C.I.9. Auxiliary Systems

Chapter 9 of the final safety analysis report (FSAR) should provide information about the facility's auxiliary systems. In particular, this chapter should identify systems that are essential for safe shutdown of the plant or for protection of the health and safety of the public. For each system, the description should provide the design bases for the system and its critical components, a safety evaluation demonstrating how the system satisfies the design bases, the testing and inspection to be performed to verify system capability and reliability, and the required instrumentation and controls. For systems that have little or no relationship to protecting the public against exposure to radiation, the description should provide enough information to allow the NRC staff to understand the design and operation and their effect on reactor safety, with emphasis on those aspects of design and operation that might affect the reactor and its safety features or contribute to the control of radioactivity.

In addition, the information provided (e.g., a failure analysis) should clearly show the system's capability to function without compromising the safe operation of the plant under both normal operating and transient situations.

Seismic design classifications should be stated with reference to detailed information provided in Chapter 3, where appropriate. Radiological considerations associated with operation of each system under normal and accident conditions, where applicable, should be summarized with reference to detailed information in Chapters 11 or 12, as appropriate.

C.I.9.1 *Fuel Storage and Handling*

C.I.9.1.1 <u>New Fuel Storage</u>

C.I.9.1.1.1 *Design Bases*

Provide the design bases for new fuel storage facilities, including such considerations as quantity of fuel to be stored, means for maintaining a sub-clinical array, the degree of subcriticality provided for the most reactive condition possible together with the assumptions used in this calculation, protection from the effects of natural phenomena, and design loadings to be withstood.

C.I.9.1.1.2 *Facilities Description*

Provide a description of the new fuel storage facilities, including drawings, and their location in the station complex.

C.I.9.1.1.3 *Safety Evaluation*

Provide an evaluation of the capability of the new fuel storage facilities to reduce the probability of occurrence of unsafe conditions. This evaluation should include consideration of the degree of sub-criticality, governing codes for design, the ability to withstand design loads and forces, protection from the effects of natural phenomena, and the safety implications related to sharing (for multi-unit facilities). Details of seismic design and testing should be presented in Section 3.7.

C.I.9.1.2 Spent Fuel Storage

C.I.9.1.2.1 *Design Bases*

Provide the design bases for the spent fuel storage facilities, including such considerations as quantity of fuel to be stored, means for maintaining a sub-clinical array, and degree of sub-criticality provided. In addition, this discussion should include the assumptions used in this calculation, circulation of coolant through the storage racks, shielding requirements, design loadings to be withstood, and protection against natural phenomena and internal missiles.

C.I.9.1.2.2 *Facilities Description*

Provide a description of the spent fuel storage facilities, including drawings, and their location in the station complex.

C.I.9.1.2.3 *Safety Evaluation*

Provide an evaluation of the protection of the spent fuel storage facilities against unsafe conditions. This evaluation should include the following considerations:

- degree of sub-criticality
- governing codes for design
- protection against natural phenomena
- ability to withstand design loads and forces
- design features (e.g., weirs and gates) to maintain an adequate coolant inventory under normal and accident conditions
- effectiveness of coolant circulation through the racks in cooling the stored fuel
- pool liner leak collection and control features
- configuration of fuel storage pool and associated handling areas to preclude accidental dropping of heavy objects on spent fuel
- material compatibility requirements
- radiological shielding design including water levels for shielding (details should be presented in Chapter 12)
- ability of the fuel storage racks to withstand accident forces associated with fuel handling
- safety implications related to sharing (for multi-unit facilities)

Additional guidance regarding acceptable design of the spent fuel storage facilities is given in Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis."

C.I.9.1.3 <u>Spent Fuel Pool Cooling and Cleanup System</u>

C.I.9.1.3.1 *Design Bases*

Provide the design bases for the cooling and cleanup system for the spent fuel facilities, including the following considerations:

- pool cleanliness requirements for normal operations
- the heat generation rate of the stored fuel
- the heat removal paths for normal and accident conditions
- protection of essential components against natural phenomena and internal missiles
- the capability of essential components to withstand design loadings
- pool water temperature limits for normal and accident conditions
- provisions to preclude inadvertent or accidental draining or siphoning of pool coolant
- provisions to collect system leakage, and instrumentation to indicate water level and temperature
- radiation levels under normal and anticipated accident conditions

C.I.9.1.3.2 *System Description*

Provide a detailed description and drawings of the cooling and cleanup system, including the instrumentation and alarms.

C.I.9.1.3.3 *Safety Evaluation*

Provide an evaluation of the cooling system, including the following considerations:

- capability to transfer the necessary heat to an ultimate heat sink under normal and accident conditions without exceeding specified spent fuel pool water temperatures
- capability of the makeup water system to maintain adequate pool water level for cooling and shielding requirements under normal and accident conditions
- provision of passive design features to ensure that pool water level will not be inadvertently reduced below the minimum level necessary for adequate cooling and shielding
- the ability to maintain acceptable pool water conditions for fuel handling and to maintain occupational exposure as low as reasonably achievable
- capability to withstand design loads and forces
- protection of essential components from the effects of natural phenomena
- provision of features to collect system leakage
- safety implications related to sharing (for multi-unit facilities)

The radiological evaluation of the cleanup system should be presented in Chapters 11 and 12.

C.I.9.1.3.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the cooling and cleanup system.

C.I.9.1.3.5 *Instrumentation Requirements*

Describe system instrumentation, including instrumentation to indicate water level, temperature, and radiation levels under normal and anticipated accident conditions.

C.I.9.1.4 Fuel Handling System

C.I.9.1.4.1 *Design Bases*

Provide the design bases for the fuel handling system (FHS), including the load handling requirements, handling control features, and provisions to prevent fuel handling accidents.

C.I.9.1.4.2 *System Description*

Provide a description of the FHS, including all components for transporting and handling fuel from the time it reaches the plant until it leaves the plant. Provide an outline of the procedures used in new fuel receipt and storage, reactor refueling operations, and spent fuel storage and shipment. Toward that end, the FSAR should also provide component drawings, building layouts, and illustrations of the fuel handling procedures. Include detailed descriptions and drawings, and provide the design data, seismic category, and quality class for all principal components. Also identify the design codes and standards used for design, manufacture, testing, operation, maintenance and seismic design aspects.

C.I.9.1.4.3 *Safety Evaluation*

Provide an evaluation of the FHS, including the system's capability to preclude unacceptable releases of radiation as a result of mechanical damage to fuel, maintain an adequate degree of sub-criticality, and maintain acceptable shielding during fuel handling. This evaluation should consider the design of components and mechanisms to withstand earthquakes, and interlocks and design features to ensure that fuel handling will be performed within acceptable limits.

C.I.9.1.4.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for FHS subsystems and components, including shop tests, pre-operational tests, and periodic operational tests.

C.I.9.1.4.5 *Instrumentation Requirements*

Describe the system instrumentation and controls, alarms and communication system(s). Include a description of the adequacy of safety-related interlocks to meet the single-failure criterion.

C.I.9.1.5 Overhead Heavy Load Handling System

C.I.9.1.5.1 *Design Bases*

Provide the design bases for the overhead heavy load handling system, including parameters defining the load that, if dropped, would cause the greatest damage; the areas of the plant where the load would be handled; the design of the overhead heavy load handling system; and the operating, maintenance, and inspection procedures applied to the load handling system.

C.I.9.1.5.2 *System Description*

Provide a description of the overhead heavy load handling system, including component drawings, building layouts, and illustrations of special lifting devices. For all principal components, provide the relevant design data, seismic category, and quality class, and identify the design codes and standards used for design, manufacture, testing, operation, maintenance and seismic design aspects.

C.I.9.1.5.3 *Safety Evaluation*

Provide an evaluation of the overhead heavy load handling system, including the following system capabilities:

- Preclude unacceptable releases of radiation through mechanical damage to fuel.
- Prevent damage that could threaten the ability to maintain an adequate degree of subcriticality.
- Prevent damage that could result in uncovering fuel in the reactor vessel or spent fuel pool.
- Prevent damage that alone could result in a loss of essential safe shutdown functions.
- Ensure that components and mechanisms withstand earthquakes.
- Ensure that intervening non-essential structures absorb the energy of load drops to protect underlying essential structures, systems, and components (SSCs).
- Provide interlocks and design features to ensure that heavy load handling will be performed with an acceptably low probability of a load drop that would damage essential SSCs.

C.I.9.1.5.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the overhead heavy load handling system components, including shop tests, pre-operational tests, and periodic operational tests and inspections.

C.I.9.1.5.5 *Instrumentation Requirements*

Describe the system instrumentation and controls, alarms and communication system(s), and the adequacy of safety-related interlocks to meet the single-failure criterion.

C.I.9.2 *Water Systems*

This section of the FSAR should provide discussions of each of the plant's water systems. Because these auxiliary water systems vary in number, type, and nomenclature for various plant designs, the standard format does not assign specific subsection numbers to these system discussions. The applicant should provide separate subsections (numbered 9.2.1 through 9.2.x) for each of the systems.

The following paragraphs provide examples of systems that should be discussed, as appropriate to the individual plant, and identify some specific information that should be provided. These examples are not intended to represent a complete list of systems to be discussed in this section.

C.I.9.2.1 Station Service Water System (Open, Raw Water Cooling Systems)

C.I.9.2.1.1 *Design Bases*

Provide the design bases for the service water system, including the following considerations:

- cooling requirements for normal and accident conditions
- capability to provide essential cooling for normal and accident conditions, assuming a single active failure

- capability to provide essential cooling using either offsite power supplies or onsite emergency power supplies
- capability to isolate non-essential portions of the system
- protection of essential components against natural phenomena and internal missiles
- capability of essential components to withstand design loadings
- provisions for inspection and functional testing of essential components and system segments
- provisions to detect leakage of radioactive material into the system and control leakage out of the system
- provisions to protect against adverse environmental and operational conditions such as freezing and water hammer
- capability of the system to function at the lowest probable water level of the ultimate heat sink

C.I.9.2.1.2 ***System Description***

Provide a detailed description and drawings of the service water system, including components cooled by the system, non-essential components that may be isolated from the service water system, cross-connection capability between trains and units, and instrumentation and alarms.

C.I.9.2.1.3 ***Safety Evaluation***

Provide an evaluation of the service water system, including the following considerations:

- capability to transfer the necessary heat to an ultimate heat sink under normal and accident conditions assuming a single active failure
- capability to isolate non-essential portions of the system
- the protection of essential components against natural phenomena and internal missiles
- capability of essential components to withstand design loadings
- capability of the system to function during adverse environmental conditions and abnormally high and-low water levels
- measures used to prevent long-term corrosion and organic fouling that may degrade system performance
- safety implications related to sharing of systems that can be cross-tied (for multi-unit facilities)

C.I.9.2.1.4 ***Inspection and Testing Requirements***

Describe the inspection and testing requirements for the service water system, including inservice inspection and testing, inspection and testing necessary to demonstrate that fouling and degradation mechanisms applicable to the site will be effectively managed to maintain acceptable system performance and integrity, and periodic flow testing though normally isolated safety-related components and infrequently used cross-connections between trains/units.

C.I.9.2.1.5 ***Instrumentation Requirements***

Describe the system alarms, instrumentation, and controls. This description should include the adequacy of instrumentation to support required testing, as well as the adequacy of alarms to notify operators of degraded conditions.

C.I.9.2.2 <u>Cooling System for Reactor Auxiliaries (Closed Cooling Water Systems)</u>

C.I.9.2.2.1 *Design Bases*

Provide the design bases for the reactor auxiliaries cooling system, including the following considerations:

- cooling requirements for normal and accident operations
- capability to provide essential cooling for normal and accident conditions assuming a single active failure
- capability to provide essential cooling using either offsite power supplies or onsite emergency power supplies
- capability to isolate non-essential portions of the system
- protection of essential components against natural phenomena and internal missiles
- capability of essential components to withstand design loadings
- provisions for inspection and functional testing of essential components and system segments
- provisions to detect and control leakage of radioactive material into or out of the system
- provisions to withstand loss of pressure boundary integrity in one train and expected long-term leakage without a loss of system functional capability

C.I.9.2.2.2 *System Description*

Provide a detailed description and drawings of the reactor auxiliaries cooling system, including the components cooled by the system, non-essential components that may be isolated, cross-connection capability between trains and units, and instrumentation and alarms.

C.I.9.2.2.3 *Safety Evaluation*

Provide an evaluation of the reactor auxiliaries cooling system, including the following considerations:

- capability to transfer the necessary heat to an ultimate heat sink under normal and accident conditions assuming a single active failure
- capability to isolate non-essential portions of the system
- protection of essential components against natural phenomena and internal missiles
- capability of essential components to withstand design loadings
- prevention of long-term corrosion that may degrade system performance
- safety implications related to sharing (for multi-unit facilities)
- the capability to withstand loss of pressure boundary integrity in one train and expected long-term leakage without a loss of system functional capability

For plants that rely on auxiliary cooling of seals to control leakage from the reactor coolant system, describe provisions to maintain seal integrity during station blackout conditions.

C.I.9.2.2.4 ***Inspection and Testing Requirements***

Describe the inspection and testing requirements for the reactor auxiliaries cooling system, including inservice inspection and testing.

C.I.9.2.2.5 ***Instrumentation Requirements***

Describe the system alarms, instrumentation and controls. Include a description of the adequacy of instrumentation to support required testing, as well as the adequacy of alarms to notify operators of degraded conditions.

C.I.9.2.3 **<u>Demineralized Water Makeup System</u>**

C.I.9.2.3.1 ***Design Bases***

Provide the design bases for the demineralized water makeup system, including makeup water requirements for normal operation, safety-related makeup requirements necessary to allow continued operation of essential safety-related systems under accident conditions, adequate redundancy to provide essential makeup, and protection of essential components against natural phenomena.

C.I.9.2.3.2 ***System Description***

Provide a description of the demineralized water makeup system, including the normal makeup water requirements and essential makeup requirements. This description should include a detailed description and drawings where the system provides essential makeup.

C.I.9.2.3.3 ***Safety Evaluation***

Provide an evaluation of the demineralized water makeup system, including its capability to provide necessary makeup to essential systems under accident conditions, as well as the protection of essential components against natural phenomena.

C.I.9.2.3.4 ***Inspection and Testing Requirements***

Describe the inspection and testing requirements for the demineralized water makeup system.

C.I.9.2.3.5 ***Instrumentation Requirements***

Describe the system alarms, instrumentation and controls.

C.I.9.2.4 **<u>Potable and Sanitary Water Systems</u>**

Provide a description of the potable and sanitary water systems. This description should include system design criteria addressing prevention of connections to systems having the potential to contain radioactive material.

C.I.9.2.5 Ultimate Heat Sink

C.I.9.2.5.1 *Design Bases*

Provide the design bases for the ultimate heat sink, including the following considerations:

- conservative estimates for heat rejection requirements for normal and accident operations
- capability to reject the necessary heat for normal and accident conditions assuming a single active failure
- capability to reject the necessary heat using either offsite power supplies or onsite emergency power supplies
- protection of essential structures and components against natural phenomena
- capability of essential components to withstand design loadings
- provisions for inspection of essential structures and subsystems
- provisions to protect against adverse environmental conditions such as freezing
- provisions to maintain an adequate cooling water inventory at an acceptable temperature for 30 days without makeup

C.I.9.2.5.2 *System Description*

Provide a detailed description and drawings of the ultimate heat sink, including water inventory, temperature limits, heat rejection capabilities under limiting conditions, instrumentation, and alarms. This description should discuss the extent to which the design of the ultimate heat sink incorporates the requirements of General Design Criteria (GDCs) 2, 5, 44, 45, and 46, as set forth in Appendix A to Title 10, Part 50, of the Code of Federal Regulations (10 CFR Part 50). In addition, this description should provide details concerning the applicability and use of guidance given in Regulatory Guide 1.27, “Ultimate Heat Sink,” and Regulatory Guide 1.72, “Spray Pond Piping Made from Fiberglass-Reinforced Thermosetting Resin.”

C.I.9.2.5.3 *Safety Evaluation*

Provide an evaluation of the ultimate heat sink, including the following considerations:

- capability to reject the necessary heat under normal and accident conditions, assuming a single active failure
- capability to retain an adequate inventory at an acceptable temperature without makeup
- protection of essential structures and components against natural phenomena
- capability of essential components to withstand design loadings
- capability of the system to function during adverse environmental conditions
- measures used to prevent long-term fouling and mitigate short-term clogging anticipated at the site that may degrade system performance
- safety implications related to sharing of the ultimate heat sink (for multi-unit facilities)

C.I.9.2.5.4 ***Inspection and Testing Requirements***

Describe the inspection and testing requirements for the ultimate heat sink, including inspection and testing necessary to demonstrate that fouling and degradation mechanisms applicable to the site will be effectively managed to maintain acceptable heat sink performance and integrity.

C.I.9.2.5.5 ***Instrumentation Requirements***

Describe the system alarms, instrumentation, and controls.

C.I.9.2.6 **<u>Condensate Storage Facilities</u>**

C.I.9.2.6.1 ***Design Bases***

Provide the design bases for the condensate storage facilities, including the following considerations:

- capability to supply water at an adequate suction head to systems that are important to safety and used for residual heat removal at high temperature
- capability to provide water for residual heat removal under normal and accident conditions assuming a single active failure
- capability to isolate non-essential portions from essential portions of the system
- protection of essential components against natural phenomena and internal missiles
- capability of essential components to withstand design loadings
- automatic switching from non-safety related to safety-related sources of water under accident conditions
- provisions for inspection and functional testing of essential components and system segments
- capability to collect potentially radioactive water leakage

C.I.9.2.6.2 ***System Description***

Provide a description of the condensate storage facilities, including the condensate storage tanks, non-essential components that may be isolated, automatic switching to safety-related water sources (if required), leakage collection features, and instrumentation and alarms.

C.I.9.2.6.3 ***Safety Evaluation***

Provide an evaluation of the condensate storage facilities, including the following considerations:

- capability of the system to supply condensate at an adequate rate and pressure under normal and accident conditions assuming a single active failure
- capability to automatically switch to safety-related water sources (if necessary)
- capability to isolate non-essential portions of the system
- protection of essential components against natural phenomena and internal missiles
- capability of essential components to withstand design loadings
- safety implications related to sharing (for multi-unit facilities)
- adequacy of stored inventory for coping with both safe shutdown and station blackout

The leakage collection features to preclude inadvertent release of radioactive water to the environment should be evaluated in Chapters 11 and 12.

C.I.9.2.6.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the condensate storage facilities, including inservice inspection and testing.

C.I.9.2.6.5 *Instrumentation Requirements*

Describe the condensate storage system alarms, instrumentation, and controls. This description should include the adequacy of instrumentation to support identification of inadequate storage inventory, automatic switching to a safety-related water source, and identification of minimum water level to supply adequate net positive suction head.

C.I.9.3 *Process Auxiliaries*

This section of the FSAR should provide discussions of each of the auxiliary systems associated with the reactor process system. Because these auxiliary systems vary in number, type, and nomenclature for various plant designs, the standard format does not assign specific subsection numbers to these systems. The applicant should provide separate subsections (numbered 9.3.1 through 9.3.x) for each of the systems. For each system, these subsections should provide the following information:

- design bases, including the GDCs to which the system is designed
- system description
- safety evaluation
- testing and inspection requirements
- instrumentation requirements
- description of the way concerns of any applicable generic letters or other applicable generic communications and regulatory guidance are addressed in the design, operation, maintenance, testing, etc., of the system

The following paragraphs provide examples of systems that should be discussed, as appropriate to the individual plant, and identify some specific information that should be provided in addition to the items identified above. These examples are not intended to represent a complete list of systems to be discussed in this section. For example, the boron recovery system and failed fuel detection system should both be discussed in this section.

C.I.9.3.1 Compressed Air Systems

Describe the compressed air systems that provide station air for service and maintenance uses, and include discussion of provisions for meeting the single-failure criterion for safety-related compressed air systems, air cleanliness and quality requirements, and environmental design requirements. Include a description of the capabilities to interconnect and/or isolate the instrumentation and control air system (ICAS) from the station service air system (SSAS) if two such systems are provided and are capable of being interconnected.

The description of the compressed air system should include a failure analysis (including diverse sources of electric power), the maintenance of air cleanliness to ensure system reliability, the capability to isolate, if required, and safety implications related to sharing (for multi-unit plants). Include in the failure analyses a description of the system's capability to function in the event of adverse environmental phenomena, abnormal operational requirements, or accident conditions such as a loss-of-coolant accident (LOCA), main steam line break concurrent with loss of offsite power, and station blackout. Address the potential for over-pressurization of air-supplied components.

Describe the instrumentation and control features to determine and ensure that the system is operating correctly, including the means to detect leakage from radioactive systems to the ICAS, and to preclude releases to the environment.

Describe the performance of interfacing reviews under the sections of the standard review plan (SRP) dealing with protection of drainage systems against flooding, internally and externally generated missiles, and high- or moderate-energy pipe breaks.

Describe the provisions for periodic testing of air quality, testing of pressure and leakage, and any necessary periodic functional testing of the safety-related portions of the ICAS.

C.I.9.3.2 Process and Post-Accident Sampling Systems

Describe the sampling system for the various plant fluids.

Include consideration of sample size and handling necessary to ensure that a representative sample is obtained from liquid and gaseous process streams and tanks. Describe provisions for purging sampling lines and reducing plateout in sample lines (e.g., heat tracing). Describe provisions to purge and drain sample streams back to the system of origin or to an appropriate waste treatment system, to minimize personnel exposure.

Describe provisions for isolating the system and the means to limit reactor coolant losses; requirements to minimize, to the extent practical, hazards to plant personnel; and design of the system, including pressure, temperature, materials of construction, and code requirements.

The process streams and points from which samples will be obtained should be delineated, along with the parameters to be determined through sampling (e.g., gross beta-gamma concentration, boric acid concentration). Describe measures to ensure that representative samples will be obtained, and address the effect of sharing on plant safety (for multi-unit facilities).

C.I.9.3.3 <u>Equipment and Floor Drainage System</u>

Describe the drainage systems for collecting the effluent from high activity and low activity liquid drains from various specified equipment and buildings. Include piping and pumps from equipment or floor drains to the sumps, and any additional equipment that may be necessary to route effluents to the drain tanks and then to the radwaste system.

Discuss design considerations for precluding back-flooding of equipment in safety-related compartments, as well as preventing transfer of contaminated fluids to non-contaminated drainage systems.

Identify areas where the drainage system is used to detect leakage from safety systems.

Describe the performance of interfacing reviews under the SRP sections dealing with protecting drainage systems against flooding, internally and externally generated missiles, and high or moderate energy pipe breaks.

Describe the seismic and safety classifications of the various portions of the system. Identify those portions of the system that are classified as Seismic Class I and Quality Group C.

An evaluation of radiological considerations for normal operation and postulated spills and accidents, including the effects of sharing (for multi-unit plants), should be presented in Chapters 11 and 12.

C.I.9.3.4 <u>Chemical and Volume Control System(Including Boron Recovery System) (PWRs only)</u>

C.I.9.3.4.1 *Design Bases*

The design bases for the chemical and volume control system (CVCS) and the boron recovery system (BRS) should include the capability to (1) vary coolant chemistry for control of reactivity and corrosion, and (2) maintain the required reactor coolant system inventory and reactor coolant pump seal water requirements. Considerations include the maximum and normal letdown flow rates, charging rates for both normal operation and maximum leakage conditions, boric acid storage requirements for reactivity control, water chemistry requirements, and boric acid and primary water storage requirements in terms of maximum number of startup and shutdown cycles.

C.I.9.3.4.2 *System Description*

Provide a complete description of the system and components, including any piping and instrumentation diagrams. Include design data, seismic category, and quality class for all components. Describe the principles of both automatic and manual system operation for steady-state, transient, startup, shutdown, and accident conditions. Describe controls, design provisions, and automatic features for protection of ion exchange resin and other components, as applicable, from the effects of high temperature in the letdown line. Provide a discussion of the adequacy of the system design to protect personnel from the effects of toxic, irritating, or explosive chemicals that may be used.

Discuss reactor coolant water chemistry requirements. Describe temperature control provisions for line heat tracing and tank heating, including provision for alarm failures. Provide tables of system design parameters and component design data.

C.I.9.3.4.3 *Safety Evaluation*

Provide a safety evaluation that addresses, at a minimum, the following considerations:

- design for safe operation, shutdown, and prevention/mitigation of postulated accidents, including the ability of the CVCS system to provide sufficient capacity and capability to support the plant's ability to withstand, or cope with, as applicable, and recover from, a station blackout
- adequacy of system boron inventory for bounding cold shutdown conditions including anticipated operational occurrences
- provisions for ensuring that boric acid solutions remain soluble
- pumping capability of system for reactor coolant makeup, and for small pipe and component failures
- provisions for a leakage detection and control program in accordance with 10 CFR 50.34(f)(xxvi)
- design for limitation of radioactive releases to the environment within normal and accident limits
- justification for the component and piping seismic design category and quality class assigned
- results of failure modes and effects analyses vis a vis single failure criteria for safe shutdown and prevention/mitigation of postulated accidents
- compliance with General Design Criteria
- extent to which applicable regulatory guides are followed
- protection of essential portions of systems from failure of non-Seismic Category I equipment and piping and also from the following events:
    - < flooding
    - < adverse environmental occurrences (e.g., hurricanes, tornadoes)
    - < abnormal operational conditions, or accident conditions, such as the following:
        - internally and externally generated missiles
        - loss of offsite power
        - the effects of high- and moderate-energy line failures

C.I.9.3.4.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the CVCS. Outline the operating procedures for the CVCS, including the controls for boron addition and primary coolant dilution.

C.I.9.3.4.5 *Instrumentation Requirements*

Describe the system instrumentation and controls, including the adequacy of safety-related instrumentation and controls to fulfill their functions.

C.I.9.3.5 <u>Standby Liquid Control System (BWRs)</u>

C.I.9.3.5.1 *Design Bases*

Provide the design bases for the standby liquid control system (SLCS), including the capability for reactor shutdown independent of the normal reactivity control system with a reasonable shutdown margin at any time during core life, system redundancy, and ability to periodically verify functional performance capability. For plants that take credit for the SLCS system as an emergency core cooling system (ECCS), the design bases for SLCS should also include the system's capability to function as part of the ECCS network. The information requested for the ECCS is given in Section 6.3 of this regulatory guide. Discuss the design with respect to the capability to detect, collect, and control system leakage and the capability to isolate portions of the system in case of excessive leakage or component malfunction.

C.I.9.3.5.2 *System Description*

Provide a description of the system and components, including piping and instrumentation diagrams. Describe temperature control provisions for line heat tracing and tank heating, including provisions for alarm failures. Provide design data, seismic category, and quality class for all components. Describe the principles of system operation and testing.

C.I.9.3.5.3 *Safety Evaluation*

Provide a safety evaluation discussing system storage capacity and the injection rate required to bring the reactor from rated power to cold shutdown at any time during core life with adequate margin for adverse factors, including xenon decay; elimination of steam voids; and allowance for imperfect mixing, leakage, and dilution. For plants that take credit for the system as an ECCS, include a discussion that addresses the system's capability to perform its function as part of the ECCS. See Section 6.3 of this regulatory guide for information requested with respect to ECCS. Discuss provisions to prevent loss of solubility of borated solutions. Include the following considerations in the safety evaluation:

- adequacy of the component and piping seismic design category and quality class
- Results of failure modes and effects analyses, with regard to the single-failure criterion for safe shutdown and prevention/mitigation of postulated accidents
- compliance with GDCs
- extent to which applicable regulatory guides are followed
- protection of essential portions of systems from failure of non-Seismic Category I equipment and piping and also from the following events:
  - flooding
  - adverse environmental occurrences (e.g., hurricanes, tornadoes)
  - abnormal operational conditions, or accident conditions, such as the following:
    - internally and externally generated missiles
    - loss of offsite power
    - the effects of high- and moderate-energy line failures

C.I.9.3.5.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the SLCS, including periodic operational testing. Include a description of any inspection and testing and other reliability assurance requirements for applicable components, including motor-operated SLCS storage tank discharge valves, if these are part of the system design.

C.I.9.3.5.5 *Instrumentation Requirements*

Describe the system instrumentation and controls. Include provisions for operational testing and the instrumentation and control features to verify that the system is available to operate in the correct mode.

C.I.9.4 *Air Conditioning, Heating, Cooling, and Ventilation Systems*

The following subsections discuss examples of systems that should be addressed, as appropriate to the individual plant, and identify some specific information that should be provided. These examples are not intended to represent a complete list of systems to be discussed in this section. For example, the ventilation system for both the diesel building and the containment ventilation system should be described in this section.

C.I.9.4.1 Control Room Area Ventilation System

C.I.9.4.1.1 *Design Bases*

Discuss the design bases for the air treatment system for the control room and other auxiliary rooms (e.g., relay rooms and emergency switchgear rooms) considered to be part of the control areas. Include the criteria and/or features that ensure performance (e.g., flow rates, temperature limits, humidity limits, filtration) and reliability of the system (i.e., single failure, redundancy, seismic design, environmental qualification) for all modes of operation, including normal, abnormal, station blackout, and toxic gas modes. The design bases should also include requirements for manual or automatic actuation, system isolation, monitoring for radiation and/or toxic gas, and other controls essential to the performance of the system functions.

C.I.9.4.1.2 *System Description*

The system description should include the system's major components, key parameters, essential controls, and operating modes. This description should also include a process flow diagram or piping and instrument diagram to enhance understanding of system operation and flow paths. Tables should be included to show the key parameters and features of major components. In addition, the description should address realignment of the system as a result of automatic actuation or operator action for all modes of operation, with reference to response to radiation, toxic gas, smoke and/or other actuation signals (i.e., LOCA signal).

C.I.9.4.1.3 *Safety Evaluation*

Identify the safety objectives to be achieved by the control room air treatment system. For example, one safety objective may be to confine, contain, or reduce contamination by isolation and filtering. Another may be to maintain acceptable zone temperature and humidity to prevent degradation of important equipment.

Discuss the manner in which the system achieves each safety objective. For example, for the objective of confinement, containment, or contamination reduction, the discussion may address the actuation signals and actions necessary to achieve system isolation or operation, as well as the system's capability to reduce contamination by high-efficiency particulate air (HEPA) or carbon filters.

Additional detailed discussion of control room ventilation systems should appear in Section 6.4, "Habitability Systems," and in Chapter 15, "Radiological Consequences," of the applicants FSAR.

C.I.9.4.1.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the control room air treatment system, including in-service inspection requirements for applicable components. Identify the inspection and testing programs to ensure that the system will meet its functional requirements, especially those that will be controlled through technical specification surveillance. For example, filter efficiencies, pressure drops, flow rates, and temperatures may need to be confirmed through test programs.

C.I.9.4.2 Spent Fuel Pool Area Ventilation System

C.I.9.4.2.1 *Design Bases*

The design bases of the ventilation system for the spent fuel pool area should include the criteria and/or features to ensure the system's performance (i.e., flow rates, temperature limits, humidity limits, filtration) and reliability (i.e., single failure, redundancy, seismic design, environmental qualification) for all modes of operation, including normal, abnormal, and station blackout modes. The design bases should also include requirements for manual or automatic actuation, system isolation, monitoring for radiation and filtration, and other controls essential to the performance of the system functions.

C.I.9.4.2.2 *System Description*

The system description should include the system's major components, key parameters, essential controls, and operating modes. This description should also include a process flow diagram or piping and instrument diagram to enhance understanding of system operation and flow paths. Tables should be included to show the key parameters and features of major components. In addition, the description should address realignment of the system as a result of automatic actuation or operator action for all modes of operation with reference to response to radiation or other actuation signals (i.e., LOCA signal).

C.I.9.4.2.3 *Safety Evaluation*

Identify the safety objectives to be achieved by the spent fuel pool area ventilation system . For example, one safety objective may be to confine, contain, or reduce contamination by isolation and filtering. Another may be to maintain acceptable zone temperature and humidity to prevent degradation of important equipment.

Discuss the manner in which the system achieves each safety objective. For example, for the objective of confinement, containment, or contamination reduction, the discussion may address the actuation signals and subsequent equipment actuation, as well as the capability to reduce contamination by HEPA or carbon filters.

Include a discussion of the ability to (1) detect radiation in the area of the spent fuel pool, and (2) filter the contaminants out of the air before exhausting it to the environment, or prevent the contaminated air from leaving the spent fuel area.

C.I.9.4.2.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the spent fuel area ventilation system components important to safety. Identify the inspection and testing programs to ensure that the system will meet its functional requirements, especially those that will be controlled through technical specification surveillance. For example, filter efficiencies, pressure drops, flow rates, and temperatures may need to be confirmed through test programs.

C.I.9.4.3 Auxiliary and Radwaste Area Ventilation System

C.I.9.4.3.1 *Design Bases*

The design bases for the air handling system for the radwaste area and areas of the auxiliary building containing safety-related equipment should include the criteria and/or features to ensure the system's performance (i.e., flow rates, temperature limits, humidity limits, filtration) and reliability (i.e., single failure, redundancy, seismic design, environmental qualification) for all modes of operation, including normal, abnormal, and station blackout. Also describe requirements for manual or automatic actuation, system isolation, monitoring for radiation, and other controls essential to the performance of the system functions. Include, as appropriate, the preferred direction of airflow from areas of low potential radioactivity to areas of high potential radioactivity, any differential pressures to be maintained and measured, and any requirements for the treatment of exhaust air, during normal, abnormal, and accident conditions. In addition, provide details concerning the means used to protect system vents and louvers from missiles.

C.I.9.4.3.2 *System Description*

The system description should include the system's major components, key parameters, essential controls, and operating modes. This description should also include a process flow diagram or piping and instrument diagram to enhance understanding of system operation and flow paths. Tables should be included to show the key parameters and features of major components. In addition, the description should address the realignment of the system as a result of automatic actuation or operator action for all modes of operation, with reference to response to radiation or other actuation signals (i.e., LOCA signal).

C.I.9.4.3.3 ***Safety Evaluation***

Provide an evaluation of the auxiliary and radwaste area ventilation system. Identify the safety objectives to be achieved by the system. For example, one safety objective may be to confine, contain or reduce contamination by isolation and filtering. Another may be to maintain acceptable zone temperature and humidity to prevent degradation of important equipment.

Discuss the manner in which the system achieves each safety objective. For example, for the objective of confinement, containment, or contamination reduction, the discussion may address the actuation signals and subsequent equipment actuation, as well as the system's capability to reduce contamination by HEPA or carbon filters.

Evaluation of radiological considerations for normal operation should be presented in Chapters 11 and 12.

C.I.9.4.3.4 ***Inspection and Testing Requirements***

Describe the inspection and testing requirements for the auxiliary and radwaste area ventilation system. Identify the inspection and testing programs to ensure that the system will meet its functional requirements, especially those that will be controlled through technical specification surveillance. For example, filter efficiencies, pressure drops, flow rates, and temperatures may need to be confirmed through test programs.

C.I.9.4.4 **Turbine Building Area Ventilation System**

C.I.9.4.4.1 ***Design Bases***

The design bases for the air handling system for the turbine-generator area in the turbine building should include the criteria and/or features to ensure the system's performance (i.e., flow rates, temperature limits, humidity limits, filtration) and reliability (i.e., single failure, redundancy, seismic design, environmental qualification) for all modes of operation, including normal, abnormal, and station blackout conditions. The design bases should also include requirements for manual or automatic actuation, system isolation, and other controls essential to the performance of system functions.

C.I.9.4.4.2 ***System Description***

The system description should include the system's major components, key parameters, essential controls, and operating modes. This description should also include a process flow diagram or piping and instrument diagram to enhance understanding of system operation and flow paths. Tables should be included to show the key parameters and features of major components. In addition, the description should address the realignment of the system as a result of automatic actuation or operator action for all modes of operation with reference to response to radiation or other actuation signals. Identify which, if any, portions of the system are essential (classified as Seismic Category I) and how those portions can be isolated from non-essential portions of the system.

C.I.9.4.4.3 *Safety Evaluation*

Present an evaluation of the turbine building air handling system. This evaluation should include a system failure analysis (including effects of inability to maintain preferred airflow patterns). Identify the safety objectives to be achieved by the system. For example, one safety objective may be to confine, contain, or reduce contamination by isolation and filtering. Another may be to maintain acceptable zone temperature and humidity to prevent degradation of important equipment.

Discuss the manner in which the system achieves each safety objective. For example, for the objective of confinement, containment, or contamination reduction, the discussion may address the actuation signals and subsequent equipment actuation, as well as the capability of the system to reduce contamination by HEPA or carbon filters.

Radiological considerations for normal operation should be evaluated in Chapters 11 and 12.

C.I.9.4.4.4 *Inspection and Testing Requirements*

Describe the inspection and testing requirements for the turbine building air handling system. Identify the inspection and testing programs to ensure that the functional requirements of the system will be met, especially those that will be controlled through technical specification surveillance. For example, filter efficiencies, pressure drops, flow rates, and temperatures may need to be confirmed through test programs.

C.I.9.4.5 Engineered Safety Feature Ventilation System

C.I.9.4.5.1 *Design Bases*

The design bases for the air handling system for areas that house engineered safety feature equipment should include the criteria and/or features to ensure the system's performance (i.e., flow rates, temperature limits, humidity limits, filtration) and reliability (i.e., single failure, redundancy, seismic design, environmental qualification) for all modes of operation, including normal, abnormal, and station blackout conditions. The design bases should also include requirements for manual or automatic actuation, system isolation, monitoring for radiation, and other controls essential to the performance of the system functions. In addition, provide details concerning the means used to protect system vents and louvers from missiles.

C.I.9.4.5.2 *Systems Description*

The system description should include the system's major components, key parameters, essential controls, and operating modes. This description should also include a process flow diagram or piping and instrument diagram to enhance understanding of system operation and flow paths. Tables should be included to show the key parameters and features of major components. In addition, the description should address the realignment of the system as a result of automatic actuation or operator action for all modes of operation with reference to response to radiation or other actuation signals (i.e., LOCA signal).

This description should identify all portions of the system that are determined to be Seismic Category I and safety-related. For these portions of the system, the system description should include the following considerations:

- capability of heating and cooling systems to maintain a suitable ambient temperature range in the areas serviced, assuming normal operation of the equipment in those areas
- capability of the safety features equipment in the serviced areas to function under the worst anticipated degraded performance of the engineered safety feature ventilation system
- capability of the system to circulate sufficient air to prevent accumulation of flammable or explosive gas or fuel-vapor mixtures from components such as storage batteries and stored fuel
- capability of the system to automatically actuate components not operating under normal operating conditions, or to actuate standby components (redundant equipment) in the event of failure or malfunction
- capability of the system to actuate ventilation equipment in the engineered safety feature areas before ambient temperatures exceed design rated temperatures of components
- capability of the system to control airborne particulate material (dust) accumulation, and, as necessary, to detect and control leakage of radioactive contamination from the system to the environment

C.I.9.4.5.3 *Safety Evaluation*

Present an evaluation of the engineered safety features ventilation system. The evaluation should include a system failure analysis. Identify the safety objectives to be achieved by the system. For example, one safety objective may be to confine, contain, or reduce contamination by isolation and filtering. Another may be to maintain acceptable zone temperature and humidity to prevent degradation of important equipment.

Discuss the manner in which the system achieves each safety objective. For example, for the objective of confinement, containment, or contamination reduction, the discussion may address the actuation signals and subsequent equipment actuation, as well as the capability to reduce contamination by HEPA or carbon filters.

If applicable, include the effect of redundant systems, and address the safety implications related to sharing (for multi-unit plants).

C.I.9.4.5.4 *Inspection and Testing Requirements*

Identify the inspection and testing programs to ensure that the system will meet its functional requirements, especially those that will be controlled through technical specification surveillance. For example, filter efficiencies, pressure drops, flow rates, and temperatures may need to be confirmed through test programs.

C.I.9.5 *Other Auxiliary Systems*

C.I.9.5.1 Fire Protection Program

C.I.9.5.1.1 *Design Bases*

Provide the design bases for the fire protection program (FPP) to demonstrate that the FPP satisfies the Commission's fire protection objectives through a defense-in-depth philosophy. Design bases for an acceptable FPP are discussed in SRP Section 9.5.1, "Fire Protection Program," and Regulatory Guide 1.189, "Fire Protection for Operating Nuclear Power Plants." At a minimum, the FSAR should include the following design bases:

- Overall FPP design bases to meet 10 CFR 50.48 as well as the criteria for new reactor enhanced fire protection in accordance with Appendix B to SRP 9.5.1.
- A list of the industry codes, standards, and guidance documents that will be used as the basis for the design, construction, testing and maintenance of the FPP, including the applicable edition date (which should be within 6 months of the COL application docket date). Identify exceptions to the guidance and/or provisions included in these documents, and provide the basis for each exception.
- The assumptions and bases for assumptions applied to analyses of fire-induced multiple spurious actuations that could prevent safe shutdown. This discussion should include the protection provided to ensure that one train of safe-shutdown structures, systems, and components remains free of fire damage.
- The acceptance criteria for operator manual actions or recovery actions credited to achieve and maintain safe shutdown during and after a fire. Identify where those actions have been credited and describe the associated fire scenario for each, as well as the analyses (including appropriate thermo-hydraulic analysis to demonstrate that safe shutdown can be achieved and maintained).

C.I.9.5.1.2 *System Description*

Provide a description of the FPP, including the fire protection system piping and instrumentation diagrams. The scope of the facility FPP and the related NRC-approved acceptance criteria are described in SRP 9.5.1. Each element of the FPP should be adequately described to permit an independent assessment of the program's capability to satisfy the Commission's fire protection objectives. As a minimum, the following should be included in the system description:

- A description of the overall FPP provisions, including the fire protection organization; administrative policies; fire prevention controls; applicable administrative, operations, maintenance, and emergency procedures; quality assurance (QA); access to fire areas for fire fighting; and fire brigade and emergency response capability.
- An evaluation of the FPP against RG 1.189 and SRP 9.5.1. This evaluation should identify and describe all differences between the facility's FPP design features, analytical techniques, and procedural measures, and those given in RG 1.189 and SRP 9.5.1. Where such differences exist, the evaluation should discuss how the proposed alternative provides an acceptable method of complying with applicable NRC rules or regulations that underlie RG 1.189 and SRP 9.5.1.
- Plant layout, facility site arrangement, and structural design features, which provide separation or isolation of redundant systems important to safety.

- Selection and design of fire detection, alarm, control, and suppression on the basis of the fire hazards analysis; design, testing, qualification, and maintenance of fire barriers; use of noncombustible materials; design of floor drains, ventilation, emergency lighting, and communication systems to the extent that they impact the FPP.
- Fire protection and control provisions (for multiple unit sites) to maintain the integrity and operability of any shared fire protection systems, and to ensure that fire hazards associated with one unit will not have an adverse affect on the adjacent unit(s).
- A description of design features that prevent migration of smoke, hot gases, or fire suppressant material into other fire areas, causing adverse effects on safe shutdown capabilities, including operator actions.
- A description of any emergency backup functions performed by the fire protection system to support operation of safe shutdown systems. This description should include the extent to which this backup function is relied upon for safe shutdown (e.g., the backup function is required for safe shutdown or is only provided for additional defense-in-depth and is not essential to achieving or maintaining safe shutdown).
- A description of the facility's design for smoke and heat control during a fire in areas important to safety.
- A description of any portions of the fire protection system that are designed to remain functional following a safe-shutdown earthquake, and provisions for isolating those portions from the rest of the system.
- A description of electrical cable and raceway penetrations in fire barriers and raceway fire barrier systems, including qualification tests and acceptance criteria.
- The schedule and detailed implementation plan for the FPP, to ensure that the program is properly established and implemented in time to provide adequate protection prior to fueling and operation of the nuclear power plant. Include the implementation plans to establish, train, and equip the site fire brigade to ensure adequate manual fire-fighting capability for areas with structures, systems, and components important to safety. As discussed, in Section C.I.13.4 of this guide, applicants should provide implementation milestones for operational programs.

C.I.9.5.1.3 ***Safety Evaluation***

A post-fire, safe-shutdown analysis should be provided to demonstrate that the FPP satisfies the Commission's fire protection objectives, in accordance with the enhanced fire protection criteria for new reactors described in Appendix B to SRP 9.5.1. This analysis should include the list of systems and components needed to provide post-fire safe-shutdown capability; the arrangement of the systems and components within the plant fire areas; the separation between redundant safe shutdown systems and components; fire protection for safe shutdown systems and components; and potential interactions between non-safety systems, fire protection systems, and systems important to safety as they relate to potential adverse effects on the safe shutdown capability. Guidance for an acceptable FPP safety evaluation and supporting analyses is provided in SRP 9.5.1 and RG 1.189. The following analysis should be included to support the safe-shutdown analysis:

- Fire hazards analysis (FHA) evaluating (1) the potential fire hazards for areas containing equipment important to safety throughout the plant, and (2) the effect of postulated fires and explosions relative to maintaining the ability to perform safe shutdown functions and minimizing radioactive releases to the environment. The FHA should specify measures for fire prevention, detection, suppression, and containment, as well as alternative shutdown capability for each fire area containing structures, systems, and components important to safety in accordance with NRC guidelines and regulations.

Guidance for fire probabilistic risk assessments (PRAs) is provided in Sections C.I.19 (Probabilistic Risk Assessment Information and Severe Accidents) and C.II.1 (Probabilistic Risk Assessment).

C.I.9.5.1.4 ***Inspection and Testing Requirements***

Provide a description of the inspection and testing requirements for the fire protection system for both initial system startup and periodic inspections and tests following startup.

C.I.9.5.2 Communication Systems

C.I.9.5.2.1 ***Design Bases***

The design bases for the communication systems for intra-plant and plant-to-offsite communications should be provided and should include a discussion of the use of diverse system types.

Address the integrated design of the system and related plant features to support effective communication between plant personnel in all vital areas of the plant during normal operation as well as during accident or incident conditions under maximum potential noise levels or other conditions that could interfere with communication (e.g., electromagnetic interference).

The FSAR should address compliance with 10 CFR 73.55(e), "Detection Aids," 10 CFR 73.55(f), "Communication Requirements," and 10 CFR 73.55(g), "Testing and Maintenance."

C.I.9.5.2.2 ***System Description***

A description and evaluation of the communication systems should be provided. The FSAR should provide a detailed description and drawings.

The FSAR should address the environmental conditions including weather, moisture, noise level, and electromagnetic interference/radio frequency interference (EMI/RFI) that might interfere with the ability for effective communication to be accomplished in all vital areas. Environmental conditions also include fire and radiological events in which personnel must be able to effectively communicate while equipped with respiratory protection.

Guidance for data communication systems is provided in C.I.7.9.

C.I.9.5.2.3 ***Inspection and Testing Requirements***

The inspection and testing requirements and any associated inspection/test procedures for the communication systems should be provided.

C.I.9.5.3 <u>Lighting Systems</u>

Provide a description of the plant's normal, emergency, and supplementary lighting systems, including the capability of these systems to provide adequate lighting during all plant operating conditions (e.g., normal operation and anticipated fire, transient, and accident conditions). Discuss the effect of a loss of all alternating current (AC) power (i.e., during a station blackout event) on emergency lighting systems. In the description of these lighting systems, include the following considerations:

- design criteria
- provisions for lighting needed in areas required for firefighting
- provisions for lighting needed in areas for control and maintenance of safety related equipment
- access routes to and from these areas
- a failure analysis

C.I.9.5.4 <u>Diesel Generator Fuel Oil Storage and Transfer System</u>

C.I.9.5.4.1 *Design Bases*

Provide the design bases for the fuel oil storage and transfer system for the diesel generator, including the requirement for onsite storage capacity, capability to meet code design requirements, and environmental design bases.

C.I.9.5.4.2 *System Description*

Provide a description and drawings of the diesel generator fuel oil storage and transfer system.

C.I.9.5.4.3 *Safety Evaluation*

Provide an evaluation of the fuel oil storage and transfer system. This evaluation should include the potential for material corrosion and fuel oil contamination, a failure analysis to demonstrate the system's capability to meet design criteria (e.g., seismic requirements, capability to perform its function in the event of station blackout, implications of sharing between units on a multi-unit site), ability to withstand environmental design conditions, external and internal missiles and forces associated with pipe breaks, and the plans by which additional fuel oil may be procured and storage tanks recharged, if necessary.

C.I.9.5.4.4 *Inspection and Testing Requirements*

Describe the test and inspection procedures for the diesel generator fuel oil storage and transfer system.

C.I.9.5.5 Diesel Generator Cooling Water System

C.I.9.5.5.1 Design Bases

Provide the design bases for the diesel generator cooling water system, including the implications of shared systems, if any, on the system's capability to perform its function. Include the following considerations in the design basis description:

- functional capability during high water levels (i.e., flooding, if applicable)
- capability to detect and control system leakage
- prevention of long-term corrosion and organic fouling, and the compatibility of corrosion inhibitors or antifreeze compounds with materials of the system
- capacity of the cooling water system relative to manufacturer's recommended engine temperature differentials under adverse operating conditions
- provision of instruments and testing systems
- provisions to ensure that normal protective interlocks do not preclude engine operation during emergency conditions, if applicable
- discussion of the adequacy of the cooling water system to perform its function in the event of a station blackout, if applicable
- provision of Seismic Category I structures to house the system, if applicable

C.I.9.5.5.2 *System Description*

Provide a description and drawings of the diesel generator cooling water system.

C.I.9.5.5.3 *Safety Evaluation*

Provide an evaluation of the diesel generator cooling water system. Include in the failure analysis consideration of the single failure criterion, internally or externally generated missiles, forces from piping cracks/breaks in high and moderate energy piping, seismic requirements, and the impact of the failure of nonseismic Category I structures, systems, and components.

C.I.9.5.5.4 *Inspection and Testing Requirements*

Describe the inspection and testing procedures for the diesel generator cooling water system.

C.I.9.5.6 Diesel Generator Starting Air System

C.I.9.5.6.1 *Design Bases*

Provide the design bases for the diesel generator starting air system, including the required system capacity and the implications of shared systems, if any, on the system's capability to perform its function.

C.I.9.5.6.2 ***System Description***

Provide a description and drawings of the diesel generator starting air system, including designation of essential portions of the system and their location. Provide descriptions of instrumentation, control, testing, and inspection features as well as applicable inspection and testing procedures for the diesel generator starting air system.

C.I.9.5.6.3 ***Safety Evaluation***

Provide an evaluation of the diesel generator starting air system, including consideration of internally or externally generated missiles, forces from piping cracks/breaks in high- and moderate-energy piping, and the impact of the failure of non-seismic Category I structures, systems, and components. Discuss, if applicable, the system's capability to perform its function in the event of a station blackout.

C.I.9.5.7 **<u>Diesel Generator Lubrication System</u>**

C.I.9.5.7.1 ***Design Basis***

Provide the design bases for the diesel generator lubrication system, including the following considerations:

- internally or externally generated missiles and forces from crankcase explosions
- the impact of the failure of non-seismic Category I structures, systems, and components
- functional capability during high water levels (i.e., flooding, if applicable)
- capability to detect and control/isolate system leakage
- provision of instrumentation and testing systems
- provisions to ensure that normal protective interlocks do not preclude engine operation during emergency conditions, if applicable
- provisions for cooling the system and removing system heat load
- adequacy of the lubrication system to perform its function in the event of a station blackout, if applicable
- system design for prevention of dry starting (momentary lack of lubrication)

C.I.9.5.7.2 ***System Description***

Provide a description and drawings of the lubrication system, including measures taken to ensure the quality of the lubricating oil.

C.I.9.5.8 Diesel Generator Combustion Air Intake and Exhaust System

C.I.9.5.8.1 *Design Bases*

Provide the design bases for the diesel generator combustion air intake and exhaust system, including the bases for protection from the effects of natural phenomena, missiles, and contaminating substances, as relate to the facility site, systems, and equipment, as well as the system's capability to meet minimum safety requirements assuming a single failure. Address the potential for a single active failure to lead to the loss of more than one diesel generator system. Seismic and quality group classifications should be provided in Section 3.2 and referenced in this section. Discuss the adequacy of the combustion air intake and exhaust system to perform its function in the event of a station blackout, if applicable.

C.I.9.5.8.2 *System Description*

Provide a complete description of the system, including system drawings detailing component redundancy, where required, and showing the location of system equipment in the facility and the relationship to site systems or components that could affect the system.

C.I.9.5.8.3 *Safety Evaluation*

Provide analyses to address the minimum quantity and oxygen content requirements for intake combustion air. Also provide the results of failure modes and effects analyses to ensure that the system meets the applicable minimum requirements. Address system degradation, if any, that could result from the consequences of missiles or failures of high- or moderate-energy piping systems located in the vicinity of the combustion air intake and exhaust system, and any impact on the system's minimum safety functional requirements.

C.I.9.5.8.4 *Inspection and Testing Requirements*

Describe inspection and periodic system testing requirements, features, and procedures for the diesel generator combustion air intake and exhaust system.

C.I.9.6 References

- 10 CFR Part 20, "Standards for Protection Against Radiation"
  - 10 CFR 20.1101(b)
  - 10 CFR 20.1101(c), as it relates to making every reasonable effort to maintain radiation exposures as low as is reasonably achievable (ALARA)
- 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"
  - 10 CFR 50.34(f), "Additional TMI-Related Requirements"
  - 10 CFR 50.48, "Fire Protection"
  - 10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients Without Scram (ATWS) Events for Light-Water-Cooled Nuclear Power Plants"
  - 10 CFR 50.63, "Loss of All Alternating Current Power," as it relates to design provisions to support the plant's ability to withstand and recover from a station blackout

- 10 CFR Part 50, Appendix A, “General Design Criteria”
    - GDC 1, “Quality Standards and Records”
    - GDC 2, “Design Bases for Protection Against Natural Phenomena”
    - GDC 3, “Fire Protection”
    - GDC 4, “Environmental and Dynamic Effects Design Bases”
    - GDC 5, “Sharing of Structures, Systems, and Components”
    - GDC 13, “Instrumentation and Control,” as it relates to monitoring variables that can affect the fission process, the integrity of the reactor core, and the reactor coolant pressure boundary
    - GDC 14, “Reactor Coolant Pressure Boundary”
    - GDC 17, “Electric Power Systems”
    - GDC 19, “Control Room”
    - GDC 23, “Protection System Failure Modes”
    - GDC 26, “Reactivity Control System Redundancy and Capability”
    - GDC 27, “Combined Reactivity Control Systems Capability”
    - GDC 29, “Protection Against Anticipated Operational Occurrences”
    - GDC 33, “Reactor Coolant Makeup”
    - GDC 35, “Emergency Core Cooling”
    - GDC 41, “Containment Atmosphere Cleanup”
    - GDC 44, “Cooling Water”
    - GDC 45, “Inspection of Cooling Water System”
    - GDC 46, “Testing of Cooling Water System”
    - GDC 60, “Control of Releases of Radioactive Materials to the Environment”
    - GDC 61, “Fuel Storage and Handling and Radioactivity Control”
    - GDC 63, “Monitoring Fuel and Waste Storage”
    - GDC 64, “Monitoring Radioactivity Releases”

- 10 CFR Part 50, Appendix R, “Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979”

- 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants”

- 10 CFR Part 73, “Physical Protection of Plants and Materials”
    - 10 CFR 73.55(e) “Detection Aids”
    - 10 CFR 73.55(f) “Communication Requirements”
    - 10 CFR 73.55(g) “Testing and Maintenance”

- Regulatory Guidance Documents
    - < Regulatory Guide (RG) 1.9, “Selection, Design, Qualification, and Testing of Emergency Diesel Generator Units Used as Class 1E Onsite Electric Power Systems at Nuclear Power Plants”
    - < RG 1.21, “Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants”
    - < RG 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants”
    - < RG 1.27, “Ultimate Heat Sink for Nuclear Power Plants”
    - < RG 1.29, “Seismic Design Classification”
    - < RG 1.52, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants”
    - < RG 1.68.3, “Pre-Operational Testing of Instrument Air Systems” (formerly Regulatory Guide 1.80)
    - < RG 1.72, “Spray Pond Piping Made from Fiberglass-Reinforced Thermosetting Resin”
    - < RG 1.78, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release”
    - < RG 1.97, “Instrumentation for Light-Water-Cooled Nuclear Power Plants To Assess Plant and Environs Conditions During and Following an Accident”
    - < RG 1.115, “Protection Against Low-Trajectory Turbine Missiles”
    - < RG 1.117, “Tornado Design Classification”
    - < RG 1.127, “Inspection of Water-Control Structures Associated with Nuclear Power Plants”
    - < RG 1.137, “Fuel Oil Systems for Standby Diesel Generators”
    - < RG 1.140, “Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants”
    - < RG 1.143, “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed In Light-Water-Cooled Nuclear Power Plants”
    - < RG 1.152, “Criteria for Digital Computers in Safety Systems of Nuclear Power Plants”
    - < RG 1.155, “Station Blackout”
    - < RG 1.189, “Fire Protection for Operating Nuclear Power Plants”
    - < RG 1.191, “Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown”
    - < RG 8.8, “Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable”
    - < NUREG-0737, “Clarification of TMI Action Plan Requirements,” (Section II.B.3)
    - < NUREG-1801, “Generic Aging Lessons Learned (GALL) Report”
    - < NUREG-CR/0660, “Enhancement of Onsite Emergency Diesel Generator Reliability”
    - < Branch Technical Position (BTP) ASB 9-2, “Residual Decay Energy for Light Water Reactors for Long-Term Cooling”
    - < BTP SPLB 9.5-1, “Guidelines for Fire Protection for Nuclear Power Plants”

- Generic Letters (GLs)
  - GL 80-21, "Vacuum Condition Resulting in Damage to Chemical Volume Control System (CVCS) Holdup Tanks (Sometimes Called 'Clean Waste Receiver Tanks')," March 10, 1980
  - GL 85-03, "Clarification of Equivalent Control Capacity for Standby Liquid Control Systems," January 28, 1985
  - GL 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," April 3, 1989
  - GL 89-13, "Service Water System Problems Affecting Safety-Related Equipment," July 18, 1989
  - GL 83-37, "NUREG-0737 Technical Specifications (Generic Letter 83-37)," November 1, 1983
- NRC Bulletins
  - Bulletin 80-18, "Maintenance of Adequate Minimum Flow Thru Centrifugal Charging Pumps Following Secondary Side High Energy Line Rupture," July 24, 1980
  - Bulletin 88-04, "Potential Safety-Related Pump Loss," May 5, 1988
- Commission Papers
  - SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements"
  - SECY 93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," April 2, 1993
  - Staff Requirements Memorandum, "SECY 93-087 - Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," July 21, 1993
  - SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs"
- Federal Coordinating Council for Science, Engineering, and Technology, "Federal Guidelines for Dam Safety," June 25, 1979
- EPRI 1002884, "PWR Primary Water Chemistry Guidelines," Revision 5, September 2003, Electric Power Research Institute
- ANS 5.1, "Decay Heat Power"
- ANSI MC 11.1-1976 (ISA-S7.3), "Quality Standard for Instrument Air"
- ANSI-N195-1976, "Fuel Oil Systems for Standby Diesel Generators," American National Standards Institute
- ANSI/IEEE Std 387-1984, "IEEE Standard Criteria for Diesel Generator Units Applied As Standby Power Supplies for Nuclear Power Generating Stations," American National Standards Institute
- ASME Code AG-1, "Code for Nuclear Air and Gas Treatment," 1991 (including the AG-1a-92 Addenda thereto)
- Diesel Engine Manufacturers Association (DEMA) Standard 1974