U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

9.2.7 CHILLED WATER

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of cooling water systems

Secondary -- Organization responsible for the review of chemical control
Organization responsible for chemical effect on control room occupants

I. AREAS OF REVIEW

The chilled water system (VWS) provides a closed loop of cooling water for room ventilation equipment and components of the emergency core cooling system (ECCS).

In addition, the VWS may also provide cooling to non-safety related components (non-essential) such as miscellaneous pumps and ventilation equipment.

Typically the safety-related VWS supplies chilled water via the chilled water pumps to “essential” (used for safety features) loads for temperature control and room cooling in the main control room

Draft Revision 0 – July 2014

(MCR), Class 1E electrical rooms, safeguard building, auxiliary feedwater room (pressurized water reactors only), fuel building, ECCS rooms, reactor core isolation cooling room (RCIC) (boiling water reactors only), or control complex.

Chillers function to cool water (usually to near 44 °F to °46 F) utilizing refrigerant with phase changes between liquid and gas. Chillers normally consists of a cooler, condenser, compressor, motor (and associated drives), guide vanes, oil support system, hot gas bypass line, instrumentation and controls, and refrigerant. A chiller compressor can be either scroll, screw or centrifugal. Each of these compressor types have limitations on heat-removal capability. Cooling for the chiller condenser is either water-cooled, for example by the reactor auxiliary cooling water system, or air cooled.

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

The VWS 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 VWS may be subject to special regulatory treatment of nonsafety-related system (RTNSS) considerations. NUREG-0800 Standard Review Plan (SRP) Section 19.3, "Regulatory Treatment of Non-Safety Systems (RTNSS) for Passive Advanced Light Water Reactors," 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 VWS may be classified as either RTNSS Criterion B (RTNSS B) or RTNSS Criterion C (RTNSS C), which are defined below:

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.

   Note: Long-term safety is defined as the period beginning 72 hours after a design basis event and lasting the following 4 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 $1.0E^{-6}$, 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.

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

The reliable nonsafety-related system SSCs are evaluated under SRP 17.6, "Maintenance Rule," (Ref. 29). These nonsafety-related system components shall be monitored for performance against licensee-established goals, in a manner sufficient to provide reasonable assurance that these SSCs are capable of fulfilling their intended functions.

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

- Safety-related risk-significant
- 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 cold shutdown (CSD) conditions

The 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 SRP Sections 3.2, 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 (Ref. 25, 32 and SRP 19.3).

RTNSS Criterion C functions address safety goals of core damage frequency. RTNSS C SSCs are considered nonsafety-related defense-in-depth backups (Ref. 25 and 32).

Defense-in-depth principles consist of a number of elements as described in Regulatory Guide (RG) 1.174 (Ref. 28).

The specific areas of review for the safety-related VWS are as listed below. Additionally, the nonsafety-related areas of review, including RTNSS B and C functions, are shown below each area of review for the safety-related VWS in ***bold-italics***. Therefore, when the description after an item states that "RTNSS B: applies", for example, this means that for SSCs classified as RTNSS B, the area of review is applicable.

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 SSCs 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, and flooding).

Note: RTNSS B SSCs may provide core cooling and heat transfer functions in the post-72 hour period. RTNSS C SSCs may provide for defense-in-depth cooling and heat transfer functions in order to meet NRC safety goal guidelines.

3. The capability of the VWS to provide adequate cooling water to safety-related ECCS components, heating-ventilation-air conditioning (HVAC), and reactor auxiliary equipment for all planned operating conditions.

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

   RTNSS C: applies for nonsafety-related 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 postulated events.

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

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

5. Multiple performance functions (if required by system design to perform a safety function) assigned to the system and the necessity of each function for system support of emergency core cooling and safe shutdown.

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

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

   For RTNSS B and C replace item 5 (above) with the following:

   Multiple performance functions (if required by system design to perform a safety function) assigned to the system and the necessity of each function for RTNSS component cooling and shutdown.

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 all operating conditions.

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

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

8. The sizing of the system for adequate design heat load transfer capability and appropriate design margin.

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

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

   Nonsafety-related nonrisk-significant: may apply for SSCs used to obtain CSD conditions. Functions that support achieving and maintaining CSD conditions are reviewed for reliability of systems and components

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 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.

11. 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 nonsafety-related functions in the post-72 hour period.

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

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

    RTNSS B and C: does not apply.

13. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the SSCs related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3 and RG 1.206 (Ref. 31).

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

RTNSS C: applies for nonsafety-related 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 nonsafety-related functions in the post-72 hour period.

RTNSS C: applies for nonsafety-related 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 SRP sections interface with this section for safety-related and nonsafety-related chilled water system, as follows:

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

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

3. SRP Section 3.4.1: review for flood protection.

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

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

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

9. SRP Sections 5.4.7, 5.4.8, 6.3, and 15.0: review of engineered safety feature components of the reactor coolant system and the ECCS required during normal operations, anticipated operational occurrences, and accident conditions. The review establishes cooling load functional requirements and minimum time intervals for safety-related components.

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

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

12. SRP Sections 7.1 through 7.8: 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 VWS portions in postulated accidents with special emphasis on proper isolation of interconnected trains in unusual conditions like VWS low pressures or low current draws for safety-related pumps and chillers.

13. SRP 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. SRP Section 8.4: overall review of compliance with station blackout (SBO) requirements.

15. SRP Section 9.2.2: review of the test program for monitoring the heat transfer capability of safety-related heat exchangers cooled by component cooling water.

16. SRP Section 9.4: review of the control room, spent fuel pool area, auxiliary and radwaste area, and engineered safety feature ventilation systems.

17. SRP Section 9.5.1: review for fire protection.

18. SRP Sections 12.3-12.4: review for radiation protection design features.

19. SRP Sections 14.2, 14.3, and 14.3.7: review for initial plant testing and plant systems ITAAC.

20. SRP Sections 16.0 and 16.1: review for technical specifications.

21. SRP Section 17.5: review for quality assurance.

22. SRP Sections 19.0 and 19.3: review for probabilistic risk assessment and for the applicable risk classification and RTNSS.

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

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations. The specific areas of review for the safety-related VWS are as listed below. Additionally, the nonsafety-related areas of review, including RTNSS B and C functions, are shown below each area of review for the safety-related VWS 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.

   Note: For passive plants and nonsafety-related VWS, GDC 1 is applicable only for containment isolation functions.

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 SSCs 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, and flooding).

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

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

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

   D. Whether a single VWS failure results in fuel damage or reactor coolant leakage in excess of normal coolant-makeup capability. Sources of single failure include, but are not limited to, operator error, spurious activation of a valve operator, and loss of a cooling water pump.

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

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 VWS 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 (LOCAs), including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

8. Title 10 of the *Code of Federal Regulations* (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 (NRC) 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 COL, 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.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this SRP 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 SRP 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 VWS (which may includes containment isolation function) are as listed below. The specific areas of review for the safety-related VWS are as listed below. Additionally, the nonsafety-related areas of review, including RTNSS B and C functions, are shown below each area of review for the safety-related VWS 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 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.

   Note: For passive plants and nonsafety-related VWS, GDC 1 is applicable only for containment isolation functions.

2. Protection Against Natural Phenomena. Information that addresses the requirements of GDC 2 regarding the capability of structures housing the VWS and the VWS itself to withstand the effects of natural phenomena will be considered acceptable if the guidance of RG 1.29, Regulatory Position C.1 for safety-related portions of the VWS and Regulatory Position C.2 for nonsafety-related portions of the VWS 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 SSCs 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.

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 SRP sections, as they apply to the VWS, are met: SRP 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, and flooding).

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 VWS 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 VWS 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 3-3 and to seismic Category I, Quality Group C, and ASME Section III, Class 3 requirements concurrent with the LOOP. In addition, the information will be considered acceptable based on appropriate application of Institute of Electrical and Electronics Engineers (IEEE) Standard 603, as endorsed by RG 1.153, "Criteria for Safety Systems," and appropriate application of RG 1.155, "Station Blackout," Regulatory Position C.3.3.4.

   Note: RTNSS B SSCs may provide core cooling and heat transfer functions in the post-72 hour period. RTNSS C may provide for defense-in-depth cooling and heat transfer functions in order to meet NRC safety goal guidelines.

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 VWS 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 VWS 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. System operability should also be monitored through Technical Specifications in Chapter 16 of the safety analysis report.

8. Minimization of contamination. Information that address the requirements of 10 CFR 20.1406 regarding 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 SRP section is discussed in the following paragraphs. The specific areas of review for the safety-related VWS (which includes containment isolation function) are as listed below. Additionally, the nonsafety-related areas of review, including RTNSS B and C functions, are shown below each area of review for the safety-related VWS 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 SSCs will satisfactorily perform their safety functions. 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.

   GDC 1 applies to this SRP section to ensure that SSCs important to safety being are designed, fabricated, erected and tested to quality standards commensurate with the importance of the safety functions to be performed.

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 SSCs 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 VWS is to provide adequate cooling water to reactor system components, reactor shutdown equipment, ventilation equipment, ECCS components, during normal operations, anticipated operational occurrences (AOOs), and accident conditions. GDC 2 applies to this SRP section to ensure that the VWS can withstand the effects of all appropriate combinations of seismic and dynamic effects from these natural phenomena without loss of capability to perform design safety functions.

   GDC 2 requirements provide assurance that the VWS 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 LOCAs and dynamic effects of pipe whip, missiles, and discharging fluids.

   GDC 4 applies to this SRP section because the reviewer evaluates the VWS 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 VWS 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 the dynamic effects of pipe whipping, missiles, and discharging fluids.

   GDC 4 requirements provide assurance that the VWS 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 the dynamic effects of pipe whipping, missiles, 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, and flooding).

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 the event of an accident in one unit, an orderly shutdown and cool down of the remaining units.

   GDC 5 applies to this SRP section because the reviewer evaluates in the safety evaluation report the use of the VWS 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 VWS and its components will continue to perform their required safety functions even if shared by multiple nuclear power units.

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

GDC 44 requires 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 of a component to perform its intended safety function .

GDC 44 applies to this SRP section because the reviewer evaluates the VWS for its capability to continue performing intended safety functions during normal operations, AOOs, and accident conditions, assuming a single failureof a component to perform its intended safety function concurrent with the LOOP.

GDC 44 requirements provide assurance that the VWS and its components will continue to perform their required safety functions, assuming a single failure of a component to perform its intended safety function concurrent with the LOOP.

Note: RTNSS B SSCs may provide core cooling and heat transfer functions in the post-72 hour period. RTNSS C may provide for defense-in-depth cooling and heat transfer functions in order to meet NRC safety goal guidelines.

6. GDC 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 SRP section because the reviewer evaluates the VWS for whether appropriate periodic inspection of important components (e.g., heat exchangers, chillers, 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 VWS must be able to prevent or mitigate the consequences of a design basis accident.

   GDC 45 requirements provide assurance that important VWS 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 testing to assure;

   A. The structure and leaktight integrity of the system(s)' 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 LOCAs, including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

   GDC 46 applies to this SRP section because the reviewer evaluates the VWS 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 VWS 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 SRP section because the VWS couples to the primary coolant system across heat exchangers, and the possibility of leakage of contaminated primary coolant via the heat exchangers into the VWS 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 SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

One of the main objectives in VWS review is to determine its safety function. Some cooling systems are designed as entirely safety-related, other systems 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 VWS, the review evaluates its necessity for achieving safe reactor shutdown conditions or for preventing or mitigating accidents. The safety functions of these systems in all designs are essentially the same; however, the method varies from plant to plant depending upon the designer.

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

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

The specific areas of review for the safety-related VWS are as listed below. Additionally, the nonsafety-related areas of review, including RTNSS B and C functions, are shown below each area of review for the safety-related VWS in ***bold-italics***.

1. Programmatic Requirements ─ In accordance with the guidance in NUREG-0800 "Introduction," Part 2 as applied to this SRP 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:

- Maintenance Rule, SRP Section 17.6 (SRP Section 13.4, Table 13.4, Item 17, RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants".
- Quality Assurance Program, SRP Sections 17.3 and 17.5 (SRP Section 13.4, Table 13.4, Item 16).
- Technical Specifications (SRP 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.
- Reliability Assurance Program (SRP Section 17.4).
- Initial Plant Test Program (RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," SRP Section 14.2, and SRP Section 13.4, Table 13.4, Item 19).
- ITAAC (SRP Chapter 14).

RTNSS B and C: applies; however, Technical Specifications 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 10 CFR 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 (TMI) 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. Provide essential cooling for components, ventilation systems, or auxiliary equipment.

      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.

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 piping and instrumentation diagrams P&IDs, layout drawings, and component descriptions and characteristics then are reviewed for the following points:

A. Chilled water system portions are identified correctly and can be isolated from the non-essential 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 non-essential portions and components from the essential. Special consideration is given to redundant interconnected trains for operation of at least one safety-related train by proper isolation in an accident or anticipated operational occurrence.

RTNSS B: applies, since RTNSS B SSCs are considered risk-significant. Replace item 5. A (above) with the following:

Important chilled water system portions are identified correctly and can be isolated from the non-essential 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 non-RTNSS portions and components from the RTNSS components.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines. Replace paragraph 5. A with the following:

Important chilled water system portions are identified correctly and can be isolated from the non-essential portions. The P&IDs are reviewed for whether they clearly indicate the physical division between each portion and indicate 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 non-RTNSS portions of the system and system components from the RTNSS components.

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

RTNSS B: applies, since RTNSS B SSCs are considered risk-significant. Replace paragraph 5.B with the following:

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

RTNSS C: may apply for defense-in-depth functions in order to meet NRC safety goal guidelines. Replace paragraph 5.B with the following:

Important chilled water system portions may be designed against the effects of seismic events. System design bases and criteria and the component classification tables are reviewed for whether the heat exchangers, pumps, valves, and piping of important system portions may be designed to seismic requirements in accordance with the applicable criteria. The review of seismic design and quality group classification is as indicated in Subsection I of this SRP section.

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.

C. The system is designed to provide water makeup as necessary. Closed-loop VWSs are reviewed for whether the surge tanks (also referred to as expansion tanks) have sufficient capacity to accommodate expected leakage from the system

for 7 days or whether a safety-related Seismic Category I automatic source of makeup can be made available within a time frame consistent with the surge tank capacity (the time period is initiated at the actuation of the low level alarm). The surge tank and connecting piping are reviewed for whether makeup water can be supplied to either header in a split header system. Redundant surge tanks (one for each header) or a divided surge tank design is acceptable to ensure that in a header rupture, the entire contents of the surge tank are not lost. Surge tank leakage over a 7 day period should include the possibility of valve seat leakage for VWS system boundaries, VWS pump seal leakage, equipment gaskets, and general valve packing leakage. Long term water surge tank manual makeup should be available post 7 days for up to 30 days from non-seismic category I sources. Surge tanks are to be designed with instrumentation to determine overall system leakage if a safety related seismic category I makeup system is not utilized. Surge tanks are designed for normal system and abnormal in-leakage contractions and expansion without radiological consequences such as spills of VWS 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.

For RTNSS B and RTNSS C, replace paragraph 5.C with the following:

The system is designed to provide water makeup as necessary. Closed-loop VWSs are reviewed for whether the surge tanks have sufficient capacity to accommodate expected leakage. Automatic or manual makeup operation may be 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 VWS to the floor.

D. The system is designed for removal of heat loads during normal operation and for VWS heat loads during accident conditions with the appropriated design margins (including considerations for heat exchanger tube plugging and fouling) for adequate operations. A comparative analysis is made of the system flow rates, heat levels, maximum temperature, and heat removal capabilities with similar designs previously found acceptable. An independent analysis may verify system performance characteristics.

RTNSS B and C: applies, 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. Replace paragraph 5.D with the following:

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. The reviewer may consider conducting an audit of the supporting calculations.

Nonsafety-related nonrisk-significant: may apply. Functions that support achieving and maintaining CSD conditions are reviewed for reliability of systems and components. Replace paragraph 5.D with the following:

The system is designed for removal of heat loads during normal operation and for CSD functions. However, for CSD functions heat removal capabilities 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: does 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 SRP Section 19.3 on the programmatic requirements for RTNSS with respect to inspection and testing.

F. Essential portions of the system are 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 chilled water portions, or for protection from the effects of failure. The means for such protection are in SAR Section 3.6, and the procedures for reviewing this information are in the corresponding SRP sections.

RTNSS B: applies for functions in the post-72 hour period. Replace paragraph 5.F with the following:

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 RTNSS B VWS portions, or for protection from the effects of failure. The means for such protection are delineated in SAR Section 3.6, and the procedures for reviewing this information are in the corresponding SRP.

RTNSS C: applies for defense-in-depth functions in order to meet NRC safety goal guidelines. Replace paragraph 5.F with the following:

The design functions are reviewed against high energy line breaks.

G. Essential components and subsystems (i.e., those necessary for safe shutdown) can function as required in a LOOP and instrument air systems. The system design is acceptable if essential chilled water system portions meet minimum system requirements as stated in the SAR, assuming a concurrent LOOP and failure of a single, active component, including a single failure of any auxiliary electric power source. The SAR is reviewed for whether, for each VWS component or subsystem affected by the LOOP or instrument air systems, system flow and heat transfer capability exceed minimum regulatory requirements. The

results of failure-modes and -effects analyses are considered for whether the system meets these regulatory requirements. This consideration is an acceptable verification of system functional reliability.

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. Replace paragraph 5.G with the following:

Components and subsystems can function as required in a LOOP and loss of instrument air systems. The system design is acceptable if the VWS 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 VWS component or subsystem affected by the LOOP or instrument air systems, system flow and heat transfer capability exceeds minimum requirements.

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. Replace paragraph 5.G with the following:

Components and subsystems can function as required in a loss of offsite power (LOOP) and loss of instrument air systems. The system design is acceptable if the VWS meet minimum system requirements as stated in the SAR. The SAR is reviewed for whether, for each VWS component or subsystem affected by the LOOP or loss of instrument air systems, system flow and heat transfer capability exceeds minimum requirements.

Nonsafety-related nonrisk-significant: may apply.

SSCs that support achieving and maintaining cold shutdown conditions in the post-72 hour period should be designed to be reliable. Replace paragraph 5.G with the following:

The design functions that support achieving and maintaining CSD are reviewed for reliability of systems and components.

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 the provision of 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: applies.

   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: applies.

C. Design consideration and provisions are made to address plate-type heat exchangers (also referred to as frame-type heat exchanger). Depending on the system water chemistry, chemical controls and or system filters/strainers may be required since the plate-type heat exchangers employ narrow clearances (generally in the 3 mm (0.118 inches) 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 (Ref. 24). The effects of chemical controls are reviewed by the secondary review organization.

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

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

D. Design considerations and provisions are made to address VWS voiding and gas intrusion. Gas intrusion or air voids have an extreme negative effect and may cause the VWS pumps to become non-functional and not able to perform their intended function.

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

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

E. For safety-related 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 panel alarms, temperature controls for the returning chilled water, and chiller protection trips (for example, freeze protection) with consideration to automatic starts of standby chillers during normal and abnormal conditions.

iv. Potential for oxygen displacement in mechanical equipment rooms due to catastrophic release of refrigerant. Certain refrigerants may require a refrigerant leak detection system. Evaluation against potential effects to MCR occupants is performed by secondary reviewers (Ref. 33).

v. Over-cooling the condenser refrigerant (Ref. 17).

vi. Determine if a refrigerant purge unit is required for removal of noncondensable gases. This may be a safety-related to nonsafety-related interface.

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

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

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

F. VWS 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 VWS pump vortexing conditions are also evaluated.

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

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

For RTNSS B and C replaces paragraph 6.K with the following:

VWS pumps are adequately designed related to net positive suction head required ($NPSH_r$) and are evaluated against NPSH available (NPSH) under post-72 hours periods and defense-in-depth functions. Potential VWS pump vortexing conditions are also evaluated.

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 essential portions of the system or of non-seismic Category I structures that house, support, or are close to essential portions of the VWS does not preclude essential functions. The review identifies these non-seismic category components or piping and ensures appropriate provision of isolation capabilities in failure.

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. RTNSS B SSCs should continue to perform their

required RTNSS functions, assuming a single failure of a component to perform its intended RTNSS function 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.

For RTNSS B and C replace paragraph 7.A. with the following:

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 VWS should not preclude its ability to support required actions in the post-72 hours period or 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.

Essential VWS portions are protected from the effects of floods, hurricanes, tornadoes, and internally- or externally-generated missiles. Flood protection and missile protection criteria are evaluated in detail under the SRP sections for SAR Chapter 3. The reviewer uses the procedures in these SRP sections to ensure that the analyses presented are valid. A statement to the effect that the system is located in a 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 whipping, and flooding). Replace paragraph 7.B. with the following:

Important chilled water system portions are protected from the effects of floods, hurricanes, tornadoes, and internally- or externally-generated missiles. Flood protection and missile protection criteria are evaluated in detail under the SRP sections for SAR Chapter 3. The reviewer uses the procedures in these SRP sections to ensure that the analyses presented are valid. A finding that the system is located in a seismically qualified Category I structure that is 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 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. Replace paragraph 7.B. with the following:

Defense-in-depth chilled water system portions may be protected from the effects of floods, hurricanes, tornadoes, and internally- or externally-generated missiles. Flood protection and missile protection criteria are evaluated in detail under the SRP sections for SAR Chapter 3. The reviewer uses the procedures in these SRP sections to ensure that the analyses presented are valid. A finding 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, VWS drawings, and failure modes and effects analyses are reviewed by the primary review organization for whether essential portions of the system function following design-basis accidents, assuming a concurrent single, active component failure. The reviewer evaluates the SAR information to determine the ability of required components to function, traces the availability of these components on system drawings, and checks that the SAR information verifies that minimum system flow and heat transfer requirements are met for each accident situation for the required time spans. For each case, the design is acceptable if it meets minimum system requirements.

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 for the post-72 hour period. Failure-modes and effects analyses are not performed. Replace paragraph 8 with the following:

The SAR descriptive information, P&IDs and VWS 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 as presented in the SAR.

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. Replace paragraph 8 with the following:

The SAR descriptive information, P&IDs, and VWS 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. Replace paragraph 8 with the following:

The SAR descriptive information, P&IDs, and VWS drawings, are reviewed for whether portions of the VWS 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 VWSs and provides means for prevention or avoidance (e.g., venting and filling capability) of water hammer and operating procedures for avoidance of water hammer. Guidance for water hammer prevention and mitigation is in NUREG-0927 (Ref. 21).

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

RTNSS C: applies for nonsafety-related 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 VWS equipment operability and containment integrity during DBA conditions, the primary review organization verifies whether the applicant addresses the following VWS design provisions consistently with GL 96-06 and GL 96-06, Supplement 1 (Ref. 20):

    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.

       RTNSS B and C: Passive designs are not expected to have this design feature.

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

       RTNSS B and C: Passive designs are not expected to have this design feature.

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

       RTNSS B: applies for nonsafety-related functions in the post-72 hour

period.

RTNSS C: applies for nonsafety-related 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 procedures outlined in this section 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 historically 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 in 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 nonsafety-related functions in the post-72 hour period.

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

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

    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 safety evaluation report. The reviewer also states the bases for those conclusions.

The VWS includes pumps, heat exchangers, chillers, valves and piping, expansion tanks, makeup piping, and the points of connection or interfaces with other systems. Portions of the VWS 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 VWS as to the requirements for adequate cooling water for the safety-related ECCS components, HVAC, and reactor auxiliary equipment for all conditions of plant operation, the staff concludes that the design of the VWS 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 VWS are as listed below. Additionally, the nonsafety-related areas of review, including RTNSS B and C functions, are shown below each area of review for the safety-related VWS in ***bold-italics***.

1. The applicant meets GDC 1 requirements for the VWS. Acceptance is based 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, Regulatory Position C.1 for the safety-related portions and Regulatory 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 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.

3. The applicant meets GDC 4 requirements for the effects of missiles inside and outside of containment, effects of pipe whipping 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. VWS preoperational testing may be 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 whipping, and flooding).

4. The applicant meets GDC 5 requirements for SSC sharing by demonstrating that such sharing does not significantly impair the ability of the VWS 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 VWS 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; VWS pump pressure (head) and system flow rates during normal and accident conditions.

   Also in meeting GDC 44 requirements the applicant has demonstrated that VWS 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 VWS pump vortexing conditions are also evaluated.

   Note: RTNSS B SSCs may provide core cooling and heat transfer functions in the post-72 hour period. RTNSS C may provide for defense-in-depth cooling and heat transfer functions in order to meet NRC safety goal guidelines.

6. The applicant meets GDC 45 requirements for inspection of VWSs by VWS design features for in-service inspection of safety-related components and equipment.

7. The applicant meets GDC 46 requirements for testing of VWSs by VWS 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: applies*.*

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

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

RTNSS C: applies for nonsafety-related 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 nonsafety-related functions in the post-72 hour period.

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

V. IMPLEMENTATION

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

The provisions of this SRP section apply to reviews of applications submitted 6 months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR 20.1406, "Minimization of Contamination."

2. 10 CFR 50.34, "Contents of Applications, Technical Information."

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, "Contents of Applications, Technical Information."

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. NRC Information Notice No.94-82; “Concerns Regarding Essential Chillers Reliability During Periods of Low Cooling Water Temperature.”

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

19. NRC Generic Letter 96-06, “Assurance of Equipment Operability And Containment Integrity During Design-Basis Accident Conditions (GL 96-06),” September 30, 1996.

20. NRC Generic Letter 96-06, Supplement 1, ”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. Institute of Electrical and Electronics Engineers (IEEE) Std. 603-1980, “IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations.”

23. Nuclear Management and Resources Council (NUMARC) Report 87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," August 1991.

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

25. 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.

26. EPRI TR 1007361, “Chiller Performance Monitoring and Troubleshooting Guide,” November 2002.

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

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

29. 10 CFR 50.65, “Requirements for monitoring the effectiveness of maintenance at nuclear power plants.”

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

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

32. 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.

33. ANSI/ASHRAE Standard 15-2013, “Safety Standard for Refrigeration Systems.”

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.