U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.2.1 STATION SERVICE WATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Plant Systems Branch (~~PSB~~SPLB)[1]

Secondary - None

I. AREAS OF REVIEW

The service water system (SWS) provides essential cooling to safety-related equipment and may also provide cooling to nonsafety-related auxiliary components that are used for normal plant operation. The ~~PSB~~SPLB[2] reviews the system from the service water pump intake to the points of cooling water discharge to assure conformance with the requirements of General Design Criteria 2, 4, 5, 44, 45, and 46. The ultimate heat sink (reviewed under SRP Section 9.2.5) provides the intake source of water to the SWS for long-term cooling of station features required for plant shutdown and also any special equipment required to prevent or mitigate the consequences of postulated accidents and as such is an interface system to the SWS. The SWS pump performance characteristics will be compared to the high and low water levels of the ultimate heat sink to assure that pumping capability can be provided for extended periods of operation following postulated events.

Site-specific portions of the SWS may not be within the scope of the design submitted by applicants for design certification (DC) in accordance with 10 CFR Part 52. The SWS piping, valves, instrumentation, and controls within the DC applicant's scope are reviewed as part of the DC submittal. Site-specific portions of the design (may include the SWS pumps) are the responsibility of the COL applicant. The DC applicant's submittal should provide a conceptual design and interface requirements for that portion of the SWS outside the scope of the DC, as required by 10 CFR Part 52.[3]

1. The ~~PSB~~SPLB[4] reviews the characteristics of the SWS components (pumps, heat exchangers, pipes, valves) with respect to their functional performance as affected by adverse operational (i.e., water hammer) and environmental occurrences including cold weather protection, by abnormal operational requirements, and by accident conditions

such as a loss-of-coolant accident (LOCA) with the loss of offsite power. Since the SWS normally has requirements that relate to cooling functions during normal plant operation as well as for safety functions, the review will include an evaluation of the capability of the system to perform these multiple functions.

2. The ~~PSB~~SPLB[5] also reviews the design of the SWS with respect to:

   a. The capability for detection, control, and isolation of system leakage including the capability for detection and control of radioactive leakage into and out of the system and prevention of accidental releases to the environment.

   b. Measures to preclude long-term corrosion and organic fouling that would tend to degrade system performance.

   c. Provisions for system and component operational testing, including the instrumentation and control features that determine and verify that the system is operating in a correct mode (i.e., valve position, pressure and temperature indication).

   d. The effects of the failure of nonseismic Category I equipment, structures or components ~~of~~on[6] safety-related portions of the SWS are taken into account in the design.

3. The ~~PSB~~SPLB[7] reviews the SWS capability to flood the reactor containment should this be required in a post-accident recovery situation.

Review Interfaces[8]

The ~~PSB~~SPLB[9] reviews the system to determine that a malfunction, a failure of a component, or the loss of a cooling source will not reduce the safety-related functional performance capabilities of the system. Specifically, ~~PSB~~SPLB[10] performs the following reviews under the SRP sections indicated:

1. Review for flood protection is performed under SRP Section 3.4.1.

2. Review of the protection against internally-generated missiles is performed under SRP Section 3.5.1.1.

3. Review of the structures, systems and components to be protected against externally-generated missiles is performed under SRP Section 3.5.1.4 and 3.5.2.

4. Review of high and moderate energy pipe breaks is performed under SRP Section 3.6.1.

In addition, the ~~PSB~~SPLB[11] will coordinate other branches' evaluations that interface with the overall review of the system as follows: ~~The Reactor Systems Branch (RSB) identifies essential components associated with the reactor coolant system and the emergency core cooling systems that are required for operation during normal operations or accident conditions. The RSB establishes accident cooling load functional requirements and minimum time intervals. The RSB performs these reviews as part of its primary review responsibility for SRP Sections 5.4.7, 5.4.8, 6.0 and 15.0.~~[12]

1. The Reactor Systems Branch (SRXB) identifies essential components associated with the reactor coolant system that are required during normal operations or accident conditions as part of its primary review responsibility for SRP Section 5.4.7.[13]

2. The Materials and Chemical Engineering Branch (EMCB) identifies essential components associated with the reactor water cleanup system of a BWR that are required during normal operations or accident conditions as part of its primary review responsibility for SRP Section 5.4.8.[14] ~~The~~ The EMCB also verifies the compatibility of the materials of construction with service conditions.[15]

3. The SRXB identifies essential components associated with the emergency core cooling systems that are required during normal operations or accident conditions as part of its primary review responsibility for SRP Section 6.3.[16]

4. The SRXB establishes accident cooling load functional requirements and minimum time intervals as part of its primary review responsibility for SRP Section 15.0.[17]

5. The ~~structural and geotechnical engineering reviewer of the Engineering Branch (EB)~~Civil Engineering and Geosciences Branch (ECGB)[18] determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), probable maximum flood (PMF), and tornado missiles as part as its primary review responsibility for 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.

6. The ~~mechanical engineering~~Mechanical Engineering Branch (EMEB)[19] ~~reviewer of EB~~ determines that the components, piping and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 through 3.9.3.

7. The ~~mechanical engineering~~ EMEB[20] ~~reviewer also~~ determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2.

8. The ~~mechanical engineering~~ EMEB[21] ~~reviewer also~~ reviews the adequacy of the inservice testing program of pumps and valves as part of its primary review responsibility for SRP Section 3.9.6.

9. The ~~materials engineering~~ ECGB ~~reviewer of EB~~[22] verifies that inservice inspection requirements are met for system components as part of its primary review responsibility for SRP Section 6.6 ~~and, upon request, verifies the compatibility of the materials of construction with service conditions~~.[23]

10. The ~~instrumentation and control systems reviewer and the power systems reviewer of the~~ Electrical Engineering Branch (EELB)[24] and Instrumentation and Controls ~~System~~ Branch (~~EICSB~~HICB)[25] will evaluate the system controls, instrumentation, and power sources with respect to capabilities, capacity, and reliability for supplying power during normal and emergency conditions to safety-related pumps, valves and other components as part of their primary review responsibility for SRP Sections 7.1 and 8.1, respectively. The ~~EICSB~~HICB[26] will review the signals used to isolate safety-related portions of the SWS from nonsafety-related portions in the event of postulated accidents with special emphasis paid to proper isolation of interconnected trains in the event of unusual conditions such as low pressures in the SWS or drawing low current for safety-related pumps.

~~The reviews for Fire Protection, Technical Specifications and Quality Assurance are coordinated and performed by the Plant Systems Branch, Technical Specification Coordination Branch and~~

~~the Facility Operations Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0, respectively.~~[27]

11. The review for fire protection is coordinated and performed by SPLB as part of its primary review responsibility for SRP Section 9.5.1.[28]

12. The review for technical specifications is coordinated and performed by the Technical Specifications Branch (TSB) as part of its primary review responsibility for SRP Section 16.0.[29]

13. The review for quality assurance is coordinated and performed by the Performance and Quality Evaluation Branch (RPEB) as part of its primary review responsibility for SRP ~~Section~~Chapter 17.0.[30]

14. The review for security considerations associated with portions of the SWS, such as intake structures, is coordinated and performed by the Safeguards Branch (PSGB) as part of its primary review responsibility for SRP Section 13.6.[31]

15. The RPEB reviews the proposed preoperational and startup test programs as part of its primary review responsibility for SRP Section 14.2.[32]

For those areas of review identified above as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections identified as the primary review responsibility of those branches.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the service water system, as described in the applicant's safety analysis report (SAR), including related sections of Chapters 2 and 3 of the SAR is based on specific general design criteria and regulatory guides. Listed below are specific criteria as they relate to the SWS.

The design of the service water system is acceptable if the integrated system design is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of earthquakes. Acceptance is based on meeting the guidance of Regulatory Guide 1.29, Position C.1 for safety-related portions and Position C.2 for nonsafety-related portions.

2. General Design Criterion 4, as related to effects of missiles inside and outside of containment, effects of pipe whip, jets and environmental conditions resulting from high and moderate energy line breaks and dynamic effects associated with flow instabilities and loads (e.g., water hammer) during normal plant operation as well as during upset or accident conditions.

3. General Design Criterion 5, as related to the capability of shared systems and components important to safety being capable of performing required safety functions.

4. General Design Criterion 44, as related to transferring heat from structures systems and components important to safety, to an ultimate heat sink. Acceptance is based on the following:

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

   b. Component redundancy so that the safety function can be performed assuming a single active component failure coincident with the loss of offsite power.

   c. The capability to isolate components, subsystems, or piping if required so that the system safety function will not be compromised.

   d. Meeting task action plan item II.K.1.22 of NUREG-0737 (Reference 9)[33] for boiling water reactors regarding automatic and manual actions necessary when the main feedwater system is not operable. For applicants subject to 10 CFR 50.34(f) and 10 CFR 52.47(a)(1)(ii) this acceptance criterion is equivalent to the requirement of 10 CFR 50.34(f)(2)(xxi) for boiling water reactors regarding the design of auxiliary heat removal systems such that necessary automatic and manual actions can be taken to ensure proper functioning when the main feedwater system is not operable.[34]

   ~~e. Meeting task action plan item II.K.1.22 of NUREG-0718 for B&W plants regarding automatic and manual actions for proper functioning of the auxiliary heat removal systems when the main feedwater system is not operable.~~[35]

5. General Design Criterion 45, as related to design provisions to permit inservice inspection of safety-related components and equipment.

6. General Design Criterion 46, as related to design provisions to permit operational functional testing of safety-related systems and components.

Technical Rationale

The technical rationale for application of the above acceptance criteria to the station service water system is discussed in the following paragraphs.[36]

1. Compliance with GDC 2 requires that the SWS structures, systems and components, which provide essential cooling for safety-related equipment, be designed to withstand the effects of natural phenomena without loss of capability to perform their safety functions. Based on reviewing a number of safety analysis reports, a seismic design classification system was developed for identifying those plant features that should be designed to withstand the effects of the safe shutdown earthquake (SSE). Regulatory Guide 1.29 describes an acceptable method for identifying and classifying those features of light-water reactor nuclear power plants that should be designed to withstand the effects of the SSE. Those structures, systems and components that should be designed to remain functional if the SSE occurs have been designated as Seismic Category 1. Position C.1 of the Regulatory Guide states that systems required for safe shutdown, including their foundations and supports, are designated as Seismic Category I and should be designed to withstand the effects of the SSE and remain functional. Position C.2 of the Regulatory Guide states that structures, systems, or components whose continued function is not required but whose failure could reduce the functioning of any seismic Category I plant feature to an unacceptable safety level, or could result in incapacitating injury to occupants of the control room, should be designed and

constructed so that the SSE would not cause such failure. Compliance with Regulatory Guide 1.29, Positions C.1 and C.2, assures that the SWS will remain functional during a SSE and provide essential cooling water necessary for the operation of safety-related components and decay heat removal.[37]

2. Compliance with GDC 4 requires that the SWS structures, systems and components, which provide essential cooling for safety-related equipment, 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, and shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from external events. Compliance with GDC 4 assures that the SWS will remain functional under postulated environmental conditions and provide essential cooling water necessary for the operation of safety-related components and decay heat removal.[38]

3. GDC 5 prohibits the sharing of structures, systems and components among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units. The service water system provides essential cooling water necessary for the operation of safety-related components and decay heat removal. The service water system needs to be designed such that the ability to perform these safety-related functions are not compromised for each unit regardless of equipment failures or other events that may occur in another unit. Meeting the requirements of GDC 5 provides assurance that unacceptable effects of equipment failures or other events occurring in one unit of a multi-unit site will not propagate to the unaffected unit(s).[39]

4. GDC 44 requires that a SWS be provided to transfer heat from structures, systems, and components important to safety to an ultimate heat sink, and specifies performance and design requirements that the SWS must meet. Based on the lessons learned from TMI-2, a requirement was issued for the design of BWR auxiliary heat removal systems to ensure that necessary automatic and manual actions could be taken to ensure the proper functioning of the SWS when the main feedwater system is inoperable. Acceptance criteria related to this issue are identified in TMI action plan item II.K.1.22 of NUREG-0737 and 10 CFR 50, section 50.34(f)(2)(xxi). Compliance with GDC 44 and the identified TMI-related requirements assures that the SWS will function to provide essential cooling to safety-related equipment and decay heat removal during normal, transient, and accident conditions.[40]

5. Compliance with GDC 45 requires that the SWS, which provides essential cooling for safety-related equipment, 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. By allowing for periodic monitoring to detect signs of system degradation or incipient failure, compliance with GDC 45 provides assurance that the SWS will reliably function to provide essential cooling to safety-related equipment and decay heat removal.[41]

6. Compliance with GDC 46 requires that the SWS, which provides essential cooling for safety-related equipment, be designed to permit appropriate periodic pressure and functional testing to assure the structural and leak-tight integrity of its components, the operability and the performance of the active components of the system, and the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation for reactor shutdown and for loss-of-coolant accidents, including operation of applicable

portions of the protection system and the transfer between normal and emergency power sources. By designing the SWS for testing to detect degradation in performance or the system pressure boundary, compliance with GDC 45 assures that the SWS will reliably function to provide essential cooling to safety-related equipment and decay heat removal.[42]

III. REVIEW PROCEDURES

The procedures set forth below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For review of operating license (OL) applications, the review procedures and acceptance criteria are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

Upon request from the primary reviewer, the coordinating review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

As a result of the various SWS designs provided, there will be variations in system requirements. For the purpose of this SRP section, a typical system is assumed which has fully redundant systems, with each of the systems having an identical essential (safety features) portion and an identical non-essential portion (used for normal operation). For cases where there are variations from the typical arrangement, the reviewer will adjust the review procedures given below. However, the system design will be required to meet the acceptance criteria given in subsection II. Also, the reviewer will need to refer to SRP sections for other systems that would interface with the SWS.[43] depending upon the nature and conditions of the ultimate heat sink cooling water (e.g., salt water).

Evaluation of various generic issues and plant-specific probabilistic risk assessments (PRAs) have shown that the loss of the SWS may be a significant contributor to the potential for a core damage accident. A review of industry experience and plant-specific PRAs is available in NUREG-1461 (Reference 11) which provides insights related to SWS vulnerabilities.[44]

1. The SAR is reviewed to determine that the system description and piping and instrumentation diagrams (P&IDs) show the SWS equipment that is used for normal operation, and the minimum system heat transfer and flow requirements for normal plant operation. The system performance requirements will also be reviewed to determine that it describes component allowable operational degradation (e.g., pump leakage) and describes the procedures that will be followed to detect and correct these conditions when they become[45] excessive.

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

   a. Essential portions of the SWS are correctly identified and are isolable from the non-essential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical division between each portion and indicate the required classification changes. System drawings are also reviewed to see that they show the means for accomplishing isolation and the SAR description is

reviewed to identify minimum performance requirements for the isolation valves. The drawings and descriptions are reviewed to verify that automatically operated isolation valves separate non-essential portions and components from the essential portions. Special consideration is given to the case of redundant interconnected trains to assure the operation of at least one safety-related train by proper isolation in the event of an accident or transient.

b. Essential portions of the SWS, including the isolation valves separating essential and non-essential portions, are classified Quality Group C and seismic Category 1. Components and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above seismic and safety classifications have been included, and that the P&IDs indicate any points of change in piping quality group classification.

c. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components important to safety. It will be acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary test recirculation loops around pumps or isolation valves that would be required by this program.

d. The review of seismic design is performed by the structural and geotechnical reviewer of ~~EB~~ EMEB[46] and the review for seismic and quality group classification is performed by the mechanical engineering reviewer of ~~EB~~ EMEB[47] as indicated in subsection I of this SRP section.

3. The reviewer determines that the safety function of the system will be maintained, as required, in the event of adverse environmental phenomena such as earthquakes, tornadoes, hurricanes, and floods, or in the event of certain pipe breaks or loss of offsite power. The reviewer uses engineering judgment, the results of a failure mode and effects analyses, and the results of reviews performed under other SRP sections to verify the following:

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

b. The essential portions of the SWS are protected from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles. Flood protection and missile protection criteria are discussed and evaluated in detail under the Section 3 series of the SRP. The reviewer will utilize the procedures identified in these SRP sections to assure that the analyses presented are valid. A statement to the effect that the system is located in a seismic Category I structure that is tornado missile and flood protected or that components of the system will be located in individual cubicles or rooms that will withstand the effects of both flooding and missiles is acceptable. The location and the design of the system, structures, and pump rooms (cubicles) are reviewed to determine that the degree of protection provided is adequate.

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

d. Provisions are made in the system to detect and control leakage of radioactive contamination into and out of the system. It will be acceptable if the system P&IDs show radiation monitors located on the system discharge and at components susceptible to leakage, and these components can be isolated by one automatic and one manual valve in series.

e. The essential portions of the system are protected from the effects of high and moderate energy line breaks. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the SWS, or that protection from the effects of failure will be provided. The means of providing such protection will be given in Section 3.6 of the SAR and the procedures for reviewing this information are given in the corresponding SRP sections.

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

g. Provisions are made for protection of the essential service water supply from potential failures or malfunctions caused by freezing, icing, and other adverse environmental conditions. Statements in the SAR that would indicate that safety grade heating sources will be used for this purpose, considering the equipment necessary for safe shutdown, will be acceptable.

4. The descriptive information, P&IDs, SWS drawings, and failure modes and effects analyses in the SAR are reviewed to assure that essential portions of the system can function following design basis accidents assuming a concurrent single active component failure. The reviewer evaluates the failure mode and effects analysis presented in the SAR to assure function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum system flow and heat transfer requirements are met for each accident situation for the required time spans. For each case the design will be acceptable if minimum system requirements are met.

5. ~~The~~ For BWRs, the[48] SAR is reviewed to assure that the applicant has described all the automatic and manual actions necessary for proper functioning of the service water system when the main feedwater system is not operable. For any manual action necessary, the reviewer verifies that procedural controls are proposed to assure that the action is taken in a timely manner, in accordance with Item 3 of IE Bulletin 79-08 (Reference 15).[49] The design will be acceptable in this regard if sufficient detail is

presented to provide reasonable assurance that the requirements of items ~~II.K.1.22 of NUREG-0718 and II.K.1-C.1.22 of NUREG-0694~~ II.K.1.22 of NUREG-0737 or 10 CFR 50.34(f)(2)(xxi) are properly implemented.[50]

6. The SAR is reviewed to assure that the applicant has committed to address the potential for water hammer in open loop systems and will provide for venting and filling of such systems, operating procedures for avoidance of water hammer, and that the system is designed to maintain functioning following an inadvertent water hammer occurrence. Guidance for water hammer prevention and mitigation is found in NUREG-0927 (Reference 10).[51]

7. In order to address concerns related to SWS fouling, the reviewer verifies that the applicant has addressed the following SWS design provisions and inspection activities consistent with Generic Letter 89-13 (Reference 12) and Supplement 1 to GL 89-13 (Reference 13):

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

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

   c. A routine inspection and maintenance program for SWS piping and components to assure that corrosion, erosion, protective coating failure, silting, and biofouling cannot degrade the performance of the safety-related systems supplied by service water.[52]

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

   a. The sharing of structures, systems and components does not significantly impair the ability of the SWS to perform its safety function, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

   b. Flushing and flow testing provisions, resulting from the implementation of Generic Letter 89-13, are applied to the cross-tie lines.

   c. Applicants proposing designs with only two SWS pumps per unit have addressed the provisions of Generic Letter 91-13 (Reference 14).[53]

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[54]

IV. EVALUATION FINDINGS

The reviewer determines that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's safety evaluation report.

The service water system (SWS) includes all components and piping from the SWS pump intake to the points of cooling water discharge. Portions of the SWS that are necessary for safe shutdown, accident prevention, or accident mitigation,[55] are designed to seismic Category I, Quality Group C requirements. Based on the review of the applicant's proposed design criteria, design bases and safety classification for the service water system regarding the requirements for continuous cooling of safety-related components necessary for a safe plant shutdown, the staff concludes that the design of the service water system is acceptable and meets the requirements of General Design Criteria 2, 4, 5, 44, 45, and 46. This conclusion is based on the following:

1. The applicant has met the requirements of General Design Criterion 2 with respect to safety-related portions of the system being capable of withstanding the effects of earthquakes. Acceptance is based on meeting Regulatory Guide 1.29 position C.1 for the safety-related portions and position C.2 for the nonsafety-related portions.

2. The applicant has met the requirements of GDC 4 with respect to the effects of missiles inside and outside of containment, effects of pipe whip, jets and environmental conditions resulting from high and moderate energy line breaks and dynamic effects associated with flow instabilities (i.e., water hammer loads) with respect to impairment of the required service water systems during normal plant operations, and under upset or accident conditions. Acceptance with respect to effects of water hammer is based on the following:

    a. Vents shall be provided for venting of components and piping at high points in liquid filled, but normally idle piping (or systems) where voiding can occur. These vents should be designed for ease of operational testing on a periodic basis.

    b. Consideration will be given to voiding which can occur following pump shutdown, or during standby. If the system design is such that voiding could occur, means should be provided for a slow system fill upon pump start for avoidance of water hammer or that the system be designed to maintain functioning following an inadvertent water hammer occurrence.

    c. operating and maintenance procedures will be reviewed by the applicant to assure that sufficient measures have been taken for avoiding water hammer (e.g., rapid fill due to pump start, periodic fill and vent checks, avoidance of sudden valve movement, or realignment).

3. The applicant has met the requirements of General Design Criterion 5 with respect to sharing of structures, systems and components by demonstrating that such sharing does not significantly impair the ability of the service water system to perform its safety function, including in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units. In addition, the applicant has conformed to the guidance provided in Generic Letter 91-13.[56]

4. The applicant has met the requirements of General Design Criterion 44 with respect to cooling water by providing a system to transfer heat from structures, systems and components important to safety to an ultimate heat sink. The applicant has demonstrated that the service water system can transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions assuming loss of offsite power and a single failure and that portions of the system can be isolated so that the safety function

of the system will not be compromised. The applicant has also met task action plan items ~~II.K.1-C.1.22 of NUREG-0694~~ II.K.1.22 of NUREG-0737 ~~and II.K.1.22 of NUREG 0718~~ (or 10 CFR 50.34(f)(2)(xxi)for applicants subject to 10 CFR 50.34(f) and 10 CFR 52.47(a)(1)(ii))[57] in meeting General Design Criterion 44[58] (applies to BWRs only).[59]

5. The applicant has met the requirements of General Design Criterion 45 with respect to inspection of cooling water systems by providing a service water system which permits inservice inspection of safety-related components and equipment.

6. The applicant has met the requirements of General Design Criterion 45 with respect to testing of cooling water systems by providing a service water system design which permits operational functional testing of the system and its components.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[60]

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[61] Except in those cases in which the applicant proposed an acceptable alternative method for complying with specified portions of the Commission's Regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission Regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[62]

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced Regulatory Guide, NUREGs and implementation of acceptance criterion subsection II.2 is as follows:

(a) ~~Operating plants~~Plants with an operating license issued prior to June 1986 and OL applications docketed prior to June 1986[63] need not comply with the provisions of ~~this~~item II.2 ~~revision~~, but may do so voluntarily[64].

(b) CP applications docketed on or after June 1986[65] will be required to comply with the provisions of ~~this~~item II.2 ~~revision~~[66].

VI. REFERENCES

1. 10 CFR Part 50, §50.34(f), "Additional TMI-related requirements."[67]

2~~1~~. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

3~~2~~. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and ~~Missile~~Dynamic Effects[68] Design Bases."

4~~3~~. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

5~~4~~. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water."

6~~5~~. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."

7~~6~~. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water Systems."

8~~7~~. Regulatory Guide 1.29, "Seismic Design Classification."

9~~8~~. ~~NUREG-0694, "TMI-Related Requirements of New Operating Licenses."~~NUREG-0737, "Clarification of TMI Action Plan Requirements."[69]

10. NUREG-0927, Revision 1, "Evaluation of Water Hammer Occurrences in Nuclear Power Plants," March 1984.[70]

11. NUREG-1461, "Regulatory Analysis for the Resolution of Generic Issue 153: Loss of Essential Service Water in LWRs," August 1993.[71]

~~9. NUREG-0718, "Proposed Licensing Requirements for Pending CP's and Manufacturing License."[72]~~

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

13. NRC Letter to All Holders of Operating Licenses or Construction Permits for Nuclear Power Plants, "Service Water System Problems Affecting Safety-Related Equipment (Generic Letter No. 89-13, Supplement 1)," April 4, 1990.[73]

14. NRC Letter to Specified Licensees and Applicants of Pressurized-Water Reactor Nuclear Power Plants, "Request for Information Related to the Resolution of Generic Issue 130, 'Essential Service Water System Failures at Multi-Unit Sites,' (Generic Letter No. 91-13)," July 18, 1989.[74]

15. NRC Bulletin, "IE Bulletin No. 79-08: Events Relevant to Boiling Water Power Reactors Identified During Three Mile Island Incident," April 14, 1979.[75]

[This Page Intentionally Left Blank]

SRP Draft Section 9.2.1

Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
2.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
3.	Integrated Impact # 122	Revised Areas of Review to describe that at the design certification stage, site-specific features of the design are not reviewed and that these design features are reviewed at the time of a COL application.
4.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
5.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
6.	Editorial	Change "of" to "on". Existing sentence was unclear.
7.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
8.	SRP-UDP format item,Reformat Areas of Review	"Review Interfaces" heading added to "Areas of Review" subsection and put existing text in numbered paragraph form to describe how SPLB reviews aspects of the SWS under other SRP sections and how other branches support the review of the SWS.
9.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
10.	SRP-UDP format item, Reformat Areas of Review and add current PRB names and abbreviations.	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1. Reviews performed by the PRB under other SRP sections associated with the SRP Section 9.2.1 review were listed and numbered.
11.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.2.1.
12.	SRP-UDP format item,Reformat Areas of Review	Editorial deletion made to separate text into four different statements and to reflect current PRB names and responsibilities for SRP Sections 5.4.7, 5.4.8, 6.3 and 15.0. Reviews performed by other branches under other SRP sections for SRP Section 9.2.1 were listed and numbered as described in items 13 through 16.

Item	Source	Description
13.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 5.4.7.
14.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 5.4.8.
15.	Editorial	The compatibility of construction materials with service conditions is more appropriately reviewed by the EMCB and therefore this text was taken from review interface 9 and placed here.
16.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 6.3. Original reference to SRP Section 6.0 was changed to SRP Section 6.3. SRP Section 6.0 does not exist. The text of the described review interface relates to the ECCS, which is covered in SRP Section 6.3.
17.	Current PRB names and abbreviations	Editorial change made to reflect current PRB names and responsibilities for SRP Section 15.0.
18.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for 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.
19.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Sections 3.9.1 through 3.9.3.
20.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Sections 3.2.1 and 3.2.2.
21.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 3.9.6.
22.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 6.6.
23.	Editorial	The compatibility of construction materials with service conditions is more appropriately reviewed by the EMCB and therefore this text has been moved to review interface 2.
24.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 8.1.
25.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 7.1.
26.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 7.1.

Item	Source	Description
27.	SRP-UDP format item,Reformat Areas of Review	Editorial deletion made to separate text into three different statements to reflect current PRB names and responsibilities for SRP Sections 9.5.1, 16.0 and 17.0. Reviews were listed and numbered as described in items 26 through 28.
28.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 9.5.1.
29.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Section 16.0.
30.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Sections 17.1, 17.2, and 17.3. Also, changed Section 17.0 to Chapter 17.0 since there is no SRP Section 17.0.
31.	Disposition of Potential Impacts Nos. 2331, 22111, 22113 and findings described in Section 9.2.1 of the evolutionary plant Advance SERs	SWS intake structures present a complication for security reviews that require special consideration. The appropriate acceptance criteria and review procedures associated with this issue are covered in SRP Section 13.6. A review interface was added to identify this relationship.
32.	Disposition of Potential Impact Nos. 2288 and 2289.	The potential impacts identify testing issues specifically related to the SWS. The appropriate acceptance criteria and review procedures associated with this issue are covered in SRP Section 14.2. A review interface was added to identify this relationship.
33.	Integrated Impact # 125	Updated TMI action plan citation from II.K.1-C.1.22 of NUREG-0694 to II.K.1.22 of NUREG-0737. Added parenthetical reference to the corresponding citation of NUREG-0737 in the References subsection.
34.	Integrated Impact # 125	Added citation of 10 CFR 50.34(f)(2)(xxi) for CP/DC/COL applicants.
35.	Integrated Impact # 125	Deleted acceptance criteria 4.e. Application of this TMI action plan item to B&W plants appears to be inappropriate.
36.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale section. Technical Rationale is a new feature added to the SRP.
37.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale for GDC 2 and Regulatory Guide 1.29. Technical Rationale is a new feature added to the SRP.
38.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale for GDC 4. Technical Rationale is a new feature added to the SRP.

Item	Source	Description
39.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale for GDC 5. Technical Rationale is a new feature added to the SRP.
40.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale for GDC 44 and 10 CFR 50.34(f)(2)(xxi). Technical Rationale is a new feature added to the SRP.
41.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale for GDC 45. Technical Rationale is a new feature added to the SRP.
42.	SRP-UDP format item,Develop Technical Rationales	Added Technical Rationale for GDC 46. Technical Rationale is a new feature added to the SRP.
43.	Editorial	Removed period which appears to be a typographical error in the existing text.
44.	Integrated Impact # 348	Added statement to Review Procedures to refer reviewers to the SWS operational and PRA experience base of NUREG-1461.
45.	Editorial	Corrected grammar error, "became" should be "become".
46.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Sections 3.9.1 through 3.9.3.
47.	Current PRB names and abbreviations	Editorial change made to reflect current PRB name and responsibility for SRP Sections 3.2.1 and 3.2.2.
48.	Integrated Impact # 125	Added text to indicate that this review procedure is applicable to BWR applicants.
49.	Integrated Impact # 125	Added reference to item 3 of Bulletin 79-08 related to II.K.1.22 of NUREG-0737 and 10 CFR 50.34(f)(2)(xxi). Added text to the review procedure to more closely follow the discussion of the issue in bulletin.
50.	Integrated Impact # 125	Updated TMI action plan citation from II.K.1-C.1.22 of NUREG-0694 to II.K.1.22 of NUREG-0737 and changed citation of II.K.1.22 of NUREG-0718 to 10 CFR 50.34(f)(2)(xxi) for CP/DC/COL applicants.
51.	PRB Comment	Added reference to NUREG-0927 in response to PRB comment, NRC Memo Li to Lyons dated November 1, 1995.
52.	Integrated Impact # 123	Added guidance to Review Procedures to confirm that the recommendations from Generic Letter 89-13 for the design and inspection of the SWS will be implemented.

Item	Source	Description
53.	Integrated Impact # 124	Added Review Procedures for the review of multi-unit sites with SWS cross-tie capability to confirm compliance with GDC 5 and that the recommendations from Generic Letter 91-13 have been considered in the design.
54.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
55.	Editorial	Added commas. Missing in existing text.
56.	Integrated Impact # 124	Added a statement to Evaluation Findings to state that compliance with GDC 5 has been met, in part, through the implementation of Generic Letter 91-13 guidance.
57.	Integrated Impact # 125	Revised Evaluation Findings citing NUREG-0694 and -0718 to cite NUREG-0737 and 10 CFR 50.34(f)(2)(xxi).
58.	Editorial	Changed existing reference to GDC 4 to GDC 44. This finding relates to GDC 44 and the reference to GDC 4 in the original text appears to be a typographical error.
59.	Integrated Impact # 125	Added parenthetical statement to indicate that this portion of the finding is only applicable to BWRs.
60.	SRP-UDP format item, Make editorial changes to implement 10 CFR 52 process	Added description on additional Evaluation Findings that should be provided for reviews of design certification applications.
61.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
62.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
63.	Change to SRP revision date effect on existing implementation subsection statement	Existing implementation statement was dependent on the SRP revision date. Added explicit implementation date based on revision 4 date of the SRP section.
64.	Editorial	Clarified statement by replacing "revision" with "item" since the implementation statement is specific to item II.2.
65.	Change to SRP revision date effect on existing implementation subsection statement	Existing implementation statement was dependent on the SRP revision date. Added explicit implementation date based on revision 4 date of the SRP section.
66.	Editorial	Clarified statement by replacing "revision" with "item" since the implementation statement is specific to item II.2.

Item	Source	Description
67.	Integrated Impact # 125	Added 10 CFR 50.34(f) to References.
68.	Editorial	Editorial correction to update the title of GDC 4 in References.
69.	Integrated Impact # 125	Updated References to reflect change in TMI action plan citation from II.K.1-C.1.22 of NUREG-0694 to II.K.1.22 of NUREG-0737.
70.	PRB Comment	Added reference to NUREG-0927 in response to PRB comment, NRC Memo Li to Lyons dated November 1, 1995.
71.	Integrated Impact # 348	Added NUREG-1461 to References.
72.	Integrated Impact # 125	Deleted NUREG-0718 from References.
73.	Integrated Impact # 123	Added Generic Letter 89-13, and Supplement 1 thereto, to References.
74.	Integrated Impact # 124	Added Generic Letter 91-13 to References.
75.	Integrated Impact # 125	Added IE Bulletin 79-08 to References.

SRP Draft Section 9.2.1
Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
122	Modify Areas of Review to clarify that, for Design Certification, site-specific features of the SWS design are not reviewed, but are reviewed as part of a COL application.	Subsection I, Areas of Review (added second paragraph).
123	Add Review Procedures for confirmation that an ongoing program of surveillance and control is implemented and maintained to reduce fouling problems in open-cycle service water systems.	Subsection III, Review Procedures, (Item 7). Subsection VI, References (Items 12 and 13).
124	Add a Review Procedure, applicable to multi-unit sites with SWS cross-tie capability, which verifies that the applicant has addressed the positions described in Generic Letters 89-13 and 91-13, and complies with the requirements of GDC-5.	Subsection III, Review Procedures, (Item 8). Subsection IV, Evaluation Findings, (Item 3). Subsection VI, References (Item 14).
125	Update Acceptance Criteria and other related portions of SRP Section 9.2.1 to reflect NUREG-0737 item II.K.1.22, 10 CFR 50.34(f)(2)(xxi) and Bulletin 79-08 and to identify this as a BWR issue.	Subsection II, Acceptance Criteria, (Items 4.d and 4.e). Subsection III, Review Procedures, (Item 5). Subsection IV, Evaluation Findings, (Item 4). Subsection VI, References (revised item 8, deleted item 9, added new item 15, and added new item 1).
348	Modify Review Procedures to reflect insights, appearing in NUREG-1461 and associated documentation, that were gained from the resolution of Generic Issue 153.	Subsection III, Review Procedures, (added fourth paragraph). Subsection VI, References (Item 11).