



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.2.1

STATION SERVICE WATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Reactor Systems Branch (RSB)
Electrical, Instrumentation and Control Systems Branch (EICSB)
Structural Engineering Branch (SEB)
Mechanical Engineering Branch (MEB)
Materials Engineering Branch (MTEB)

I. AREAS OF REVIEW

The service water system (SWS) provides essential cooling to safety-related equipment and may also provide cooling to non-safety-related auxiliary components that are used for normal plant operation. The APCSB reviews the system from the service water pump intake to the points of cooling water discharge. The ultimate heat sink (reviewed under Standard Review Plan (9.2.5) is the intake source of water provided to the SWS for longterm 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.

1. The APCSB reviews the characteristics of the SWS components (pumps, heat exchangers, pipes, valves) with respect to their functional performance as affected by adverse environmental occurrences, by abnormal operational requirements, and accident conditions such as a loss-of-coolant accident (LOCA) and 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 APCSB 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, the system is reviewed to verify that:

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to Revision 2 of the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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- a. System components and piping have sufficient physical separation or shielding to protect the essential portions of the system from missiles, pipe whip, and jet impingement that may result from piping cracks or breaks.
 - b. Design code requirements, as applicable to the assigned quality group and seismic category, are met.
 - c. Effects of failure of the non-seismic Category I equipment, structure, or components on safety-related portions of the SWS system are taken into account in the design. In addition, the review includes the consequences of postulated pipe breaks in high and moderate energy fluid systems.
3. The APCSB also reviews the design of the SWS with respect to:
- a. Functional capability during abnormally high water levels; i.e., adequate flood protection during the probable maximum flood.
 - b. 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.
 - c. Measures to preclude long-term corrosion and organic fouling that would tend to degrade system performance.
 - d. 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).
4. The APCSB reviews the SWS capability to flood the reactor containment should this be required in a post-accident recovery situation.
5. The applicant's proposed technical specifications are reviewed for operating license applications, as they relate to areas covered in this review plan.

Secondary reviews are performed by other branches and the results used by the APCSB to complete the overall evaluation of the system. The secondary reviews are as follows: the RSB identifies essential components associated with the reactor coolant system and the emergency core cooling systems that are required for operation during normal operations and accident conditions. The RSB establishes accident cooling load functional requirements and minimum time intervals and determine that the seismic and quality group classifications for system components are acceptable. The SEB 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. The MEB will review the seismic qualification of components and confirm that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB will verify that inservice inspection requirements are met for system components and, upon request, will verify the compatibility of the materials of construction with service conditions. The EICSB will evaluate the 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.

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. An additional basis for determining the acceptability of the SWS will be the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience. 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 natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods.
2. General Design Criterion 4, with respect to structures housing the system and the system itself being capable of withstanding the effects of external missiles and internally generated missiles, pipe whip, and jet impingement forces associated with pipe breaks.
3. General Design Criterion 5, as related to the capability of shared systems and components important to safety seem capable of performing required safety functions.
4. General Design Criterion 44, to assure:
 - 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 under LOCA conditions the safety function can be performed assuming a single active component failure coincident with the loss of offsite power.
 - c. Component redundancy so that the safety function can be performed assuming a single active component failure coincident with the loss of offsite power.
 - d. The capability to isolate components, subsystems, or piping if required so that the system safety function will not be compromised.
5. General Design Criterion 45, as related to design provisions made to permit inservice inspection of safety-related components and equipment.
6. General Design Criterion 46, as related to design provisions made to permit operational functional testing of safety-related systems and components to assure:
 - a. Structural integrity and system leak tightness.
 - b. Operability and adequate performance of active system components.
 - c. Capability of the integrated system to perform required functions during normal, shutdown, and accident situations.

7. Regulatory Guide 1.26, as related to the quality group classification of systems and components.
8. Regulatory Guide 1.29, as related to the seismic design classification of system components.
9. Branch Technical Position APCS 3-1, as related to breaks in high and moderate energy piping systems outside containment.

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 Section II of this review plan. 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.

The review procedures for OL applications include a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed as a result of the staff's review.

As a result of the various SWS designs provided, there will be variations in system requirements. For the purpose of this review plan, 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 Section II of this review plan. Also, the reviewer will need to refer to review plans for other systems that would interface with the SWS, depending upon the nature and conditions of the ultimate heat sink cooling water (e.g., salt water).

1. The SAR is reviewed to determine that the system description section 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 section 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 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 failure 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 system 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.
 - b. Essential portions of the SWS, including the isolation valves separating essential and non-essential portions, are classified Quality Group C or higher and seismic Category I. 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.
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 review plans to verify 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 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 standard review plans for Chapter 3 of the SAR. The reviewer will utilize the procedures identified in these review plans 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 SAR 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 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 review plans.
 - 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.
3. 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.

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. The scope of review of the service water system for the _____ plant includes layout drawings, process flow diagrams, piping and instrumentation diagrams, and descriptive information for the SWS and auxiliary supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the service water system regarding the requirements for continuous cooling during all conditions of plant operation. (CP)] [The review has determined that the applicant's analysis of the design of the service water system and auxiliary supporting systems is in conformance with the design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs and design criteria for the service water system and necessary auxiliary supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the service water system conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection against Natural Phenomena."
2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."
3. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."
4. 10 CFR Part 50, Appendix A, General Design Criterion 44, "Cooling Water."
5. 10 CFR Part 50, Appendix A, General Design Criterion 45, "Inspection of Cooling Water System."
6. 10 CFR Part 50, Appendix A, General Design Criterion 46, "Testing of Cooling Water Systems."
7. Regulatory Guide 1.26, "Quality Group Classification and Standards For Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants."
8. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.
9. Branch Technical Position APCS 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1.

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