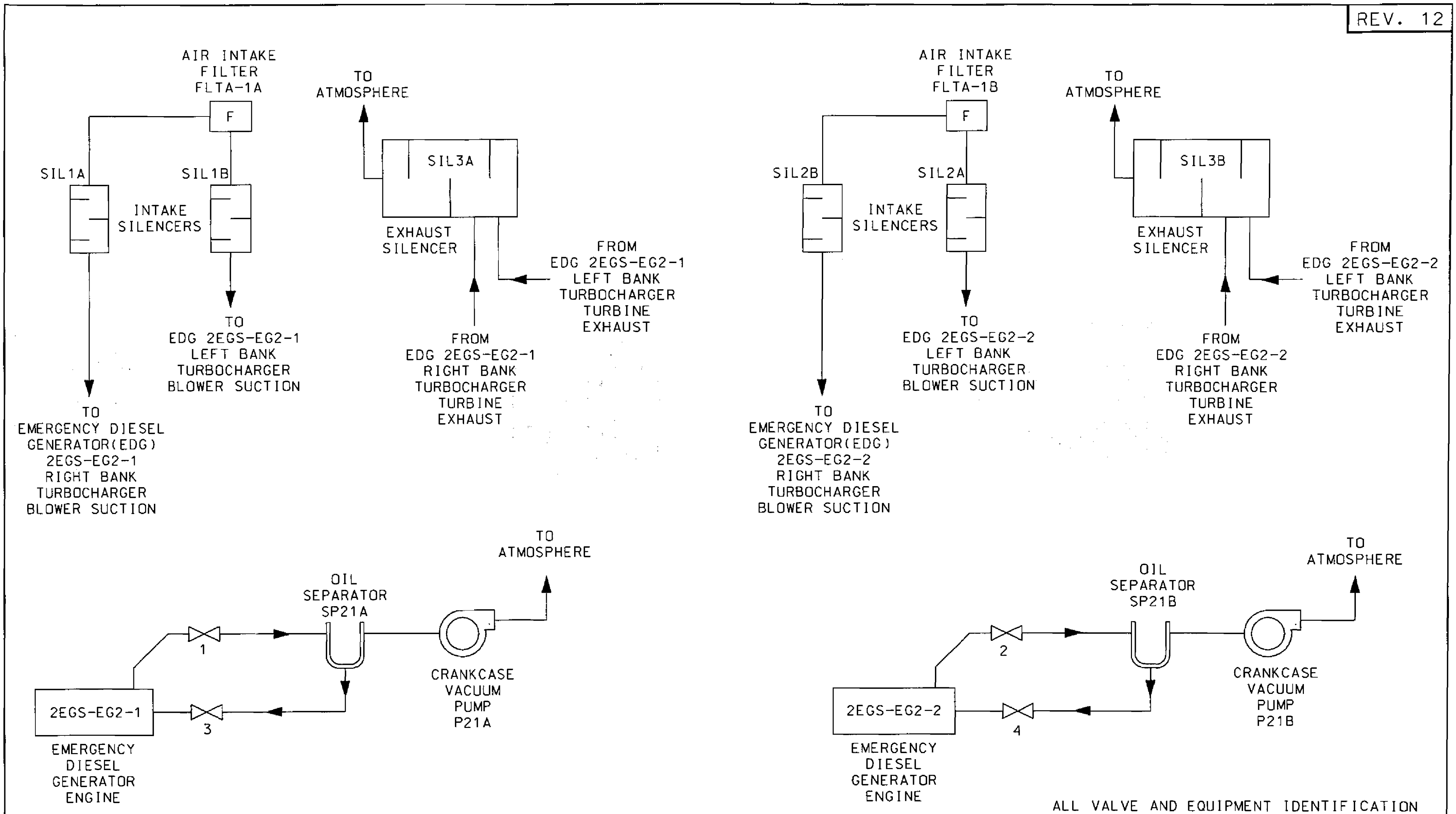
LEGEND

L.O. LUBE OIL
WTR WATER

FIGURE 9.5-11
EMERGENCY DIESEL GENERATOR LUBRICATION SYSTEM

REFERENCE: STATION DRAWINGS OM 36-5A AND B

BEAVER VALLEY POWER STATION UNIT NO. 2
UPDATED FINAL SAFETY ANALYSIS REPORT



ALL VALVE AND EQUIPMENT IDENTIFICATION NUMBERS ON THIS FIGURE ARE PRECEDED BY THE SYSTEM DESIGNATOR "2EDG" UNLESS OTHERWISE INDICATED.

FIGURE 9.5-12
EMERGENCY DIESEL GENERATOR COMBUSTION AIR INTAKE, EXHAUST AND VACUUM SYSTEM

REFERENCE: STATION DRAWING OM 36-2
BEAVER VALLEY POWER STATION UNIT NO.2
UPDATED FINAL SAFETY ANALYSIS REPORT