NUREG-0800

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

9.2.7 CHILLED WATER SYSTEM

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

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

Typically the safety-related CWS 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 (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 the control complex.

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

The CWS may perform cooling water functions to nonsafety-related risk-significant and nonsafety-related nonrisk-significant equipment as part of a "passive plant" design. For these designs, the CWS may be subject to special regulatory treatment of nonsafety-related system (RTNSS) considerations. 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. The CWS may be classified as either RTNSS Criterion B (RTNSS B) or RTNSS Criterion C (RTNSS C).

RTNSS Criterion B functions pertain to SSCs required during the post-72 hour period[1] after a design basis event and 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.

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

The reliable nonsafety-related SSCs are evaluated in accordance with 10 CFR 50.65, and SRP 17.6, "Maintenance Rule."

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 CWS may be classified as:

- Safety-related risk-significant

[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.

- 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 the information according to SRP Sections 3.2.1, "Seismic Classification," 3.2.2, "System Quality Group Classification," 17.4, Reliability Assurance Program (RAP)", and 19.3 to confirm the determination of the safety-related and risk-significant SSCs.Defense-in-depth principles consist of a number of elements as described in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis."

The specific areas of review are as follows:

1. Review safety/risk-significant classification as discussed above.
2. Compliance with the requirements of General Design Criteria (GDCs) 1, 2, 4, 5, 44, 45, and 46 for CWS SSCs.
3. The capability of the CWS to provide adequate cooling water to safety-related ECCS components, heating-ventilation-air conditioning (HVAC), and reactor auxiliary equipment for all planned operating 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.
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.
6. The capability of the system surge tank to perform its intended function with considerations for system leakage.
7. The capability of the system to provide adequate cooling water during all operating conditions.
8. The sizing of the system for adequate design heat load transfer capability and appropriate design margin.
9. The effects of non-seismic Category I component failures on the seismic Category I portion of the system (e.g., containment penetrations).

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

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

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

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, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

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.

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

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 CWS portions in postulated accidents with special emphasis on proper isolation of interconnected trains in unusual conditions like CWS 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, turbine area ventilation system, 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.

1. GDC 1, "Quality Standards and Records," 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, "Design Bases for Protection against Natural Phenomena," 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).

3. GDC 4, "Environmental and Dynamic Effects Design Bases," 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.

4. GDC 5, "Sharing of Structures, Systems, and Components," 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, "Cooling Water," 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 CWS 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 CWS piping failure results in excessive fuel damage or reactor coolant leakage in excess of normal coolant makeup capability. A single active failure is considered in evaluations of the consequences of this accident. Moderate leakage cracks are determined in accordance with the guidelines of Branch Technical Position (BTP) 3-3, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

6. GDC 45, "Inspection of Cooling Water System," 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, "Testing of Cooling Water System," as to design provisions to permit appropriate periodic pressure and functional test to assure;

A. The structure and leaktight integrity of CWS 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.

9. Regulations in 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.

10. Regulations in 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.

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 SRP acceptance criteria for a safety-related CWS are as listed below. Additionally, the SRP acceptance criteria for a nonsafety-related CWS are listed in Table II.1, "SRP Acceptance Criteria for Nonsafety-Related SSCs of the Chilled Water System".

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

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

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 CWS, are met: SRP Sections 3.5.1.1, "Internally Generated Missiles (Outside Containment)," 3.5.1.4, "Missiles Generated by Tornadoes and Extreme Winds," 3.5.2, "Structures, Systems, and Components to be Protected from Externally-Generated Missiles," and 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."

   In addition, the information will be considered acceptable if the design provisions presented in Generic Letter (GL) 96-06, ""Assurance of Equipment Operability And

Containment Integrity During Design-Basis Accident Conditions," and GL 96-06, "Assurance of Equipment Operability And Containment Integrity During Design-Basis Accident Conditions," Supplement 1 are appropriately addressed.

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

5. Cooling Water System. Information that addresses the requirements of GDC 44 regarding consideration of the cooling water system will be considered acceptable if the CWS and its components will continue to perform their required safety functions, assuming a single active failure or a moderate-energy line crack as defined in BTP 3-3 and to seismic Category I, Quality Group C, and American Society of Civil Engineers (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 (std) 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.

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 CWS components ensures system integrity and capability to perform design safety functions.

7. Cooling Water System Testing. Information that addresses the requirements of GDC 46 regarding the testing of cooling water systems will be considered acceptable if periodic system pressure and function testing of the CWS will ensure the leak tight integrity and operability of its components, as well as the operability of the system as a whole, at conditions as close to the design basis as practical. System operability should also be monitored through Technical Specifications in Chapter 16 of the safety analysis report (SAR).

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.

Table II.1: SRP Acceptance Criteria Applicability for Nonsafety-Related SSCs of the Chilled Water System

SRP Acceptance Criteria:	RTNSS B	RTNSS C	All Other Nonsafety-Related
1. GDC 1 is applicable only for containment isolation functions.	X	X	X
2. Compliance with GDC 2 is not required for RTNSS SSCs; however, RTNSS B SSCs should be 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.	X	X	
3. Compliance with GDC 4 is not required for RTNSS SSCs; however, RTNSS B SSCs should be analyzed and designed to withstand adverse effects associated with internal hazards, i.e., those created from conditions inside the plant (e.g. flooding).	X		
4. GDC 5 is not applicable to nonsafety-related SSCs.			
5. Compliance with GDC 44 is not required for RTNSS SSCs; however, 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.	X	X	
6. GDC 45 is not applicable to nonsafety-related SSCs.			
7. GDC 46 is not applicable to nonsafety-related SSCs.			
8. 10 CFR 20.1406 is applicable to nonsafety-related SSCs.	X	X	X

<u>Technical Rationale</u>

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 CWS are as listed below.

1. GDC 1 requires that SSCs important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. A quality assurance program shall be established and implemented in order to provide adequate assurance that these 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 CWS 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 CWS can withstand the effects of all appropriate combinations of seismic and dynamic effects from these natural phenomena without loss of capability to perform design safety functions.

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

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 CWS and its equipment to verify their capability to continue functioning to ensure safe-shutdown during normal operations, AOOs, and accident conditions (e.g. containment isolation). In addition, the CWS must be able to prevent or mitigate the consequences of an accident caused by exposure to environmental conditions of normal operations, maintenance, testing, or postulated accidents, including LOCAs and the dynamic effects of pipe whipping, missiles, and discharging fluids.

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

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 (SER) the use of the CWS in multiple unit plants for whether an accident in one unit significantly affects the capability to conduct a safe and orderly shutdown and cool down in other units.

   GDC 5 requirements provide assurance that the CWS 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 CWS for its capability to continue performing intended safety functions during normal operations, AOOs, and accident conditions, assuming a single failure of a component to perform its intended safety function concurrent with the LOOP.

   GDC 44 requirements provide assurance that the CWS 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.

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 CWS 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 CWS must be able to prevent or mitigate the consequences of a design basis accident.

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

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

   A. The structure and leaktight integrity of the components of the systems.

   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 CWS for whether periodic system pressure and function testing will ensure the leak-tight integrity and operability of its components, as well as the operability of the system as a whole, at conditions as close to the design basis as practical.

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

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

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

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case. These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

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

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

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

The review procedures for a safety-related CWS are listed below. Additionally, for a nonsafety-related CWS, the reviewer should use review procedures listed in Table III.1, "Review Procedures for Nonsafety-Related SSCs of the Chilled Water System".

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, Sample final safety analysis report (FSAR) Table 13.4-x, Item 17), and RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants".

    - Quality Assurance Program, SRP Sections 17.3, "Quality Assurance Program Description," and 17.5, "Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants," (SRP Section 13.4, Table 13.4, Item 16).

    - Technical Specifications (SRP Section 16.0, "Technical Specifications," and SRP Section 16.1, "Risk-informed Decision Making: Technical Specifications") – 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, "Initial Plant Test Program - Design Certification and New License Applicants," and SRP Section 13.4, Table 13.4, Item 19).

    - ITAAC (SRP Chapter 14).

2. In accordance with 10 CFR 52.47(a)(8), 10 CFR 52.47(a)(21), and 10 CFR 52.47(a)(22), for new reactor license applications submitted under 10 CFR Part 52, ""Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," 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 10 CFR 50.34(f)(1)(xii), 10 CFR 50.34(f)(2)(ix), and 10 CFR 50.34(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 SER section.

3. The 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 provide essential cooling for components, ventilation systems, or auxiliary equipment.

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.

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 components. Special consideration is given to redundant interconnected trains for operation of at least one safety-related train by proper isolation in an accident or anticipated operational occurrence.

   B. 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.

C. The system is designed to provide water makeup as necessary. Closed-loop CWSs 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 CWS system boundaries, CWS 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 CWS to the floor.

D. The system is designed for removal of heat loads during normal operation and for CWS 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.

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.

F. Essential portions of the system are protected from the effects of high-energy and moderate-energy line breaks. The system description and layout drawings are reviewed (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.

G. Essential components and subsystems (i.e., those necessary for safe shutdown) can function as required in a LOOP and loss of 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 CWS component or subsystem affected by the LOOP or loss of 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.

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.

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

   C. Design 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. The effects of chemical controls are reviewed by the secondary review organization.

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

   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.

iv. Over-cooling the condenser refrigerant.

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

F. CWS pumps are adequately designed related to net positive suction head required ($NPSH_r$) and are evaluated against NPSH available ($NPSH_a$) under normal and accident conditions. Potential CWS pump vortexing conditions are also evaluated.

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 CWS does not preclude essential functions. The review identifies these non-seismic category components or piping and ensures appropriate provision of isolation capabilities in failure.

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

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

spans. For each case, the design is acceptable if it meets minimum system requirements.

9. The SAR is reviewed by the primary review organization for whether the applicant commits to address the potential for water hammer in the CWS 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.

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

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

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

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

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 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).

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.

Table III.1: Review Procedures for Nonsafety-Related SSCs of the Chilled Water System

Review Procedure:	RTNSS B	RTNSS C	All Other Nonsafety-Related
Section III, Item 1: applies; however, Technical Specifications may not apply and instead are replaced with Short-Term Availability Controls, as required.	X	X	
Section III, Item 2: is not applicable to nonsafety-related SSCs.			
Section III, Item 3: applies	X	X	
Section III, Item 4: applies.	X	X	
Section III, Item 5A: RTNSS B or C 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.	X	X	
Section III, Item 5B: RTNSS B portions of the CWS 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 provide for defense-in-depth cooling and heat transfer functions in order to meet NRC safety goal guidelines. 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.	X	X	

Review Procedure:	RTNSS B	RTNSS C	All Other Nonsafety-Related
Section III, Item 5C: The RTNSS B or C system is designed to provide water makeup as necessary. Closed loop CWSs are reviewed for whether the surge tanks have sufficient capacity to accommodate expected leakage. Automatic or manual makeup operation 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 CWS to the floor.	X	X	
Section III, Item 5D: The RTNSS B or C 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 functions that support achieving and maintaining CSD conditions are reviewed for reliability of systems and components. The system is designed for removal of heat loads during normal operation and for CSD functions.	X	X	X
Section III, Item 5E: does not directly apply to RTNSS; however, 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.			
Section III, Item 5F: A RTNSS B 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 CWS portions, or for protection from the adverse 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.	X	X	

Review Procedure:	RTNSS B	RTNSS C	All Other Nonsafety-Related
For a RTNSS C system, the design functions are reviewed against high energy line breaks.			
Section III, Item 5G: RTNSS B and C components and subsystems can function as required in a LOOP and loss of instrument air systems. The system design is acceptable if the CWS meet minimum system requirements as stated in the SAR, assuming a concurrent failure of a single active component (for RTNSS B only), including a single failure of any auxiliary electric power source. Nonsafety-related SSCs that support shutdown cooling are reviewed for reliability of systems and components.	X	X	X
Section III.6.A applies.	X	X	X
Section III.6.B applies.	X	X	
Section III.6.C applies.	X	X	
Section III.6.D applies.	X	X	
Section III.6.E applies. Nonsafety-related SSCs related to refrigerant leak detection systems are reviewed.	X	X	X
Section III, Item 6F: RTNSS B or C CWS pumps are adequately designed related to net positive suction head required ($NPSH_r$) and are evaluated against NPSH available ($NPSH_a$) under post-72 hours periods and defense-in-depth functions. Potential CWS pump vortexing conditions are also evaluated.	X	X	
Section III, Item 7A: The failure of portions of the RTNSS B or C system or of other systems not designed to seismic Category I standards and located close to important portions of the system or of non-seismic Category I structures that house, support, or are close to important portions of the CWS 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	X	X	

Review Procedure:	RTNSS B	RTNSS C	All Other Nonsafety-Related
classifications for structures and systems.			
Section III, Item 7B: CWS portions are protected from the effects of floods, hurricanes, tornadoes, and internally or externally-generated missiles consistent with the guidance in SRP 19.3. 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 extreme wind-, 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.	X	X	
Section III, Item 8: For RTNSS B or C SSCs, the SAR descriptive information, P&IDs, and CWS drawings, are reviewed. The reviewer evaluates the SAR information to determine the ability of required components to function, traces the availability of these components on system drawings, and checks that the SAR information verifies that minimum system flow and heat transfer requirements are met for each defense-in-depth function. For each case, the design is acceptable if it meets minimum system requirements. RTNSS B SSCs should additionally consider the effects of a single active component failure. Section III, Item 8 is applicable to nonsafety-related SSCs that are credited for cold shutdown conditions, in the post-72 hour period.	X	X	X
Section III.9 applies. Nonsafety-related SSCs are reviewed to the extent that consequences from a water hammer do not negatively affect safety-related SSCs or RTNSS B SSCs	X	X	X
Section III, Item 10A: is not applicable to nonsafety-related SSCs			

Review Procedure:	RTNSS B	RTNSS C	All Other Nonsafety-Related
Section III, Item 10B: is not applicable to nonsafety-related SSCs			
Section III, Item 10C: Capability of isolated water-filled sections of piping in containment to withstand thermally-induced overpressurization is reviewed.	X	X	X
Section III.11 applies.	X	X	
Section III.12 applies.	X	X	

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 CWS 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 CWS necessary for safe shutdown and accident prevention or mitigation are designed to seismic Category I and Quality Group C requirements. After review of the applicant's proposed design criteria, design bases, and safety classification for the CWS 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 CWS is acceptable and meets the requirements of GDCs 1, 2, 4, 5, 44, 45 and 46. These conclusions are based on the following findings.

1. The applicant meets GDC 1 requirements for the CWS. 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.

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

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

5. The applicant meets GDC 44 requirements for cooling water by a system to transfer heat from SSCs important to safety to an ultimate heat sink. The applicant has demonstrated that the CWS can transfer the combined heat load of these SSCs under normal operating and accident conditions, assuming LOOP and a single failure, and that portions of the system can be isolated so system safety functions are not compromised. The design has been evaluated for adequate margins related to heat exchanger heat removal performance during normal and accident conditions; CWS pump pressure (head) and system flow rates during normal and accident conditions.

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

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

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

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

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

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

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50, "General Design Criteria for Nuclear Power Plants," 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. American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers, ANSI/ASHRAE Standard 15-2013, "Safety Standard for Refrigeration Systems," New York, NY.

2. Electric Power Research Institute, EPRI TR 1007361, "Chiller Performance Monitoring and Troubleshooting Guide," November 2002.

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

4. Institute of Electrical and Electronics Engineers Standards, IEEE Std. 603-1980, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations."

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

6. *U.S. Code of Federal Regulations*, "Requirements For Monitoring The Effectiveness Of Maintenance At Nuclear Power Plants," §50.65, Chapter 1, Title 10, "Energy."

7. *U.S. Code of Federal Regulations* “Minimization of Contamination,” §20.1406, Chapter 1, Title 10, “Energy.”

8. *U.S. Code of Federal Regulations*, “Contents of Applications, Technical Information,” §50.34, Chapter 1, Title 10, “Energy.”

9. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 1, “Quality Standards and Records.”

10. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 2, “Design Bases for Protection Against Natural Phenomena.”

11. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 4, “Environmental and Dynamic Effects Design Bases.”

12. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 5, “Sharing of Structures, Systems, and Components.”

13. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 44, “Cooling Water.”

14. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 45, “Inspection of Cooling Water System.”

15. *U.S. Code of Federal Regulations,* “Domestic Licensing of Production and Utilization,” Part 50, Chapter 1, Title 10, “Energy,” Appendix A, “General Design Criteria for Nuclear Power Plants,” GDC 46, “Testing of Cooling Water System.”

16. *U.S. Code of Federal Regulations,* ““Contents of Applications, Technical Information,” §52.47, Chapter 1, Title 10, “Energy,”

17. *U.S. Code of Federal Regulations*, “Contents of Applications, Additional Technical Information, Inspections, Tests, Analyses, and Acceptance Criteria,” §52.80(a), Chapter 1, Title 10, “Energy,”

18. U.S. Nuclear Regulatory Commission, “Seismic Design Classification,” Regulatory Guide 1.29.

19. U.S. Nuclear Regulatory Commission, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” Regulatory Guide 1.68.

20. U.S. Nuclear Regulatory Commission, “Criteria for Safety Systems,” Regulatory Guide 1.153.

21. U.S. Nuclear Regulatory Commission, “Station Blackout,” Regulatory Guide 1.155.

22. U.S. Nuclear Regulatory Commission, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,” Regulatory Guide 1.160.

23. U.S. Nuclear Regulatory Commission, “Concerns Regarding Essential Chillers Reliability During Periods of Low Cooling Water Temperature,” Information Notice No.94-82.

24. U.S. Nuclear Regulatory Commission, “Guidance for ITAAC Closure Under 10 CFR Part 52,” Regulatory Guide 1.215.

25. U.S. Nuclear Regulatory Commission, Generic Letter 96-06, “Assurance of Equipment Operability And Containment Integrity During Design-Basis Accident Conditions (GL 96-06),” September 30, 1996.

26. U.S. Nuclear Regulatory Commission, 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.

27. U.S. Nuclear Regulatory Commission, “Evaluation of Water Hammer Occurrences in Nuclear Power Plants,” NUREG-0927, Revision 1, March 1984.

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

29. U.S. Nuclear Regulatory Commission, “Protection Against Postulated Piping Failures in Fluid Systems Outside Containment,” BTP 3-3.

30. U.S. Nuclear Regulatory Commission, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis,” Regulatory Guide 1.174.

31. U.S. Nuclear Regulatory Commission, “Quality Assurance Program Criteria (Design and Construction),” Regulatory Guide 1.28.

32. U.S. Nuclear Regulatory Commission, “Combined License Applications for Nuclear Power Plants,” Regulatory Guide 1.206.

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

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.