U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER^{TM} iPWR DESIGN

9.2.1 STATION SERVICE 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
Organization responsible for the review of chemical control
Organization responsible for radiation protection and monitoring

I. AREA OF REVIEW

For active plants, the service water system (SWS) provides cooling to essential auxiliary components used for normal and abnormal plant operation.

The mPower^{TM} standard plant design may not utilize a separate SWS. Discussion of the component cooling water (CCW) heat sinks (based on operation mode) may be provided in Sections 9.2.2, 9.2.7 and 10.4.5 of the mPower^{TM} Design Control Document (DCD). The balance of this DSRS may be utilized as necessary and is based on the SWS as it applies to active power plants and passive power plants (such as the AP1000 or Economic Simplified Boiling Water Reactor (ESBWR)).

The SWS provides essential cooling to safety-related equipment and may also cool nonsafety-related auxiliary components used for normal plant operation. The SWS safety-related system is reviewed for compliance with the requirements of General Design Criteria (GDCs) 1, 2, 4, 5, 44, 45, and 46. The SWS is reviewed from the service water pump intake to the points of cooling water discharge. The ultimate heat sink (UHS), reviewed under Design-Specific Review Standard (DSRS) Section 9.2.5, is the intake source of water to the SWS for long-term cooling of station features required for plants shutdown and also of any special equipment required to prevent or mitigate the consequences of postulated accidents and as such is an SWS interface system. The SWS pump performance characteristics are compared to the high and low water levels of the UHS to assure pumping capability for extended periods of operation following postulated events.

This DSRS is applicable to an array of similar open and closed cooling systems such as emergency SWS, SWS, plant SWS, essential SWS and non-essential SWSs. This DSRS is also applicable to those makeup water systems needed to support SWS; however, makeup water systems to support the UHS is described in DSRS Section 9.2.5.

The review of the SWS encompasses components required for normal operations, and post accident functions.

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For active plants, portions of the SWS are typically safety-related and GDCs 1, 2, 4, 5, 44, 45, and 46 are applicable since the SWS performs a function that is "important to safety." For passive plants, the GDCs do not apply to the portions of the SWS which are nonsafety-related since the SWS does not perform a function that is "important to safety."

The SWS 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 SWS 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 (Reference 28). Standard Review Plan (SRP) Section 19.3 provides the process used to identify the structures, systems, and components (SSCs) that are to be treated as RTNSS. As indicated in SRP Section19.3, the RTNSS process uses Criteria A through E to determine the SSC functions.

For the passive designs, SWS may be classified as either RTNSS Criterion B (RTNSS B) or RTNSS Criterion C (RTNSS C), which is defined below (Reference 28):

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

   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, SWS, in support of nonsafety-related shutdown cooling, and reactor auxiliary cooling water system (CWS) reviewed under DSRS Section 9.2.2, SWS should be available to bring the plant to cold shutdown (CSD) conditions for inspection and repairs. The nonsafety-related SWS should be reliable and is potentially subject to RTNSS Criterion, (Reference 28).

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1 The "Post 72-hour period" is stated in SRP 19.3 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.

Note: For both active and passive plants, there could be portions of the SWS which are nonsafety-related.

The reliable nonsafety-related system SSCs are evaluated under SRP 17.6, Maintenance Rule, (Reference 32). 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.

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

Safety-related risk-significant
Safety-related nonrisk-significant
Nonsafety-related risk-significant, which includes RTNSS B and RTNSS C
Nonsafety-related nonrisk-significant, which may include functions to support CSD

The mPower™ 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 addresses long-term safety, in the post-72 hour period which includes the functions to maintain core cooling and containment integrity. RTNSS B SSCs are considered nonsafety-related backups to safety-related SSCs.

RTNSS Criterion C functions address safety goals of core damage frequency. RTNSS C SSCs are considered nonsafety-related defense-in-depth backups.

Defense-in-depth principles consist of a number of elements as described in (Reference 30).

Site-specific SWS portions may not be within the scope of the design submitted by applicants for design certification (DC) under 10 CFR Part 52. The SWS piping, valves, instrumentation, and controls within the DC applicant's scope are reviewed as part of the DC submission. Site-specific portions of the design (may include the SWS pumps) are the responsibility of the combined license (COL) applicant. The DC applicant's submission should provide a conceptual design and interface requirements for that SWS portion outside the scope of the DC as required by 10 CFR Part 52.

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

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 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.

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 characteristics of the SWS components (pumps, heat exchangers, pipes, valves) are reviewed as to their functional performance as affected by adverse operational (i.e., water hammer) and environmental occurrences including cold weather protection, by abnormal operational requirements, and by such accident conditions caused by a loss-of-coolant accident (LOCA) with the loss of offsite power. As the SWS normally has requirements for cooling functions during normal plant operation, as well as for safety functions, the review includes an evaluation of system capability to perform these multiple functions.

   RTNSS B and C: apply. Revise the above paragraph to read:

   The characteristics of the SWS components (pumps, heat exchangers, pipes, valves) are reviewed as to their functional performance as affected by adverse operational (i.e., water hammer) and environmental occurrences, including cold weather protection and by abnormal operational requirements. As the SWS normally has requirements for cooling functions (in the post-72 hour period [RTNSS B] or to meet the NRC safety goal guidelines [defense-in-depth RTNSS C]), the review includes an evaluation of system capability to perform these functions.

   Nonsafety-related nonrisk-significant: Revise the above paragraph to read:

   Functions that support achieving and maintaining CSD are reviewed. Water hammer is reviewed to the extent that consequences from a water hammer do not negatively affect safety-related SSCs or RTNSS B SSCs.

4. The SWS design is reviewed for:

   A. The capabilities to detect, control, and isolate system leakage including radioactive leakage into and out of the system and prevent accidental releases to the environment.

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

   B. Measures to preclude long-term corrosion and organic fouling tending to degrade system performance.

      RTNSS B and C: apply. The capability of the SWS to provide adequate cooling water to reactor auxiliary equipment for SSCs in the post-72 hour period or to meet the NRC safety goal guidelines is reviewed.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

C. Provisions for system and component operational testing, including the instrumentation and control features that determine and confirm whether the system operates in a correct mode (i.e., critical valve position, pressure and temperature indication).

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.

D. The effects of the failure of non seismic Category I equipment, structures or components on safety-related SWS portions taken into account.

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

E. Water makeup to the SWS, which is outside the scope of DSRS Section 9.2.5.

RTNSS B and C: apply. The capability of the SWS to provide adequate cooling water to reactor auxiliary equipment for SSCs in the post-72 hour period or to meet the NRC safety goal guidelines is reviewed.

Nonsafety-related (nonrisk-significant): May apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

5. SWS capability to flood the reactor containment if required in a post-accident recovery situation is reviewed.

RTNSS B and C and nonsafety-related nonrisk-significant: does not apply.

6. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For DC and COL reviews, the staff reviews the applicant's proposed ITAAC associated with the 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.

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.

7. 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

8. 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

The system is reviewed for whether a malfunction, a failure of a component, or the loss of a cooling source could reduce the safety-related functional performance capabilities of the system.

Other DSRS sections interface with this section for safety-related and nonsafety-related SWS, 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, 3.7.2, and SRP Sections 3.7.2, 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 (SSE), probable maximum flood, and tornado missiles.

3. DSRS Section 3.4.1: review for flood protection.

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

5. DSRS Sections 3.5.1.4 and 3.5.2: review of the SSCs to be protected against 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 Sections 3.9.2 and 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 Section 5.4.7: review of essential components associated with the reactor coolant system required during normal operations or accident conditions.

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

11. DSRS Section 6.3: review of essential components associated with the emergency core cooling systems required during normal operations or accident conditions.

12. DSRS Section 6.6: verification of whether system components meet in service inspection requirements and, upon request, verification of the compatibility of the materials of construction with service conditions.

13. DSRS Chapter 7 and DSRS Section 8.1: review of the system controls, instrumentation, and power sources as to capabilities, capacity, and reliability for supplying power during normal and emergency conditions to safety-related pumps, valves and other components. The review evaluation includes the signals for isolating safety-related from nonsafety-related SWS portions in postulated accidents with special emphasis on proper isolation of interconnected trains in unusual conditions like SWS low pressures or low current draws for safety-related pumps.

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

15. SRP Section 9.5.1: review for fire protection.

16. 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.

17. DSRS Section 12.3-12.4: review for radiation protection design features and minimization of contamination.

18. SRP Section 13.6: review for security considerations for such SWS portions as intake structures.

19. DSRS Sections 14.2 and 14.3.7: review of the proposed pre-operational and startup test programs and ITAAC.

20. DSRS Chapter 15: review of accident cooling load functional requirements and minimum time intervals.

21. DSRS Section 16.0: review of technical specifications.

22. SRP Section 17.5: review for quality assurance.

23. SRP Section 19.0: review for probabilistic risk assessment and for the applicable risk

classification.

The specific acceptance criteria and review procedures are contained in the referenced DSRS 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 SWS are as listed below. The nonsafety-related areas of review and RTNSS B and C functions, if they apply, are shown below in ***bold-italics***. For nonsafety-related nonrisk-significant SWS, nothing applies unless noted below in ***bold-italics***.

1. GDC 1 as to SSCs important to safety being designed, fabricated, erected and tested to quality standards commensurate with the importance of the safety functions to be performed.

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.

   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 being designed not 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 system to transfer heat from SSCs important to safety to an UHS. Acceptance is based on the following:

   A. The capability to transfer heat loads 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 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 COL, the provisions of the AEA, and the NRC's rules and regulations.

   RTNSS B and C: apply for 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 same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

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

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 Regulatory Guide (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 SWS and the SWS 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 SWS and Position C.2 for nonsafety-related portions of the SWS 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 SWS, are met: DSRS Sections 3.5.1.1, 3.5.1.4, 3.5.2, and DSRS Section 3.6.1. In addition, the information will be considered acceptable if the design provisions presented in Generic Letter (GL) 96-06 and to 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 SWS 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). In addition, the information will be considered acceptable if the provisions GL 89-13 and GL 91-13 are appropriately addressed.

5. Cooling Water System. Information that addresses the requirements of GDC 44 regarding consideration of the cooling water system will be considered acceptable if a system to transfer heat from SSCs important to safety to an UHS is provided. In addition, the SWS 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 system portions can be isolated so the safety function of the system is not compromised.

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 SWS 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 SWS 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: 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 SWS are as listed below. The nonsafety-related areas of review and RTNSS B and C functions, if they apply, are shown below in ***bold-italics***. For nonsafety-related nonrisk-significant SWS, nothing applies unless noted below in ***bold-italics***

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

   Based on numerous safety analysis review (SAR) reviews, a seismic design classification system developed for identifying plant features should be designed to withstand SSE effects. RG 1.29 describes an acceptable method for classifying light-water reactor nuclear power plant features that should be designed to withstand SSE effects. SSCs that should be designed to remain functional in SSEs are designated as seismic Category 1. RG 1.29, Position C.1, states that systems required for safe-shutdown, including their foundations and supports, are designated as seismic Category I and should be designed to withstand SSE effects and remain functional. RG 1.29, Position C.2, states that SSCs with continued functions not required, the failure of which could reduce the functioning of any seismic Category I plant feature to an unacceptable safety level or could result in incapacitating injury to control room occupants, should be designed and constructed so that SSEs would not result in such failures. RG 1.29, Positions C.1 and C.2, assure that the SWS will remain functional during a SSE and provide essential cooling water necessary for the operation of safety-related components and decay heat removal.

   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.

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 shall not 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, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining 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.

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.
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 20.1406(a) 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 SWS may cool the CWS, which 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 specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the DSRS criteria provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

The procedures set forth below determine during the construction permit application review whether the design criteria and bases and the preliminary design in the preliminary SAR meet the acceptance criteria of Subsection II of this DSRS section. For review of operating license applications, the review procedures and acceptance criteria verify whether the initial design criteria and bases are implemented appropriately in the final design as in the final SAR. Upon request from the primary reviewer, the coordinating reviewers provide input for the areas of review stated in Subsection I of this DSRS section. The primary reviewer uses such input as required to complete this review procedure.

For the various SWS designs there will be variations in system requirements. For purposes of this DSRS section, a typical system is assumed to have fully redundant systems, each with identical essential (safety features) and nonessential (used for normal operation) portions. For variations from the typical arrangement, the reviewer adjusts the review procedures; however, the system design must meet the acceptance criteria of Subsection II. Also, the reviewer needs to refer to DSRS sections for other systems interfacing with the SWS depending upon the nature and conditions of the UHS cooling water (e.g., salt water).

Evaluation of various generic issues and plant-specific PRAs show that the loss of the SWS may contribute significantly to the potential for a core damage accident. A review of industry experience and plant-specific PRAs is available in NUREG-1461 (Reference 16), which provides insights into SWS vulnerabilities.

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

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 SAR is reviewed for whether the system description and piping and instrumentation diagrams (P&IDs) show the SWS equipment used for normal operation and the minimum system heat transfer and flow requirements for normal plant operation. The system performance requirements also are reviewed for whether the SAR describes component allowable operational degradation (e.g., pump leakage) and the procedures followed to detect and correct these conditions when they become excessive.

RTNSS B and C: apply since RTNSS B SSCs are considered risk-significant. Delete paragraph and replace with;

The SAR is reviewed for whether the system description and piping and instrumentation diagrams (P&IDs) show the SWS equipment used for functions in the post-72 hour period (RTNSS B) or defense-in-depth functions (RTNSS C). The system performance requirements also are reviewed for adequate margins (e.g. pump flow, pump head, heat exchanger heat removal capability).

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

The SAR is reviewed for whether the system description and piping and instrumentation diagrams (P&IDs) show the SWS equipment used to support and maintaining CDS conditions

4. The reviewer, using the results of failure modes and effects analyses as appropriate, comparisons with previously approved systems, or independent calculations, determines whether the system can sustain the loss of any active component and meet minimum system requirements (cooling load and flow) for the degraded conditions. The system P&IDs, layout drawings (if available), and component descriptions and characteristics then are reviewed for the following points:

   A. Essential SWS portions are identified correctly and can be isolated from nonessential portions. The P&IDs are reviewed for whether they clearly indicate both the physical division between each portion and the required classification changes. System drawings are also reviewed for whether they show how isolation is accomplished and the SAR description is reviewed for minimum performance requirements for the isolation valves. The drawings and descriptions are reviewed for whether automatically-operated isolation valves separate nonessential and essential portions and components. Redundant interconnected trains are considered for assurance of the operation of at least one safety-related train by proper isolation in an accident or transient.

   RTNSS B: applies since RTNSS B SSCs are considered risk-significant. Replace paragraph to read:

   SWS components are identified correctly and can be isolated from nonrisk significant portions. The P&IDs are reviewed for whether they clearly indicate both the physical division between each portion and the required classification changes. System drawings are also reviewed for whether they show how isolation is accomplished and the SAR description is reviewed for minimum performance requirements for the isolation valves. The drawings and descriptions are reviewed for whether automatically-operated isolation valves separate portions and components. Redundant interconnected trains are considered especially for assurance of the operation of at least one train by proper isolation, in the post-72 hour period.

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

   Defense-in-depth SWS portions are identified correctly and can be isolated from non defense-in-depth portions. The P&IDs are reviewed for whether they clearly indicate both the physical division between each portion and the required classification changes. System drawings are also reviewed for whether they show how isolation is accomplished and the FSAR description is reviewed for minimum performance requirements for the isolation valves. The drawings and descriptions are reviewed for whether automatically-operated isolation valves separate portions and components.

   Nonsafety related (nonrisk significant): may apply to support CSD. Replace paragraph to read:

The P&IDs are reviewed for whether they clearly indicate the SWS can achieve and maintaining CSD function.

B. Essential SWS portions, including the isolation valves separating essential and nonessential portions, are classified Quality Group C and seismic Category 1. SAR component and system descriptions of mechanical and performance characteristics are reviewed for whether the seismic and safety classifications are included and whether the P&IDs indicate any points of change in piping quality group classification.

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.

RTNSS B: applies since RTNSS B SSCs are considered risk-significant. Replace entire paragraph to read:

SWS risk significant portions meet seismic Category I or II design requirements. SAR component and system descriptions of mechanical and performance characteristics are reviewed for whether the seismic and classifications are included and whether the P&IDs indicate any points of change in piping quality group classification.

RTNSS C: may apply. Replace paragraph to read:

SWS portions that support defense-in-depth functions (in order to meet NRC safety goal guidelines) are housed in non-seismic structures that are designed using the International Building Code. SAR component and system descriptions of mechanical and performance characteristics are reviewed for whether the seismic and classifications are included and whether the P&IDs indicate any points of change in piping quality group classification.

Note: The cooling water system will be considered acceptable if system portions can be isolated so the safety function or defense-in-depth function of the system is not compromised.

Nonsafety-related (nonrisk-significant): may apply. SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable. Replace paragraph to read:

SWS portions that support achieving and maintaining CSD conditions (in the post-72 hour period) are housed in non-seismic structures that are designed using the International Building Code. SSCs repairs maybe expected post seismic event.

C. Design provisions permit appropriate in service inspection and functional testing of system components important to safety. The design is acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves required by 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.

5. The reviewer determines whether the safety function of the system will be maintained, as required, in adverse environmental phenomena like earthquakes, tornadoes, tsunamis, hurricanes, and floods or in certain pipe breaks or loss of offsite power. The reviewer uses engineering judgment, the results of a failure mode and effects analyses, and the results of reviews under other DSRS sections to verify whether:

A. The failure of portions of the system or of other systems not designed to seismic Category I and located close to essential portions of the system or of non-seismic Category I structures that house, support, or are in close proximity to essential SWS portions do not preclude their operation. Reference to SAR Chapter 2 describing site features and the general arrangement and to layout drawings (if available) is necessary as well as to the SAR tabulation of seismic design classifications for structures and systems. SAR statements that the above conditions are met are acceptable.

RTNSS B: applies since 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 the post 72 hour period functions. Replace paragraph with:

The failure of portions of the system or of other systems not designed to seismic Category I and located close to important portions of the system or of non-seismic Category I structures that house, support, or are in close proximity to SWS risk-significant portions do not preclude their operation. Reference to SAR Chapter 2 describing site features and the general arrangement and to layout drawings (if available) is necessary, as well as to the SAR tabulation of seismic design classifications for structures and systems. SAR statements that the above conditions are met are acceptable.

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

The failure of portions of the system or of other systems not designed to seismic Category I and located close to important portions of the system or of non-seismic Category I structures that house, support, or are in close proximity to SWS defense-in-depth portions do not preclude their operation.

Reference to SAR Chapter 2 describing site features and the general arrangement and to layout drawings (if available) is necessary, as well as to the SAR tabulation of seismic design classifications for structures and systems. SAR statements that the above conditions are met are acceptable.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

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.

B. Essential SWS 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 Chapter 3 series. The reviewer utilizes the procedures in these DSRS sections for assurance that the analyses presented are valid. A statement to the effect that the system is located in a tornado-, missile-, and flood-protected seismic Category I structure or that system components are in individual cubicles or rooms that withstand the effects of both flooding and missiles is acceptable. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed for whether the protection is adequate.

RTNSS B: applies since 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. 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). Replace paragraph with:

Risk significant SWS 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 Chapter 3 series. The reviewer utilizes the procedures in these DSRS sections for assurance that the analyses presented are valid. A statement to the effect that the system is located in a tornado-, missile-, and flood-protected seismic Category I or Category II structure or that system components are in individual cubicles or rooms that withstand the effects of both flooding and missiles is acceptable. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed for whether the protection is adequate.

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

Defense-in-depth SWS 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.

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.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

C. The SWS pumps have sufficient available net positive suction head at the pump suction locations with low water levels. Reference to DSRS Section 2.4, which indicates the lowest probable water level of the heat sink, and to drawings indicating the elevation of service water pump impellers, is necessary. An independent calculation (or audit) verifying the applicant's conclusion is necessary for acceptance.

RTNSS B and C: apply.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

D. There are provisions to detect and control leakage of radioactive contamination into and out of the system. The design is acceptable if the system P&IDs show radiation monitors located on the system discharge and at components susceptible to leakage, and these components can be isolated by one automatic and one manual valve in series.

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

E. Essential system portions are protected from the effects of high- and moderate-energy line breaks. Layout drawings are reviewed (if available) for the

absence of high- or moderate-energy piping systems close to essential SWS 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 sections.

RTNSS B: applies since 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. Replace paragraph with:

Risk significant SWS portions are protected from the effects of high- and moderate-energy line breaks. Layout drawings are reviewed (if available) for the absence of high- or moderate-energy piping systems close to essential SWS 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 sections.

RTNSS C: may apply. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon to meet the NRC safety goal guidelines. Replace paragraph with:

Defense-in-depth SWS portions (relied upon to meet NRC safety goal guidelines) may be protected from the effects of high- and moderate-energy line breaks. Layout drawings are reviewed (if available) for the absence of high- or moderate-energy piping systems close to essential SWS 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 sections.

Nonsafety-related (nonrisk-significant): May apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

F. Essential components and subsystems necessary for safe-shutdown can function as required in a loss of offsite power. The system design is acceptable if the SWS meets minimum system requirements as stated in the SAR, assuming a concurrent failure of a single, active component, including a single failure of an auxiliary electric power source. The SAR is reviewed to determine whether each SWS component or subsystem affected by the loss of offsite power system flow and heat transfer capability meets or exceeds minimum requirements. The results of failure modes and effects analyses are considered for assurance that the system meets these requirements. This verification of system functional reliability is acceptable.

RTNSS B: applies since 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 the post-72 hour period functions. Failure-modes and effects are not performed. Replace paragraph with:

Components and subsystems necessary for risk significant function as required in a loss of offsite power. The system design is acceptable if the SWS meets minimum system requirements as stated in the SAR, assuming a concurrent failure of a single, active component, including a single failure of an auxiliary electric power source. The SAR is reviewed to determine whether for each SWS component or subsystem affected by the loss of offsite power, system flow and heat transfer capability meets or exceeds minimum requirements. This verification of system functional reliability is acceptable.

RTNSS C: may apply. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon to meet NRC safety goal guidelines. Failure-modes and effects are not performed. Replace paragraph with:

Components and subsystems necessary for defense-in-depth can function as required in a loss of offsite power. The system design is acceptable if the SWS meets minimum system requirements as stated in the SAR. The SAR is reviewed to determine whether for each SWS component or subsystem affected by the loss of offsite power system flow and heat transfer capability meets or exceeds minimum requirements. This verification of system functional reliability is acceptable.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

G. The essential service water supply is protected from potential failures or malfunctions caused by freezing, icing, and other adverse environmental conditions. SAR statements that safety grade heating sources fulfill this purpose, considering the equipment necessary for safe-shutdown, are acceptable.

RTNSS B: applies. Replace paragraph with:

The service water supply is protected from potential failures or malfunctions caused by freezing, icing, and other adverse environmental conditions. SAR statements that risk-significant grade heating sources fulfill this purpose, are acceptable.

RTNSS C: may apply. Replace paragraph with:

The service water supply maybe protected from potential failures or malfunctions caused by freezing, icing, and other adverse environmental conditions. SAR statements that defense-in-depth grade heating sources fulfill this purpose, considering the equipment necessary for defense-in-depth to meet NRC safety goal guidelines are acceptable.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

H. 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 considerations are made due to the large number of gaskets utilized in the design of the plate-type heat exchangers (Reference 27). The effects of chemical controls are reviewed by the secondary review organization.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

I. Design consideration and provisions are made to address the throttling of system valves (such as control or butterfly valves) to balance and limit SWS flows. Valves which are utilized to limit flow may result if pipe wall thinning down-steam of the valves and may cause future system boundary leakage.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

J. Design considerations and provision are made to address SWS voiding and gas intrusion. Gas intrusion has an extreme negative affect and may cause the SWS pumps to become inoperable and not able to perform their intended function.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

K. Underground (buried) piping portions of the SWS are adequately designed for the corrosive nature of the water and soil and may include piping protection such as cathodic protection for metallic materials. Design considerations and provisions are made to utilize non-metallic materials for the SWS as allowed by the applicable Codes and Standards.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

L. Design consideration and provisions are made to address water makeup (quality and quantity, including required duration) to the SWS, which is not addressed under DSRS Section 9.2.5.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

M. Design consideration and provisions are made to address potential intergranular stress corrosion cracking (IGSCC) of SWS pump shaft and couplings (Reference 29). Material susceptible to IGSCC should be avoided.

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

RTNSS C: may apply since RTNSS C SSCs are considered risk-significant.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

6. The SAR descriptive information, P&IDs, SWS drawings (if available), and failure modes and effects analyses are reviewed for whether essential system portions can function following DBAs, assuming a concurrent, single, active component failure. The reviewer evaluates the SAR failure mode and effects analysis for assured function of required components, traces the availability of these components on system drawings, and checks that the SAR 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.

RTNSS B: applies. RTNSS B SSCs are considered risk-significant. Failure-modes and effects are not performed. Revise paragraph to read:

The SAR descriptive information, P&IDs, SWS drawings (if available), are reviewed for whether risk-significant portions can function in the post-72 hour period DBAs, assuming a concurrent, single, active component failure. The reviewer evaluates the SAR, traces the availability of these components on system drawings, and checks that the SAR verifies that minimum system flow and heat transfer requirements are met.

RTNSS C: may apply. Failure-modes and effects are not performed. RTNSS C SSCs do not need to operate during accident conditions, but are relied upon in

order to meet NRC safety goal guidelines. Revise paragraph to read:

The SAR descriptive information, P&IDs, SWS drawings (if available), are reviewed for whether defense-in-depth functions can meet the NRC safety goal guidelines. The reviewer should evaluate the SAR traces the availability of these components on system drawings, and checks that the SAR verifies that minimum system flow and heat transfer requirements are met for each defense-in-depth function.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable. Revise paragraph to read:

The SAR descriptive information, P&IDs, SWS drawings (if available), are reviewed for whether portions that support achieving and maintaining CSD conditions in the post-72 hour period can function in the post-72 hour period. The reviewer may evaluate that the SAR traces the availability of these components on system drawings, and checks that the SAR verifies that minimum system flow and heat transfer requirements are reasonable to support achieving and maintaining CSD conditions.

7. The SAR is reviewed for applicant commitments for venting and filling of open loop systems to address the potential for water hammer, for operating procedures for avoidance of water hammer, and for system design to maintain functions following an inadvertent water hammer occurrence. Guidance for water hammer prevention and mitigation is in NUREG-0927 (Reference 15).

   RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

   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 SSCs. SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

8. To address concerns about SWS fouling, the reviewer verifies whether the applicant addresses the following SWS design provisions and inspection activities consistently with GL 89-13 (Reference 9) and GL 89-13, Supplement 1(Reference 10):

   A. A program of surveillance and control techniques to reduce significantly the incidence of flow blockage problems from biofouling.

   B. A test program, consisting of an initial test program and a periodic retest program, to verify the heat transfer capability of all safety-related heat exchangers cooled by service water.

   C. A routine inspection and maintenance program for SWS piping and components for assurance that corrosion, erosion, protective coating failure, silting, and biofouling cannot degrade the performance of the safety-related systems supplied

by service water.

Note: In many cases, a DCD (design control document) =only addresses a single unit and a COL applicant may address a single unit or a multiple unit site. SWS flow blockage and biofouling issues addressed under GL 89-13 and surveillance, control techniques, testing programs, routine inspections, maintenance programs, and related practices/procedures addressed under GL 91-13 are to be addressed regardless of GDC 5 applicability.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

Nonsafety-related (nonrisk-significant): may apply.

SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

Note: GDC 5 does not apply to RTNSS B and C SSCs.

9. For multi-unit sites with SWS cross-tie capability, the reviewer verifies whether:

   A. The sharing of SSCs does not significantly impair SWS capability to perform its safety function, including, in an accident in one unit, an orderly shutdown and cool-down of the remaining unit(s).

   B. Flushing and flow testing provisions from implementation of GL 89-13 are applied to the cross-tie lines.

   C. Applicants proposing designs with only two SWS pumps per unit address the provisions of GL 91-13 (Reference 11).

   Note: In many cases, a DCD only addresses a single unit and a COL applicant may address a single unit or a multiple unit site. SWS flow blockage and biofouling issues addressed under GL 89-13 and surveillance, control techniques, testing programs, routine inspections, maintenance programs, and related practices/procedures addressed under GL 91-13 are to be addressed regardless of GDC 5 applicability.

   RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

   Nonsafety-related (nonrisk-significant): may apply.

   SWS should be available to bring the plant to CSD conditions for inspection and repairs. The nonsafety-related SWS should be reliable.

   Note: GDC 5 does not apply to RTNSS B and C SSCs.

10. To address concerns about SWS equipment operability and containment integrity during design-basis accident conditions, the reviewer verifies whether the applicant addresses the following SWS design provisions consistently with GL 96-06 (Reference 12) and to GL 96-06, Supplement 1 (Reference 13):

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 DBA scenarios, even during two-phase flow conditions.

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

Note: GL 96-06 and, Supplement 1 to GL 96-06 may not be applicable if the SWS does not provide cooling to the containment air coolers or penetrate containment. GL 96-06 and GL 96-06, Supplement 1 to GL 96-06 are also described in DSRS Section 9.2.2.

RTNSS B and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

It is assumed that RTNSS B and C functions will not include containment air cooler cooling (Items A and B). Item C applies.

Nonsafety-related nonrisk-significant: Item C only applies.

11. For review of a DC application, the reviewer 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 FSAR meets the acceptance criteria. DCs have referred to the FSAR as the 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 and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

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 and C: apply to the extent to support functions in the post-72 hour period or defense-in-depth functions.

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 SWS includes all components and piping from the SWS pump intake to the points of cooling water discharge. Portions of the SWS necessary for safe-shutdown, accident prevention, or accident mitigation, are designed to seismic Category I, Quality Group C requirements. After review of the applicant's proposed SWS design criteria, design bases, and safety classification for required continuous cooling of safety-related components necessary for a safe plant shutdown, the staff concludes that the SWS design is acceptable and meets the requirements of GDCs 1, 2, 4, 5, 44, 45, and 46. This conclusion is based on the following findings. The nonsafety-related areas of review and RTNSS B and C functions, if they apply, are shown below in ***bold-italics***. For nonsafety-related nonrisk-significant SWS nothing applies unless noted below in ***bold-italics***.

1. The applicant meets GDC 1 requirements for the SWS. 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 in keeping 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. 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, jets, and environmental conditions from high- and moderate-energy line breaks, and dynamic effects of flow instabilities (i.e., water hammer loads) as to impairment of required SWS functions during normal plant operations and under upset or accident conditions. Acceptance for water hammer effects is based on the following:

   A. Vents are provided at high points for liquid-filled, but normally idle, piping (or systems) where voiding can occur. These vents should be designed for ease of periodic operational testing.

   B. Consideration is given to voiding following pump shutdown or during standby. If in the system design voiding could occur, the design should provide for a slow system fill upon pump start to avoid water hammer, or the design should maintain functions following an inadvertent water hammer occurrence. Keep-fill systems should be considered for SWS during standby conditions.

C. Operating and maintenance procedures are reviewed by the applicant for assurance of sufficient measures for avoiding water hammer (e.g., rapid fill due to pump start, periodic fill and vent checks, avoidance of sudden valve movement or realignment).

D. SWS preoperational testing may be necessary to verify that during various system alignments or train transfers/shutdowns that 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 sharing of SSCs by demonstrating that such sharing does not significantly impair SWS capability to perform its safety function, including in an accident in one unit an orderly shutdown and cool-down of the remaining unit(s). In addition, the applicant complies with the guidance of GL 91-13.

   Note: In many cases, a DCD only addresses a single unit and a COL applicant may address a single unit or a multiple unit site. SWS flow blockage and biofouling issues addressed under GL 89-13 and surveillance, control techniques, testing programs, routine inspections, maintenance programs, and related practices/procedures addressed under GL 91-13 are to be addressed regardless of GDC 5 applicability.

5. The applicant meets GDC 44 requirements for cooling water by providing a system to transfer heat from SSCs important to safety to an UHS. The applicant has demonstrated that the SWS 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 system portions can be isolated so the safety function of the system is not compromised. SWS pumps are adequately designed related to the prevention of debris entering the SWS pump suction. In addition, net positive suction head required ($NPSH_r$) and is evaluated against NPSH available ($NPSH_a$) under normal and accident conditions. Potential SWS pump vortexing conditions are also evaluated.

6. The applicant meets GDC 45 requirements for inspection and for testing of cooling water systems by an SWS design which permits in service inspection of safety-related components and equipment and operational functional testing of the system and its components.

7. The applicant meets GDC 46 requirements for testing of SWSs by SWS 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 DSRS section.

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 and C apply for functions in the post-72 hour period or defense-in-depth functions.

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 and C apply for functions in the post-72 hour period or defense-in-depth functions.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower^{TM}-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^{TM} 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^{TM}-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^{TM} 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 Part 50, Appendix A, GDC 1, "Quality standards and records."
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 Systems.”

8. RG 1.29, “Seismic Design Classification.”

9. NRC Letter to All Holders of Operating Licenses or Construction Permits for Nuclear Power Plants, “Service Water System Problems Affecting Safety-Related Equipment (Generic Letter No. 89-13),” July 18, 1989.

10. NRC Letter to All Holders of Operating Licenses or Construction Permits for Nuclear Power Plants, “Service Water System Problems Affecting Safety-Related Equipment (Generic Letter No. 89-13, Supplement 1),” April 4, 1990.

11. NRC Letter to Specified Licensees and Applicants of Pressurized-Water Reactor Nuclear Power Plants, “Request for Information Related to the Resolution of Generic Issue 130, Essential Service Water System Failures at Multi-Unit Sites,’ (Generic Letter No. 91-13),” July 18, 1989.

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-0718, “Proposed Licensing Requirements for Pending CP’s and Manufacturing License.”

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

16. NUREG-1461, “Regulatory Analysis for the Resolution of Generic Issue 153: Loss of Essential Service Water in LWRs,” August 1993.

17. 10 CFR 20.1406, “Minimization of Contamination.”

18. 10 CFR 52.47(b)(1), “Contents of Applications, Technical Information, Inspections, Tests, Analyses, and Acceptance Criteria.”

19. 10 CFR 52.80(a), “Contents of Applications, Additional Technical Information,

Inspections, Tests, Analyses, and Acceptance Criteria."

20. RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants."

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

22. RG 1.155, "Station Blackout."

23. RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants."

24. RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants."

25. RG 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52."

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

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

28. SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in the Passive Plant Designs," and SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in the Passive Plant Designs."

29. NRC Information Notice 2007-05, "Vertical Deep Draft Pump Shaft and Coupling Failure."

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

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

32. 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants."

33. RG 1.206, "Combined License Applications for Nuclear Power Plants."