U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

9.2.2 REACTOR AUXILIARY COOLING WATER

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of cooling water systems

Secondary - Organization responsible for the review of component performance and testing
Organization responsible for the review of chemical control
Organization responsible for chemical affect on control room occupants
Organization responsible for radiation protection and monitoring

I. AREA OF REVIEW

The reactor auxiliary cooling water system (CWS), also referred to as the component cooling water system, provides a closed loop of cooling water for reactor system components (e.g. reactor coolant pump motor and drain tank cooler), reactor shutdown equipment, and spent fuel pool. Its function includes removing decay heat from the decay heat removal heat exchangers. In addition, the CWS may also provide cooling to non-essential related components. The CWS heat sink is provided by either air cooled chillers or the main cooling tower which are air-cooled.

The CWS may perform cooling water functions to nonsafety-related risk-significant and nonsafety-related nonrisk-significant equipment as part of a “passive plant” design. For these designs, the CWS may be subject to special regulatory treatment of nonsafety-related system (RTNSS) considerations. The criteria for classifying nonsafety-related systems that perform risk-significant or important functions as RTNSS are provided by SECY-94-084, and SECY 95-132, (References 26 and 33). Standard Review Plan (SRP) Section 19.3 RTNSS (passive designs only) provides the process used to identify the structures, systems, and components (SSCs) that are to be treated as RTNSS. As indicated in SRP Section 19.3, the RTNSS process uses Criteria A through E to determine the SSC functions.

For the passive designs, the CWS may be classified as either RTNSS Criterion B or RTNSS Criterion C, which are defined below as: (References 26 and 33)

1. Criterion B – Required to address SSC functions relied upon to resolve long-term (post-72 hour) safety and to address seismic events. This criterion pertains to SSCs required after 72 hours of a design-basis accident (DBA) initiation that are key to maintaining core cooling, containment integrity, control room habitability, and post accident monitoring that would require a RTNSS evaluation.

ADAMS Accession No. ML12325A088

Note: Long-term safety is defined as the period beginning 72 hours after a design basis event and lasting the following four days (168 hours) hereafter referred to as the "post-72 hour period[1]".

2. Criterion C – Required to meet safety goals of core damage frequency (CDF) less than $1.0E^{-4}$ and large release frequency (LRF) less than $1.06E^{-6}$, each reactor year. This criterion pertains to active nonsafety-related components relied upon to reduce initiating event frequencies, CDF and LRF in the focused probabilistic risk assessment (PRA) sensitivity study, the baseline PRA, or in the assessment of uncertainties that would require a RTNSS evaluation.

For the passive designs in support of nonsafety-related shutdown cooling (SDC), the CWS should be available to bring the plant to cold shutdown (CSD) conditions for inspection and repairs. The nonsafety-related CWS should be reliable and may not be subject to RTNSS (References 26 and 33).

The reliable nonsafety-related system SSCs are evaluated under SRP 17.6, Maintenance Rule, (Reference 30). These nonsafety-related components shall be monitored for performance against licensee-established goals, in a manner sufficient to provide reasonable assurance that these structures, systems, and components, are capable of fulfilling their intended functions.

For the evaluation of chilled water systems, chilled water and cooling water can be used interchangeably.

Depending on the design and RTNSS analysis, the CWS may be classified as:

- Safety-related risk-significant (e.g. containment valves/isolation)
- Safety-related nonrisk-significant
- Nonsafety-related risk-significant, which may include RTNSS Criterion B and RTNSS Criterion C SSCs
- Nonsafety-related nonrisk-significant, which may include functions to support CSD

The mPower^{TM} application will include the classification of SSCs, a list of risk-significant SSCs, and a list of RTNSS equipment. Based on this information, the staff will review according to DSRS Section 3.2, SRP Sections 17.4 and 19.3 to confirm the determination of the safety-related and risk-significant SSCs.

RTNSS Criterion B function pertains to SSCs required during the post-72 hour period that are key to maintaining long term safety which includes the functions to maintain core cooling and containment integrity. RTNSS B SSCs are considered nonsafety-related backups to safety related SSCs (References 26, 33 and SRP 19.3).

---

1 The "Post 72-hour period" is stated in SRP 19.3 defined as the period beginning 72 hours after a design basis event and lasting the following 4 days. This period is important from a safety perspective because passive plants are designed such that safety-related SSCs can satisfy all safety functions for a period up to 72 hours following a design basis event, but additional equipment and procedural action will be needed to either extend the ability of safety-related SSCs to accomplish the safety functions or perform the safety functions themselves until systems designed to bring the plant to a long-term cold shutdown condition can be put in service.

RTNSS Criterion C functions address safety goals of core damage frequency. RTNSS C SSCs are considered nonsafety-related defense-in-depth backups (References 26 and 33).

Defense-in-depth principles consist of a number of elements as described (Reference 29).

The specific areas of review for the safety-related CWS are as listed below. Additionally, the nonsafety-related areas of review are shown in ***bold-italics***. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (nonrisk-significant) CWS, nothing applies unless noted below.

1. Review safety/risk-significant classification as discussed above.

   Safety-related: Safety/risk-significant classifications are to be verified.

   RTNSS B and C and nonsafety-related nonrisk-significant: Safety/risk-significant classifications are to be verified.

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

   Note: RTNSS B SSCs are designed to withstand the effects of natural phenomena without loss of function. RTNSS C SSCs are evaluated, utilizing the "graded approach philosophy", against the effects of the most probable hazards (e.g. floods, winds, missiles, seismic events). As a result of this evaluation, RTNSS C may be designed against the effects of natural phenomena. SRP Section 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

   Note: RTNSS B SSCs are analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g., turbine missiles, pipe whip).

3. The capability of the auxiliary cooling systems to provide adequate cooling water to reactor auxiliary equipment for normal and abnormal conditions.

   RTNSS B: apply for functions in the post-72 hour period. .

   RTNSS C: apply for defense-in-depth functions in order to meet NRC safety goal guidelines.

   Nonsafety-related nonrisk-significant: apply for normal and abnormal conditions.

4. 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 operations during and following other abnormal events.

   RTNSS B: applies for functions in the post-72 hour period.

   RTNSS C: may apply defense-in-depth functions in order to meet NRC safety goal guidelines.

5. Multiple performance functions (if required) assigned to the system and the necessity of each function.

   RTNSS B: applies for functions in the post-72 hour period.

   RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

6. The capability of the system surge tank to perform its intended function with considerations for system leakage.

   RTNSS B and C: apply.

7. The capability of the system to provide adequate cooling water during normal operating conditions and abnormal operating conditions.

   RTNSS B: applies for functions in the post-72 hour period.

   RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

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

   RTNSS B: applies for functions in the post-72 hour period.

   RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

   Nonsafety-related nonrisk-significant: may apply. Functions that support achieving and maintaining CSD conditions are reviewed.

9. The effects of non-seismic Category I component failures on the seismic Category I portion of the system (e.g. containment penetrations).

   RTNSS B and C and nonsafety-related nonrisk-significant: apply.

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.

    RTNSS B and C and nonsafety-related nonrisk-significant: apply.

11. The requirements for operational testing and in-service inspection of the system.

    RTNSS B and C: does not directly apply. Testing and in-service inspection are elements of the reliability assurance program (RAP). Also, surveillance testing is done for items in the Availability Controls Manual. Alternative criteria are addressed in SRP Section 19.3 on the programmatic requirements for RTNSS with respect to inspection and testing.

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

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines (actuation for redundant equipment may not be required).

13. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicants proposed ITAAC associated with the structures, systems, and components (SSCs) related to this DSRS section in accordance with DSRS 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 DSRS 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 DSRS Section 14.3 and Regulatory Guide (RG) 1.206 (Reference 30).

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

14. 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.

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

15. The provisions for minimization of contamination of the facility and environment, the generation of radioactive waste, and the provisions to facilitate eventual decommissioning.

RTNSS B and C and nonsafety-related nonrisk-significant: apply.

Review Interfaces

Other DSRS or SRP sections interface with this section for safety-related and nonsafety-related CWS, as follows:

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

2. DSRS Sections 3.3.1, 3.3.2, 3.5.3, and 3.7.2, and SRP Sections 3.7.1, 3.7.3, 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. DSRS Section 3.4.1: review for flood protection.

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

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

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

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

8. DSRS Section 3.9.6: review of the adequacy of the in-service testing program of pumps and valves.

9. DSRS Sections 5.4.7, 6.3, and 15.0: review of engineered safety feature components of the reactor coolant system and the ECCS required during normal operations, AOOs, and accident conditions. The review establishes or verifies if CWS is needed to support cooling load functional requirements.

10. DSRS Section 6.2.4, review of the isolation of fluid systems penetrating the containment boundary.

11. DSRS Section 6.6: review to verify whether system components meet in-service inspection requirements and the compatibility of the materials of construction with service conditions.

12. DSRS Chapter 7: 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.

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

14. DSRS Section 8.4: review to determine the cooling of components related to station blackout (SBO) requirements.

15. SRP Section 9.5.1: review for fire protection.

16. DSRS Section 12.3-12.4: review for radiation protection design features.

17. DSRS Sections 14.2 and 14.3.7: review for initial plant testing and plant systems ITAAC.

18. DSRS Section 11.5, as it relates to the review for radiation monitoring systems and specified detection sensitivity in response Table 2 of DSRS Section 11.5 in the context of IE Bulletin 80-10 about uncontrolled and unmonitored releases for systems not covered by the offsite dose calculation manual.

19. DSRS Chapter 16.0: review for technical specifications.

20. SRP Section 17.5: review for quality assurance.

21. SRP Section 19.3: review for probabilistic risk assessment and for the applicable risk classification.

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

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations. The specific areas of review for the safety-related CWS are as listed below. Additionally, the nonsafety-related areas of review are shown in ***bold-italics***. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (nonrisk-significant) CWS, nothing applies unless noted below.

1. GDC 1, as to SSCs important to safety being designed, fabricated, erected and tested to to quality standards commensurate with the importance of the safety functions to be performed (as it relates to containment isolation function only).

2. GDC 2, as to SSCs important to safety being designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, tsunami, seiches and floods without loss of capability to perform their safety functions (as it relates to containment isolation function only).

   Note: RTNSS B SSCs are designed to withstand the effects of natural phenomena without loss of function. RTNSS C SSCs are evaluated, utilizing the "graded approach philosophy", against the effects of the most probable hazards (e.g. floods, winds, missiles, seismic events). As a result of this evaluation, RTNSS C maybe designed against the effects of natural phenomena. SRP Section 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. GDC 4, as to SSCs important to safety being appropriately protected against dynamic effects, including the effects of missiles, pipe whipping and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

   Note: RTNSS B SSCs are analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g., turbine missiles, pipe whip).

4. GDC 5, as to SSCs important to safety which shall be designed not to be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.

5. GDC 44, as to:

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

   B. Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

6. GDC 45, as to design provisions for appropriate periodic inspection of important components, such as heat exchanges and piping, to assure the integrity and capability of the system..

7. GDC 46 as to design provisions to permit appropriate periodic pressure and functional test to assure;

   A. The structure and leaktight integrity of its components.

   B. The operability and the performance of active components of the system.

   C. The operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for loss-of-coolant accidents, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources

8. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed 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 facility that incorporates the DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act (AEA), and the U.S. Nuclear Regulatory Commission's (NRC's) rules and regulations.

   RTNSS B and C apply for the review for ITAAC related to the importance of each function.

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 AEA, and the NRC's rules and regulations.

RTNSS B and C apply for the review for ITAAC related to the importance of each function.

10. 10 CFR 20.1406(a), which requires that a DC or COL applicant to describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

RTNSS B and C and nonsafety-related (nonrisk-significant): apply

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information."

The specific areas of review for the safety-related CWS (e.g. containment isolation function) are as listed below. Additionally, the nonsafety-related areas of review are shown in ***bold-italics***. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (nonrisk-significant) CWS, nothing applies unless noted below.

1. Quality standards and records. Information that addresses the requirements of GDC 1 regarding the quality standards and records for SSCs important to safety will be considered acceptable if the guidance of RG 1.28, "Quality Assurance Program Requirements (Design and Construction)," are appropriately addressed. A quality assurance program shall be established and implemented. Appropriate records of the design, fabrication, erection, and testing of SSCs important to safety shall be maintained.

2. 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 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.

   Note: RTNSS B SSCs are designed to withstand the effects of natural phenomena without loss of function. RTNSS C SSCs are evaluated, utilizing the "graded approach philosophy", against the effects of the most probable hazards (e.g. floods, winds, missiles, seismic events). As a result of this evaluation, RTNSS C maybe designed against the effects of natural phenomena. SRP Section 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. 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 DSRS sections, as they apply to the reactor auxiliary CWS, are met: DSRS Sections 3.5.1.1, 3.5.1.4, 3.5.2, and 3.6.1.

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

Note: RTNSS B SSCs are analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g., turbine missiles, pipe whip).

4. Sharing of SSCs. 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).

5. 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 BTP ASB 3-3 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 (LOOP). In addition, the information will be considered acceptable based on appropriate application of IEEE Std 603, as endorsed by RG 1.153, “Criteria for Safety Systems,” and appropriate application of RG 1.155, “Station Blackout,” Position C.3.3.4.

6. 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.

7. 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 (Technical Specifications) of its components, as well as the operability of the system as a whole, at conditions as close to the design basis as practical.

8. 10 CFR 20.1406. Minimization of contamination to the facility and the environment, and designs to facilitate eventual decommissioning, will be considered acceptable if the design identifies provisions to detect contamination that may enter as in-leakage from other systems, identifies potential collection points such as water treatment systems or system low points, and addresses the long-term control of radioactive material in the system.

RTNSS B and C and nonsafety-related nonrisk-significant: apply.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs. The specific areas of review for the safety-related CWS (e.g. containment isolation function) are as listed below. Additionally, the nonsafety-related areas of review are shown in ***bold-italics***. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (nonrisk-significant) CWS, nothing applies unless noted below.

1. GDC 1 requires that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

2. GDC 2 requires that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena and (3) the importance of the safety functions to be performed

   The function of the reactor auxiliary CWS is to provide adequate cooling water to reactor system components, reactor shutdown equipment, and fuel pool cooling during normal operations, AOOs, and accident conditions. GDC 2 applies to this DSRS 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 (e.g. containment isolation).

   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.

   Note: RTNSS B SSCs are designed to withstand the effects of natural phenomena without loss of function. RTNSS C SSCs are evaluated, utilizing the "graded approach philosophy", against the effects of the most probable hazards (e.g. floods, winds, missiles, seismic events). As a result of this evaluation, RTNSS C maybe designed against the effects of natural phenomena. SRP Section 19.3

provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. GDC 4 requires that SSCs important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

   GDC 4 applies to this DSRS section because the reviewer evaluates the CWS and its equipment to verify their capability to continue functioning to ensure safe-shutdown during normal operations, AOOs, and accident conditions (e.g. containment isolation). 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, water hammer, and discharging fluids.

   Note: RTNSS B SSCs are analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g., turbine missiles, pipe whip).

4. 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 DSRS 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.

5. GDC 44 requires that SSC*s* important to safety, to an ultimate heat sink shall be provided. The system safety function shall be to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.

Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.

GDC 44 applies to this DSRS section because the reviewer evaluates the reactor auxiliary CWS for its capability to continue performing intended safety functions during normal operations, AOOs, and accident conditions, assuming a single failure concurrent with the LOOP.

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 LOOP.

6. *G*DC 45 requires that the cooling water system shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the system.

GDC 45 applies to this DSRS 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, AOOs, 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.

7. GDC 46 as to design provisions to permit appropriate periodic pressure and functional test to assure;

   A. The structure and leaktight integrity of its components.

   B. The operability and the performance of active components of the system.

   C. The operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for loss-of-coolant accidents, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources

GDC 46 applies to this DSRS 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.

8. 10 CFR 20.1406(a), which requires that a DC or COL applicant to describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

   10 CFR 20.1406(a) applies to this DSRS section because the CWS couples to the primary coolant system across heat exchangers, and the possibility of leakage of contaminated primary coolant into the CWS exists.

   RTNSS B and C and nonsafety-related nonrisk-significant: apply.

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 DSRS 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 DSRS 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 DSRS section.

The specific areas of review for the safety-related CWS are as listed below. Additionally, the nonsafety-related areas of review are shown in ***bold-italics***. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (nonrisk-significant) CWS, nothing applies unless noted below.

1. Programmatic Requirements ─ In accordance with the guidance in NUREG-0800 "Introduction," Part 2 as applied to this DSRS Section, the staff will review the programs proposed by the applicant to satisfy the following programmatic requirements. If any of the proposed programs satisfies the acceptance criteria described in Subsection II, it can be used to augment or replace some of the review procedures. It should be noted that the wording of "to augment or replace" applies to nonsafety-related risk-significant SSCs, but "to replace" applies to nonsafety-related nonrisk-significant SSCs according to the "graded approach" discussion in NUREG-0800 "Introduction," Part 2. Commission regulations and policy mandate programs applicable to SSCs that include:

A. Maintenance rule, SRP Section 17.6 (DSRS Section 13.4, Table 13.4, Item 17, RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," and RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants."

B. Quality Assurance Program, SRP Sections 17.3 and 17.5 (DSRS Section 13.4, Table 13.4, Item 16).

C. Technical Specifications (DSRS Section 16.0 and SRP Section 16.1) – including brackets value for DC and COL. Brackets are used to identify information or characteristics that are plant specific or are based on preliminary design information.

D. Reliability Assurance Program (SRP Section 17.4).

E. Initial Plant Test Program (RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," DSRS Section 14.2, and DSRS Section 13.4, Table 13.4, Item 19).

F. ITAAC (DSRS Chapter 14).

RTNSS B and C: apply; however, Technical Specification may not apply and are replaced with Short-Term Availability Controls, as required.

2. In accordance with 10 CFR 52.47(a)(8),(21), and (22), for new reactor license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium- and high-priority generic safety issues that are identified in the version of NUREG-0933 current on the date 6 months before application and that are technically relevant to the design; (2) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v). These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding safety evaluation report (SER) section.

3. The safety analysis report (SAR) information on the design bases and design criteria and the system description section are reviewed 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 its RTNSS functions.

RTNSS B: applies, since RTNSS B SSCs are considered risk-significant for functions in the post-72 hour period.

RTNSS C: may apply for defense-in-depth functions in order to meet NRC safety goal guidelines.

Note: For RTNSS B, as described in DSRS Section 9.2.5, functions are expected to be available in the post-72 hour period[2] with onsite SSCs with available water sources. Offsite assistance and supplemental equipment and water sources may be required to maintain CSD conditions to 30 days.

B. Cool RTNSS components.

RTNSS B: applies, since RTNSS B SSCs are considered risk-significant for function the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines

4. The system performance requirements section of the SAR is reviewed 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.

RTNSS B and C: apply.

5. 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. Important 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 RTNSS trains by proper isolation.

RTNSS B: applies, since RTNSS B SSCs are considered risk-significant.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines. Replace "essential CWS" with "important CWS." Delete last sentence starting with special consideration…"

B. Important CWS portions meet seismic Category II design requirements. System design bases and criteria and the component classification tables are reviewed for whether the heat exchangers, pumps, valves, and piping of important system

[2] The staff has previously accepted that defense-in-depth functions are to be available in the post-72 hour period and lasting the following 4 days (168 hours) for the Economic Simplified Boiling Water Reactor and AP1000 DCs.

portions are designed to seismic Category II requirements in accordance with the applicable criteria. The review of seismic design and quality group classification is as indicated in Subsection I of this DSRS section.

RTNSS B: applies, since RTNSS B SSCs are considered risk-significant.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

Note: RTNSS B SSCs are designed to withstand the effects of natural phenomena without loss of function. RTNSS C SSCs are evaluated, utilizing the "graded approach philosophy", against the effects of the most probable hazards (e.g. floods, winds, missiles, seismic events). As a result of this evaluation, RTNSS C maybe designed against the effects of natural phenomena. SRP Section 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

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. Automatic or manual makeup operation maybe required. Surge tanks are to be designed with instrumentation to determine overall system leakage. Surge tanks are designed for normal system and abnormal in-leakage contractions and expansion without radiological consequences such as spills of CWS to the floor.

RTNSS B: applies since RTNSS B SSCs are considered risk-significant.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

D. The system is designed for removal of heat loads during normal operation and for RTNSS functions. However, for RTNSS functions, margins in system flow rates, heat levels, maximum temperature, and heat removal capabilities are reviewed. Calculations should be available for an audit by the staff.

RTNSS B and C: apply, since RTNSS B and C SSCs are considered risk-significant. Design margins, such as system heat loads, pump and heat exchanger performance, pump net positive suction head requirements, are reviewed.

Nonsafety-related nonrisk-significant: may apply. Functions that support achieving and maintaining CSD conditions are reviewed.

E. Design provisions permit appropriate in-service 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.

RTNSS B and C: do not directly apply, since RTNSS B and C SSCs are considered risk-significant. Testing and in-service inspection are elements of the RAP. Also, surveillance testing is done for items in the Availability

Controls Manual. Alternative criteria are addressed in DSRS Section 19.3 on the programmatic requirements for RTNSS with respect to inspection and testing.

F. The system may be evaluated for protection from the effects of high-energy and moderate-energy line breaks. The system description and layout drawings are reviewed (if available) 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 DSRS

RTNSS B: apply for functions in the post-72 hour period.

RTNSS C: apply for defense-in-depth functions in order to meet NRC safety goal guidelines.

The design functions are reviewed against high energy line breaks.

G. Components and subsystems can function as required in a LOOP and instrument air systems. The system design is acceptable if the CWS 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 LOOP or instrument air systems, system flow and heat transfer capability exceed minimum requirements.

RTNSS B: applies. RTNSS B SSCs are considered risk-significant. RTNSS B SSCs do not need to operate during accident conditions, but are required for the post-72 hour period. Single failure is considered to support functions in the post-72 hour period.

RTNSS C: applies. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon in order to meet NRC safety goals guidelines.

Nonsafety-related nonrisk-significant: may apply.
SSCs that support achieving and maintaining CSD conditions in the post-72 hour period should be designed to be reliable. Failure-modes and effects analyses are not performed. Add the following to the end of the above paragraph:

However, functions that supports achieving and maintaining CSD in the post-72 hour period, the design function is reviewed.

6. 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 (including backup power for alarms) in the immediate area of the system.

RTNSS B and C: apply.

Nonsafety-related nonrisk-significant: applies.

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

RTNSS B and C: apply.

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.

RTNSS B and C: apply.

Nonsafety-related nonrisk-significant: applies.

D. The system is designed for cooling the RCP motor bearings during normal plant operating conditions.

RTNSS B and C: may not apply. It is assumed that RTNSS functions are not required for RCP seal/thermal barrier cooling.

E. Design provisions are made for the CWS piping associated with the RCS pressure boundary cooler to be designed to withstand those conditions that are associated with a possible break at the reactor coolant pump heat exchanger, (RCS conditions; pressure and temperature). The CWS piping system (protecting the lower CWS designed pressure) should be automatically isolated during sensed conditions of a breach or break in the thermal barrier heat exchanger (or other RCS pressure boundary cooler) by at least two of these four variables; pressure, temperature, flow, or radiation.

RTNSS B and C: apply. The consequence of a break should be evaluated with respect to SSCs in the affected area of the break. Containment valves and penetrations effects are to be evaluated as they apply.

Nonsafety-related nonrisk-significant: The consequence of a break should be evaluated with respect to SSCs in the affected area of the break. Containment valves and penetrations effects are to be evaluated as they apply.

F. Design consideration and provisions are made to address plate-type heat exchangers (also referred to as frame-type heat exchanger. Chemical controls and or system filters/strainers maybe required since the plate-type heat exchangers employ narrow clearances (generally in the 3 mm or less range).

System leakage and radiological considerations are reviewed due to the large number of gaskets utilized in the design of the plate-type heat exchangers, Reference 23. The effects of chemical controls are reviewed by the secondary review organization.

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

G. Design considerations and provision are made to address CWS voiding and gas intrusion. Gas intrusion or air voids have an extreme negative effect and may cause the CWS pumps to become inoperable and not able to perform their intended function.

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

H. For systems that utilized mechanical chillers, they are selected and arranged to provide reliability and redundancy to transfer heat. Review emphases are placed on:

i. Air cooled mechanical chillers are adequately designed to the outside environmental (dry bulb) conditions.

ii. Chiller (condenser, evaporator, and compressor) design margins.

iii. Instrumentation and controls such as chiller trips with automatic starts of standby chillers.

iv. Refrigerants and refrigerant leak detection systems (evaluated against potential effects to main control room occupants by secondary reviewers).

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

Nonsafety-related nonrisk-significant: applies to refrigerant leak detection systems.

7. The reviewer verifies whether the system is designed to maintain system functions as required in such adverse environmental phenomena as earthquakes, tornadoes, tsunami, 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 important portions of the system or of non-seismic Category I structures that house, support, or are close to important portions of the CWS does not preclude functions important to safety. The review identifies these non-seismic 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.

RTNSS B: applies. RTNSS B SSCs are considered risk-significant RTNSS B SSCs do not need to operate during accident conditions, but in the post-72 hour period. Single failure is considered to support functions in the post-72 hour period.

RTNSS C: applies. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon in order to meet NRC safety goals guidelines.

Delete paragraph and replace with:

The failure of portions of the system or of other systems not designed to seismic Category I standards and located close to important portions of the system or of non-seismic Category I structures that house, support, or are close to important portions of the CWS does not preclude its ability to support defense-in-depth functions. The review identifies these non-seismic 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. Important 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 DSRS sections for SAR Chapter 3. The reviewer uses the procedures in these DSRS sections to ensure that the analyses presented are valid. A statement to the effect that the system is located in a seismically qualified 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.

RTNSS B: applies. RTNSS B SSCs are considered risk-significant. RTNSS B SSCs do not need to operate during accident conditions, but are required to operate in the post-72 hour period. RTNSS B SSCs are analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g., turbine missiles, pipe whip).

RTNSS C: applies. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon in order to meet NRC safety goals guidelines. Delete paragraph and replace with:

Defense-in-depth CWS portions maybe 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 DSRS sections for SAR Chapter 3. The reviewer uses the procedures in these DSRS sections to ensure that the analyses presented are valid. A statement to the effect that the system is located in a seismic qualified (Category I or II) tornado-, missile-, and flood-protected structure 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.

8. The SAR descriptive information, P&IDs and CWS drawings are reviewed by the primary review organization for whether the system function, 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 case, the design is acceptable if it meets minimum system requirements.

RTNSS B: applies. RTNSS B SSCs are considered risk-significant. RTNSS B SSCs do not need to operate during accident conditions, but are required for the post-72 hour period

RTNSS C: applies. Failure-modes and effects analyses are not performed. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon in order to meet NRC safety goals guidelines. Delete paragraph and replace with:

The SAR descriptive information, P&IDs, and CWS drawings, are reviewed. 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 defense-in-depth function. For each case, the design is acceptable if it meets minimum system requirements.

Nonsafety-related (nonrisk-significant): may apply. Delete paragraph and replace with:

The SAR descriptive information, P&IDs, and CWS drawings, are reviewed for whether portions of the CWS support taking the plant to CSD and maintain CSD conditions in the post-72 hour period. 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 case, the design is acceptable if it meets minimum system requirements.

9. 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 19).

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

Nonsafety-related nonrisk-significant: Water hammer is reviewed to the extent that consequences from a water hammer do not negatively affect safety-related SSCs or RTNSS B SSCs.

10. To address concerns about CWS equipment operability and containment integrity during DBA 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 isolated water filled sections of piping in containment to withstand thermally induced overpressurization.

RTNSS B: applies for functions in the post-72 hour period.
RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

Nonsafety-related nonrisk-significant: applies.

11. 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).

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

12. For review of both DC and COL applications, DSRS 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.

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

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 SER. 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 1, 2, 4, 5, 44, 45, and 46. These conclusions are based on the following findings.

The specific areas of review for the safety-related CWS are as listed below. Additionally, the nonsafety-related areas of review are shown in ***bold-italics***. RTNSS B and C functions, if they apply, are also shown below. For nonsafety-related (nonrisk-significant) CWS, nothing applies unless noted below.

1. The applicant meets GDC 1 requirements for the CWS. Acceptance is bases on the SSCs important to safety as being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Recognized codes and standards shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product. Appropriate records of the design, fabrication, erection, and testing of SSCs important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.

2. The applicant meets GDC 2 requirements for system safety-related portions capable of withstanding the effects of natural phenomena such as earthquake, tornado, hurricane flood, tsunami, and seiche without loss of capability to perform intended safety function. For 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.

   Note: RTNSS B SSCs are designed to withstand the effects of natural phenomena without loss of function. RTNSS C SSCs are evaluated, utilizing the "graded approach philosophy", against the effects of the most probable hazards (e.g. floods, winds, missiles, seismic events). As a result of this evaluation, RTNSS C maybe designed against the effects of natural phenomena. SRP Section 19.3 provides further guidance related to the reliability and availability missions of RTNSS B and C SSCs.

3. 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 (e.g. containment isolation). 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.

   D. CWS preoperational testing maybe necessary to verify that during various system alignments or train transfers/shutdowns there is no evidence of water hammer occurrence.

   Note: RTNSS B SSCs are analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g., turbine missiles, pipe whip).

4. 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 cool down of the remaining unit(s).

5. 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 LOOP and a single failure, and that portions of the system can be isolated so system safety functions are not compromised. The design has been evaluated for adequate margins related to heat exchanger heat removal performance during normal and accident conditions; CWS pump pressure (head) and system flow rates during normal and accident conditions.

   Also in meeting GDC 44 requirements the applicant has demonstrated that CWS pumps are adequately designed related to net positive suction head required ($NPSH_r$) and are evaluated against NPSH available ($NPSH_a$) under normal and accident conditions. Potential CWS pump vortexing conditions are also evaluated.

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

7. 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.

8. The applicant meets 10 CFR 20.1406 requirements for minimization of contamination of the facility and the environment, and for avoiding design features that would interfere with eventual decommissioning.

RTNSS B and C and nonsafety-related nonrisk-significant: apply.

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 DSRS section.

RTNSS B: applies for functions in the post-72 hour period.
RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

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.

RTNSS B: applies for functions in the post-72 hour period.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific DC, or COL, applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM-COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (Agencywide Documents Access and Management System Accession No. ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor reviews, including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™-specific DC, or COL submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9), as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing

this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47(a)(9). Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

VI. REFERENCES

1. 10 CFR 20.1406, “Minimization of Contamination.”

2. 10 CFR 50.34(f), “Contents of Applications, Technical Information, Additional TMI-Related Requirements.”

3. 10 CFR Part 50, Appendix A, GDC 1, “Quality standards and records.”

4. 10 CFR Part 50, Appendix A, GDC 2, “Design Bases for Protection Against Natural Phenomena.”

5. 10 CFR Part 50, Appendix A, GDC 4, “Environmental and Dynamic Effects Design Bases.”

6. 10 CFR Part 50, Appendix A, GDC 5, “Sharing of Structures, Systems, and Components.”

7. 10 CFR Part 50, Appendix A, GDC 44, “Cooling Water.”

8. 10 CFR Part 50, Appendix A, GDC 45, “Inspection of Cooling Water System.”

9. 10 CFR Part 50, Appendix A, GDC 46, “Testing of Cooling Water System.”

10. 10 CFR Part 52.47(b)(1), “Contents of Applications, Technical Information, Inspections, Tests, Analyses, and Acceptance Criteria.”

11. 10 CFR Part 52.80(a), “Contents of Applications, Additional Technical Information, Inspections, Tests, Analyses, and Acceptance Criteria.”

12. RG 1.29, “Seismic Design Classification.”

13. RG 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants.”

14. RG 1.153, ”Criteria for Safety Systems.”

15. RG 1.155, ”Station Blackout.”

16. RG 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.”

17. RG 1.182, “Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants.”

18. RG 1.215, “Guidance for ITAAC Closure Under 10 CFR Part 52.”

19. 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 (GL 96-06),” September 30, 1996.

20. 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 (GL 96-06, Supplement 1),” November 13, 1997.

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

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

23. Nuclear Management and Resources Council (NUMARC) Report 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors,"

24. GL 23, “Reactor Coolant Pump Seal Failure” and its Possible Effects on Station Blackout (GL 91-07)

25. EPRI TR 101347, “Plant Support Engineering: Guidance for Replacing Heat Exchangers at Nuclear Power Plant with Plate Heat Exchanger,” July 2006.

26. SECY-95-132, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in the Passive Plant Designs,” dated May 22, 1995, and associated SRM, June 28, 1995.

27. EPRI TR 1007361, “Chiller Performance Monitoring and Troubleshooting Guideline,” November 2002,

28. BTP 3-3, “Protection Against Postulated Piping Failures in Fluid Systems Outside Containment.”

29. RG 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis.”

30. 10 CFR 50.65, “Requirements for monitoring the effectiveness of maintenance at nuclear power plants.”

31. RG 1.28, “Quality Assurance Program Criteria (Design and Construction).”

32. RG 1.206, “Combined License Applications for Nuclear Power Plants.”

33. SECY-94-084, “Policy and Technical Issues Associated with the Regulatory Treatment of Non-safety Systems in Passive Plant Designs,” dated March 28, 1994, and associated Staff Requirements Memorandum (SRM), June 30, 1994.