U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

9.2.2 REACTOR AUXILIARY COOLING WATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of cooling water systems

Secondary - Organization responsible for the review of component performance and testing

I. AREAS OF REVIEW

The reactor auxiliary cooling water system (CWS) provides a closed loop of cooling water for reactor system components, reactor shutdown equipment, ventilation equipment, and components of the emergency core cooling system (ECCS).

The review of reactor auxiliary CWS encompasses components required for safe shutdown during normal operations, anticipated operational occurrences, and accident conditions and for prevention or mitigation of the consequences of accidents.

The review of these systems includes system components, valves and piping, and points of connection or interfaces with other systems. The CWS is emphasized for such safety-related components as ECCS, ventilation, and reactor shutdown equipment.

The specific areas of review are as follows:

1. Compliance with the requirements of General Design Criteria (GDCs) 2, 4, 5, 44, 45, and 46.

2. The capability of the auxiliary cooling systems to provide adequate cooling water to safety-related ECCS components and reactor auxiliary equipment for all planned operating conditions.

3. The functional performance requirements of the system, including the ability to withstand adverse operational (e.g., water hammer) and environmental occurrences, operability requirements for normal operation, and requirements for operation during and following postulated accidents.

4. Multiple performance functions (if required) assigned to the system and the necessity of each function for emergency core cooling and safe shutdown.

5. The capability of the system surge tank to perform its intended function.

6. The capability of the system to provide adequate cooling water during all operating conditions.

7. Controls to ensure that the component cooling water loop to the reactor coolant pump (RCP) seal does not automatically isolate and provisions for the control room operators to isolate the RCP seal coolant line by remote manual means (see subsection III.4.F of this Standard Review Plan (SRP) section).

8. The sizing of the system for core cooling and decay heat loads and the design margin.

9. The effects of nonseismic Category I component failures on the seismic Category I portion of the system.

10. The provisions for detection, collection, and control of system leakage and the means for detecting leakage of radioactivity from one system to another and preclude its release to the environment.

11. The requirements for operational testing and inservice inspection of the system.

12. System capability for adequate cooling of all RCP seals and bearings.

13. Instrumentation and control features necessary to accomplish design functions, including isolation of components for leakage or malfunctions and actuation requirements for redundant equipment.

14. Simplified reliability analyses using event-tree and fault-tree logic techniques.

15. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

16. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

    For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. Sections 3.2.1 and 3.2.2: review of the acceptability of the seismic and quality group classifications for system components.

2. Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5: review of the acceptability of the design analyses, procedures, and criteria establishing the capability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena like the safe shutdown earthquake, probable maximum flood, and tornado missiles.

3. Section 3.4.1: review for flood protection.

4. Section 3.5.1.1: review of protection against internally-generated missiles.

5. Sections 3.5.1.4 and 3.5.2: review of SSC protection against the effects of externally-generated missiles.

6. Section 3.6.1: review of high- and moderate-energy pipe breaks.

7. Sections 3.9.1 and 3.9.3: review for whether components, piping, and structures are designed in accordance with applicable codes and standards.

8. Section 3.9.6: review of the adequacy of the inservice testing program of pumps and valves.

9. Sections 5.4.7, 5.4.8, 6.0, and 15.0: review of engineered safety feature components of the reactor coolant system and the ECCS required during normal operations, anticipated operational occurrences, and accident conditions. The review establishes cooling load functional requirements and minimum time intervals for safety-related components.

10. Section 6.6: review to verify whether system components meet inservice inspection requirements and the compatibility of the materials of construction with service conditions.

11. Section 7.1: review to determine the adequacy of the design, installation, inspection, and testing of all essential system controls and instrumentation required for proper operation. The review evaluation includes the signals for isolating safety-related from nonsafety-related reactor auxiliary CWS portions in postulated accidents with special emphasis on proper isolation of interconnected trains in unusual conditions like reactor auxiliary CWS low pressures or low current draws for safety-related pumps.

12. Section 8.1: review to determine the adequacy of the design, installation, inspection, and testing of all essential electrical components required for proper operation.

13. Section 8.4: overall review of compliance with station blackout requirements.

14. Section 9.2.1: review of the test program for monitoring the heat transfer capability of safety-related heat exchangers cooled by service water.

15. Section 9.5.1: review for fire protection.

16. Chapter 16.0: review for technical specifications.

17. Section 17.5: review for quality assurance.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. GDC 2 as to capability of structures housing the system and the system itself to withstand the effects of natural phenomena like earthquakes, tornadoes, hurricanes, and floods.

2. GDC 4 as to effects of missiles inside and outside of containment, effects of pipe whip, jets, environmental conditions from high- and moderate-energy line breaks, and dynamic effects of flow instabilities and attendant loads (i.e., water hammer) during normal plant operation as well as upset or accident conditions.

3. GDC 5 as to capability of shared systems and components important to safety to perform required safety functions.

4. GDC 44 as to:

   A. The capability to transfer heat loads from safety-related SSCs to a heat sink under both normal operating and accident conditions.

   B. Component redundancy for performance of safety functions assuming a single, active component failure coincident with the loss of offsite power.

   C. The capability to isolate components, systems, or piping, if required, so system safety functions are not compromised.

   D. Remote manual isolation of the RCP seal coolant water by the main control room operator for continued long-term pump operation in an actual event.

   E. Whether a single CWS failure results in fuel damage or reactor coolant leakage in excess of normal coolant-makeup capability. Single failure includes, but is not limited to, operator error, spurious activation of a valve operator, and loss of a cooling water pump.

   F. Whether a moderate-energy leakage crack or an accident from a CWS piping failure results in excessive fuel damage or reactor coolant leakage in excess of normal coolant makeup capability. A single, active failure is considered in evaluations of the consequences of this accident. Moderate leakage cracks are determined in accordance with the guidelines of Branch Technical Position 3-3, “Protection Against Postulated Piping Failures in Fluid Systems Outside Containment.”

   G. Demonstration by testing that RCPs withstand a complete loss of cooling water for 20 minutes and instrumentation in accordance with Institute of Electrical and Electronics Engineers Standard (IEEE Std) 603, as endorsed by RG 1.153 with control room alarms detecting loss of cooling water so a period of 20 minutes is available for the operator to have sufficient time to initiate manual protection of

the plant. Alternatively, if it is not demonstrated by the necessary pump testing that the RCPs will operate for 20 minutes without operator corrective action, then the following requirements apply:

i. Instrumentation in accordance with IEEE Std 603, as endorsed by RG 1.153 consistent with the criteria for the protection system to initiate automatic protection of the plant upon loss of cooling water to a pump. For this case, the component cooling water supply to the seal and bearing of the pump may be designed to nonseismic Category I requirements and Quality Group D; or

ii. The component cooling water supply to each pump is designed to withstand a single, active failure or a moderate-energy line crack as defined in Branch Technical Position ASB 3-1 and to seismic Category I, Quality Group C, and American Society of Mechanical Engineers (ASME) Section III Class 3 requirements.

6. GDC 45 as to design provisions for inservice inspection of safety-related components and equipment.

7. GDC 46 as to design provisions for operational functional testing of safety-related systems or components for:

   A. Structural integrity and system leak-tightness.

   B. Operability and adequate performance of active system components.

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

8. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

9. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. Protection Against Natural Phenomena. Information that addresses the requirements of GDC 2 regarding the capability of structures housing the reactor auxiliary CWS and the reactor auxiliary CWS itself to withstand the effects of natural phenomena will be considered acceptable if the guidance of Regulatory Guide (RG) 1.29, Position C.1 for safety-related portions of the reactor auxiliary CWS and Position C.2 for nonsafety-related portions of the reactor auxiliary CWS are appropriately addressed.

2. Environmental and Dynamic Effects. Information that addresses the requirements of GDC 4 regarding consideration of environmental and dynamic effects will be considered acceptable if the acceptance criteria in the following SRP sections, as they apply to the reactor auxiliary CWS, are met: SRP Sections 3.5.1.1, 3.5.1.4, 3.5.2, and SRP Section 3.6.1.

   In addition, the information will be considered acceptable if the design provisions presented in GL 96-06 and GL 96-06, Supplement 1 are appropriately addressed.

3. Sharing of Structures, Systems, and Components. Information that addresses the requirements of GDC 5 regarding the capability of shared systems and components important to safety to perform required safety functions will be considered acceptable if the use of the reactor auxiliary CWS in multiple-unit plants during an accident in one unit does not significantly affect the capability to conduct a safe and orderly shutdown and cool-down in the unaffected unit(s).

4. Cooling Water System. Information that addresses the requirements of GDC 44 regarding consideration of the cooling water system will be considered acceptable if the reactor auxiliary CWS and its components will continue to perform their required safety functions, assuming a single, active failure or a moderate-energy line crack as defined in Branch Technical Position ASB 3-1 and to seismic Category I, Quality Group C, and American Society of Mechanical Engineers (ASME) Section III Class 3 requirements concurrent with the loss of offsite power. In addition, the information will be considered acceptable based on appropriate application of IEEE Std 603, as endorsed by RG 1.153, and appropriate application of RG 1.155, Position C.3.3.4.

5. Cooling Water System Inspection. Information that addresses the requirements of GDC 45 regarding the inspection of cooling water systems will be considered acceptable if the periodic inspection of important reactor auxiliary CWS components ensures system integrity and capability to perform design safety functions.

6. Cooling Water System Testing. Information that addresses the requirements of GDC 46 regarding the testing of cooling water systems will be considered acceptable if periodic system pressure and function testing of the reactor auxiliary CWS will ensure the leak-tight integrity and operability of its components, as well as the operability of the system as a whole, at conditions as close to the design basis as practical.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena like earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform intended safety functions.

   The function of the reactor auxiliary CWS is to provide adequate cooling water to reactor system components, reactor shutdown equipment, ventilation equipment, and ECCS components during normal operations, anticipated operational occurrences, and

accident conditions. GDC 2 applies to this SRP section to ensure that the CWS can withstand the effects of all appropriate combinations of seismic and dynamic effects from these natural phenomena without loss of capability to perform design safety functions.

GDC 2 requirements provide assurance that the reactor auxiliary CWS and its equipment can operate during the most severe historical natural phenomena combined with appropriate normal operations and accident conditions without loss of capability to perform intended safety functions.

2. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of, and to be compatible with, environmental conditions of normal operations, maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs) and dynamic effects of pipe whip, missiles, and discharging fluids.

   GDC 4 applies to this SRP section because the reviewer evaluates the CWS and its equipment to verify their capability to continue functioning to ensure safe shutdown during normal operations, anticipated operational occurrences, and accident conditions. In addition, the CWS must be able to prevent or mitigate the consequences of an accident caused by exposure to environmental conditions of normal operations, maintenance, testing, or postulated accidents, including LOCAs and dynamic effects of pipe whip, missiles, and discharging fluids.

   GDC 4 requirements provide assurance that the reactor auxiliary CWS and its components will continue to perform required safety functions while exposed to environmental conditions of normal operations, maintenance, testing, and postulated accidents, including LOCAs and dynamic effects of pipe whip, missiles, and discharging fluids.

3. GDC 5 requires that SSCs important to safety not be shared by nuclear power units unless such sharing can be shown not to significantly impair their ability to perform their intended safety functions, including, in an accident in one unit, an orderly shutdown and cool-down of the remaining units.

   GDC 5 applies to this SRP section because the reviewer evaluates the use of the reactor auxiliary CWS in multiple-unit plants for whether an accident in one unit significantly affects the capability to conduct a safe and orderly shutdown and cool-down in other units.

   GDC 5 requirements provide assurance that the reactor auxiliary CWS and its components will continue to perform their required safety functions even if shared by multiple nuclear power units.

4. GDC 44 requires a system to transfer heat from SSCs important to safety. The system must be able to function under normal operating and accident conditions, assuming a single, failure concurrent with the loss of offsite power.

   GDC 44 applies to this SRP section because the reviewer evaluates the reactor auxiliary CWS for its capability to continue performing intended safety functions during normal operations, anticipated operational occurrences, and accident conditions, assuming a single, failure concurrent with the loss of offsite power.

   GDC 44 requirements provide assurance that the reactor auxiliary CWS and its components will continue to perform their required safety functions, assuming a single, failure concurrent with the loss of offsite power.

5. GDC 45 requires CWS design for appropriate periodic inspection of important components (e.g., heat exchangers and piping) to ensure system integrity and capability.

   GDC 45 applies to this SRP section because the reviewer evaluates the reactor auxiliary CWS for whether appropriate periodic inspection of important components (e.g., heat exchangers and piping) ensures the integrity and capability of the system to perform its safety-related functions during normal operations, anticipated operational occurrences, and accident conditions. In addition, the CWS must be able to prevent or mitigate the consequences of an accident.

   GDC 45 requirements provide assurance that important CWS components can be inspected, thereby ensuring system integrity and capability to perform design safety functions.

6. GDC 46 requires CWS design for appropriate periodic pressure and function testing to ensure the leak-tight integrity and operability of components, as well as the operability of the system as a whole, at conditions as close to the design basis as practical.

   GDC 46 applies to this SRP section because the reviewer evaluates the CWS for whether periodic system pressure and function testing will ensure the leak-tight integrity and operability of its components, as well as the operability of the system as a whole, at conditions as close to the design basis as practical.

   GDC 46 requirements provide assurance that components of the reactor auxiliary CWS can be tested, ensuring that it will be capable of performing intended safety functions.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

One of the main objectives in CWS review is to determine its safety function. Some cooling systems are designed as entirely safety-related, others have only portions safety-related, and others are classified as nonsafety-related because they perform no safety function. To determine the safety category of a reactor auxiliary CWS, the review evaluates its necessity for achieving safe reactor shutdown conditions or for preventing or mitigating accidents. The safety functions of these systems in all designs are essentially the same; however, the method varies from plant to plant depending upon the designer.

Upon request from the primary reviewer, the coordinating reviewers provide input for the areas of review in subsection I of this SRP section. The primary reviewer uses such input as required to complete this review procedure.

In view of the various designs, the procedures are for a typical reactor auxiliary CWS designed entirely as a safety-related system. Any variance of the review procedures to take account of a proposed unique design ensures that the system meets the criteria of subsection II of this SRP section.

1. The safety analysis report (SAR) information on the design bases and design criteria and the system description section are reviewed by the primary review organization for whether the equipment and the minimum system heat transfer and flow requirements for normal plant operations are identified. The system piping and instrumentation diagrams (P&IDs) show which system components:

   A. Remove heat from the reactor primary coolant system necessary to achieve a safe reactor shutdown.

   B. Provide essential cooling for containment components or systems like the sprays, ventilation coolers, or sump equipment.

   C. Cool decay heat removal equipment.

   D. Cool emergency core cooling pump bearings or other emergency core cooling equipment necessary to prevent or mitigate the consequences of an accident.

2. The system performance requirements section of the SAR is reviewed by the primary review organization for whether it describes allowable component operational degradation (e.g., pump leakage) and the procedures followed to detect and correct these conditions when degradation becomes excessive.

3. The primary review organization, using the results of failure-modes and effects analyses, determines whether the system can sustain the loss of any active component and, on the basis of previously-approved systems or independent calculations, whether the system meets minimum requirements (cooling load and flow) for these failure conditions. The system P&IDs, layout drawings, and component descriptions and characteristics then are reviewed for the following points:

   A. Essential CWS portions are identified correctly and can be isolated from the nonessential portions. The P&IDs are reviewed for whether they clearly indicate the physical division between each portion and indicate required classification changes. System drawings are reviewed for whether they show the means for accomplishing isolation, and the SAR description is reviewed for minimum performance of the isolation valves. The drawings and description are reviewed for whether automatically-operated isolation valves separate nonessential portions and components from the essential. Special consideration is given to redundant interconnected trains for operation of at least one safety-related train by proper isolation in an accident or anticipated operational occurrence.

   B. Essential CWS portions, including the isolation valves separating seismic Category I portions from the nonseismic, are Quality Group C and seismic Category I. System design bases and criteria and the component classification tables are reviewed for whether the heat exchangers, pumps, valves, and piping of essential system portions are designed to seismic Category I requirements in accordance with the applicable criteria. The review of seismic design and quality group classification is as indicated in subsection I of this SRP section.

   C. The system is designed to provide water makeup as necessary. Closed-loop CWSs are reviewed for whether the surge tanks have sufficient capacity to accommodate expected leakage from the system for seven days or whether a seismic source of makeup can be made available within a time frame consistent with the surge tank capacity (time zero starts at low level alarm). The surge tank and connecting piping are reviewed for whether makeup water can be supplied to either header in a split header system. Redundant surge tanks (one to each

header) or a divided surge tank design is acceptable to ensure that in a header rupture, the entire contents of the surge tank are not lost.

D. The system is designed for removal of heat loads during normal operation and for emergency core cooling heat loads during accident conditions with appropriate design margins for adequate operation. A comparative analysis is made of the system flow rates, heat levels, maximum temperature, and heat removal capabilities with similar designs previously found acceptable. An independent analysis may verify system performance characteristics.

E. Design provisions permit appropriate inservice inspection and functional testing of system components important to safety. The SAR information delineates a testing and inspection program, and the system drawings show the necessary test recirculation loops around pumps or isolation valves necessary for this program.

F. Essential portions of the system are protected from the effects of high-energy and moderate-energy line breaks. The system description and layout drawings are reviewed for whether no high- or moderate-energy piping systems are close to essential CWS portions, or for protection from the effects of failure. The means for such protection are in SAR Section 3.6, and the procedures for reviewing this information are in the corresponding SRP sections.

G. Essential components and subsystems (i.e., those necessary for safe shutdown) can function as required in a loss of offsite power and instrument air systems. The system design is acceptable if essential CWS portions meet minimum system requirements as stated in the SAR, assuming a concurrent failure of a single, active component, including a single failure of any auxiliary electric power source. The SAR is reviewed for whether, for each CWS component or subsystem affected by the loss of offsite power or instrument air systems, system flow and heat transfer capability exceed minimum requirements. The results of failure-modes and -effects analyses are considered for whether the system meets these requirements. This consideration is an acceptable verification of system functional reliability. The effects of loss of cooling water to RCP seals as a result of loss of power is reviewed by the secondary review organization as clarified in subsection III.4.E of this SRP section.

4. The system design information and drawings are analyzed by the primary review organization for whether the following features are incorporated:

A. A leakage detection system to detect component or system leakage is provided. An adequate means for implementing this criterion is by sumps or drains with adequate capacity and appropriate alarms in the immediate area of the system.

B. Components and headers of the system are designed for individual isolation capabilities to ensure system function, control system leakage, and allow system maintenance.

C. Design provisions ensure the capability to detect radioactivity leakage or chemical contamination from one system to another. Radioactivity monitors and conductivity monitors should be located in the system component discharge lines to detect leakage. An alternative means of preventing leakage is by operating the system at higher pressure so leakage is in the preferred direction.

D. The system is designed for cooling the RCP seals and bearings during normal plant operating conditions, anticipated operational occurrences, and following

postulated accidents. There should be instrumentation in accordance with IEEE Std 603, as endorsed by RG 1.153, with alarms in the control room to detect a loss of cooling water to ensure that the operator has a period of 20 minutes to initiate manual protection of the plant, if necessary.

E. For new pressurized-water reactor applications, the design provides for RCP seal integrity during station blackout. Acceptable provisions include a diverse injection/cooling system that may be powered from the alternate alternating current (AAC) source for station blackout independent of non-AAC source-backed injection/cooling systems and support systems to the extent practicable. Where a system for RCP seal injection/cooling is required specifically to meet the station blackout duration, the system should comply with RG 1.155, Position C.3.3.4, on ability to actuate and control the system from appropriate locations.

As an alternative to independent RCP seal cooling, the applicant may provide adequate testing data in support of the proposed RCP seal design and demonstrate maintenance of seal integrity after extended loss of seal injection and cooling. The capability of RCP seals to maintain their integrity following an external loss of cooling water is reviewed by the secondary review organization.

F. Design provisions are made for isolation of component cooling water supply and return lines to the RCP by remote manual means only. Design provisions are made for the control room operator to have the necessary information to determine when it is appropriate to isolate the lines by remote manual means and how soon the lines should be isolated if they become release paths from the containment during a LOCA.

5. The primary review organization verifies whether the system is designed to maintain system functions as required in such adverse environmental phenomena as earthquakes, tornadoes, hurricanes, and floods. The reviewer evaluates the system using engineering judgment and the results of failure-modes and -effects analyses to determine the following:

A. The failure of portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system or of nonseismic Category I structures that house, support, or are close to essential portions of the CWS does not preclude essential functions. The review identifies these nonseismic category components or piping and ensures appropriate provision of isolation capabilities in failure. Reference to SAR Chapter 2, describing site features and the general arrangement and layout drawings, is necessary as well as the SAR tabulation of seismic design classifications for structures and systems.

B. Essential CWS portions are protected from the effects of floods, hurricanes, tornadoes, and internally- or externally-generated missiles. Flood protection and missile protection criteria are evaluated in detail under the SRP sections for SAR Chapter 3. The reviewer uses the procedures in these SRP sections to ensure that the analyses presented are valid. A statement to the effect that the system is located in a seismic Category I structure tornado-, missile-, and flood-protected or that system components are located in individual cubicles or rooms that withstand both flooding and missiles is acceptable. The location and design of the system, structures, and pump rooms (cubicles) are reviewed for whether the degree of protection is adequate.

6. The SAR descriptive information, P&IDs, CWS drawings, and failure-modes and -effects analyses are reviewed by the primary review organization for whether essential portions of the system function following design-basis accidents, assuming a concurrent single, active component failure. The reviewer evaluates the SAR information to determine the ability of required components to function, traces the availability of these components on system drawings, and checks that the SAR information verifies that minimum system flow and heat transfer requirements are met for each accident situation for the required time spans. For each case, the design is acceptable if it meets minimum system requirements.

7. The SAR is reviewed by the primary review organization for whether the applicant commits to address the potential for water hammer in the auxiliary CWSs and provides means for prevention or avoidance (e.g., venting and filling capability) and operating procedures for avoidance of water hammer. Guidance for water hammer prevention and mitigation is in NUREG-0927 (Reference 12).

8. To address concerns about CWS equipment operability and containment integrity during design-basis accident conditions, the primary review organization verifies whether the applicant addresses the following CWS design provisions consistently with GL 96-06 and GL 96-06, Supplement 1:

   A. Capability of cooling water systems serving the containment air coolers to withstand the hydrodynamic effects of water hammer and to satisfy system design and operability requirements.

   B. Capability of cooling water systems serving the containment air coolers to meet heat removal assumptions for design-basis accident scenarios, even during two-phase flow conditions.

   C. Capability of isolated water-filled sections of piping in containment to withstand thermally-induced overpressurization.

9. For review of a DC application, the reviewers should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

   For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

10. For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The reactor auxiliary CWS includes pumps, heat exchangers, valves and piping, expansion tanks, makeup piping, and the points of connection or interfaces with other systems. Portions of the reactor auxiliary CWS necessary for safe shutdown and accident prevention or mitigation are designed to seismic Category I and Quality Group C requirements. After review of the applicant's proposed design criteria, design bases, and safety classification for the reactor auxiliary CWS as to the requirements for adequate cooling water for the safety-related ECCS components and reactor auxiliary equipment for all conditions of plant operation, the staff concludes that the design of the reactor auxiliary CWS is acceptable and meets the requirements of GDCs 2, 4, 5, 44, 45, and 46. These conclusions are based on the following findings:

1. The applicant meets GDC 2 requirements for system safety-related portions capable of withstanding the effects of earthquakes. Acceptance is based on RG 1.29, Position C.1 for the safety-related portions and Position C.2 for the nonsafety-related portions.

2. The applicant meets GDC 4 requirements for the effects of missiles inside and outside of containment, effects of pipe whip and jets, and environmental conditions caused by high- and moderate-energy line breaks and dynamic effects of flow instabilities and attendant loads (i.e., water hammer) as to impairment of the required functions of auxiliary cooling systems during normal plant operations and under upset or accident conditions. Acceptance as to effects of water hammer is based on the following:

   A. Vents for venting components and piping at high points in liquid-filled systems, which are normally idle and in which voids could occur, are provided. These vents should be located for ease of operation and periodic testing.

   B. If in the system design voiding could occur after pump shutdown or during standby, there should be means for a slow system fill upon pump start to avoid water hammer, or the system should be designed to maintain function following an inadvertent water hammer occurrence.

   C. The applicant shall review operation and maintenance procedures for adequate measures to avoid water hammer due to voided line conditions.

3. The applicant meets GDC 5 requirements for SSC sharing by demonstrating that such sharing does not significantly impair the ability of the reactor auxiliary CWS to perform safety functions, including, in an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

4. The applicant meets GDC 44 requirements for cooling water by a system to transfer heat from SSCs important to safety to an ultimate heat sink. The applicant has demonstrated that the reactor auxiliary CWS can transfer the combined heat load of these SSCs under normal operating and accident conditions, assuming loss of offsite power and a single failure, and that portions of the system can be isolated so system safety functions are not compromised.

   Also in meeting GDC 44 requirements the applicant has demonstrated that:

   A. The system can withstand a loss of power without damage to RCP seals in accordance with the guidance of subsection III.4.E of this SRP section.

   B. The RCP seal coolant lines do not isolate automatically.

C. The main control room operator has the necessary information and basis to determine when it is appropriate to isolate the lines by remote manual means and how fast the lines should be isolated.

5. The applicant meets GDC 45 requirements for inspection of CWSs by reactor auxiliary CWS design features for inservice inspection of safety-related components and equipment.

6. The applicant meets GDC 46 requirements for testing of CWSs by reactor auxiliary CWS design features for operational functional testing of the system and its components.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR 50.34(f), "Contents of Applications, Technical Information, Additional TMI-Related Requirements."

2. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."

3. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases."

4. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of Structures, Systems, and Components."

5. 10 CFR Part 50, Appendix A, GDC 44, "Cooling Water."

6. 10 CFR Part 50, Appendix A, GDC 45, "Inspection of Cooling Water System."

7. 10 CFR Part 50, Appendix A, GDC 46, "Testing of Cooling Water System."

8. RG 1.29, "Seismic Design Classification."

9. RG 1.153, "Criteria for Power, Instrumentation, and Control Portions of Safety Systems."

10. RG 1.155, "Station Blackout."

11. Branch Technical Position 3-3, “Protection Against Postulated Piping Failures in Fluid Systems Outside Containment.”

12. NRC Letter to All holders of operating licenses for nuclear power reactors, except for those licenses that have been amended to possession-only status, “Assurance of Equipment Operability And Containment Integrity During Design-Basis Accident Conditions (Generic Letter No. 96-06),” September 30, 1996.

13. NRC Letter to All holders of operating licenses for nuclear power reactors, except for those licenses that have been amended to possession-only status, “Assurance of Equipment Operability And Containment Integrity During Design-Basis Accident Conditions (Generic Letter No. 96-06, Supplement 1),” November 13, 1997.

14. NUREG-0927, Revision 1, “Evaluation of Water Hammer Occurrences in Nuclear Power Plants,” March 1984.

15. IEEE Std 603-1980, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations,” The Institute of Electrical and Electronics Engineers, Inc.