



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

SECTION 9.5.5

EMERGENCY DIESEL ENGINE COOLING WATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

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

I. AREAS OF REVIEW

The emergency diesel engine cooling water system (EDECWS) provides cooling water to the station emergency diesel engines. The APCSB review includes those portions of the EDECWS that receive heat from components essential for proper operation of the diesel engines and that are housed within their respective diesel engine compartments, and those additional parts of the system that transfer the heat to a heat sink. The system includes all valves, heat exchangers, pumps and piping up to the engine housing.

1. The APCSB reviews the functional performance characteristics of the EDECWS and the effects on those characteristics of adverse environmental occurrences, abnormal operational requirements, accident conditions, and loss of offsite power.
2. The system is reviewed to determine that a malfunction or single failure of a component, or the loss of a cooling source, will not reduce the safety-related functional performance capabilities of the system. The APCSB verifies that:
 - a. System components and piping have sufficient physical separation or shielding to protect the system from internally or externally generated missiles and from pipe whip and jet impingement caused by cracks or breaks in high and moderate energy piping.
 - b. System components are designed in accordance with the design codes required by the assigned quality group and seismic category classifications.
 - c. The system is housed in structures designed to seismic Category I requirements.
 - d. Failures of non-seismic Category I structures and components would not affect the safety-related functions of the EDECWS.

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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3. The APCSB reviews the design of the EDECWS with respect to the following:
 - a. Functional capability during periods of abnormally high water levels (the probable maximum flood).
 - b. Capability to detect and control system leakage, including isolating portions of the system in the event of excessive leakage or component malfunction.
 - c. Measures to preclude long-term corrosion and organic fouling that would degrade system cooling performance, and the compatibility of any corrosion inhibitors or antifreeze compounds used with the materials of the system.
 - d. The capacity of the EDECWS with regard to the manufacturer's recommended engine temperature differentials under adverse operating conditions.
 - e. Provision of proper instruments and testing systems to permit operational testing of the system.
 - f. Provisions to assure that normal protective interlocks do not preclude engine operation during emergency conditions.
4. The APCSB will review the applicant's proposed technical specifications for operating license applications as they relate to areas covered in this plan.

Secondary reviews will be 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 SEB will determine the acceptability of the design analyses, procedures, and criteria used to establish the ability of the Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as a safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB will review the seismic qualification testing of components and will determine 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 RSB will determine that the seismic and quality group classifications for system components are acceptable. The EICSB will determine the adequacy of the design, installation, inspection, and testing of all electrical components (sensing, control, and power) required for proper operation of the system, including interlocks (EICSB BTP-17).

II. ACCEPTANCE CRITERIA

Acceptability of the diesel engine cooling system design, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. An additional basis for determining the acceptability of the system will be the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience. Listed below are the specific criteria as they relate to the EDECWS.

The system is acceptable if the 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, as established in Chapters 2 and 3 of the SAR.
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 being capable of performing required safety functions.
4. General Design Criterion 44, to assure:
 - a. The capability to transfer heat from systems and components to a heat sink under transient or accident conditions.
 - b. Redundancy of components so that under accident conditions the safety function can be performed assuming a single active component failure.
 - c. The capability to isolate components of the system or piping, if required to maintain the system safety function.
5. General Design Criterion 45, as related to design provisions to permit periodic inspection of safety-related components and equipment of the system.
6. General Design Criterion 46, as related to design provisions to permit appropriate functional testing of safety-related systems or components to assure structural integrity and leaktightness, operability and performance of active components, and the capability of the system to function as intended under accident conditions.
7. Regulatory Guide 1.26, as related to the quality group classification of system components.
8. Regulatory Guide 1.29, as related to the seismic design classification of system components.
9. Branch Technical Positions APCSB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.
10. Branch Technical Position EICSB-17, diesel-generator protective trip circuit bypasses as it relates to engine cooling water protective interlocks during accident conditions.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) 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 plan. For the review of operating license (OL) applications, the procedures are used 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 procedures for OL reviews 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.

The design of the diesel engine cooling water system may vary considerably from plant to plant due to the requirements of various diesel engine manufacturers, the number and type of secondary cooling loops used for heat removal, and the number of intermediate cooling loops required to transfer the rejected heat to the ultimate heat sink. Variations in design may also occur due to preferences of various architect-engineer firms. Therefore, for the purpose of this review plan, a typical system is assumed. Any variance in the review procedure, to suit a particular design, will be such that the system review areas in Section I are covered, and the system will meet the criteria in Section II.

1. The SAR is reviewed to establish that the EDECWS description and related diagrams clearly delineate system operation, individual and total heat removal rates required by components, and the margin in the design heat removal rate capability. The reviewer verifies the following:
 - a. Failure of a piping interconnection, as shown on system piping and instrumentation diagrams (P&IDs), between subsystems does not cause total degradation of the EDECWS. The results of failure modes and effects analyses are used as a basis of acceptance.
 - b. Provisions have been made to permit inspection of components, as shown on system layout drawings.
 - c. The performance and water chemistry of the EDECWS is in conformance with the engine manufacturer's recommendations.
 - d. The engine "first try" starting reliability has been increased by providing an independent loop for circulating heated water while the engine is in the stand-by mode.
 - e. Temperature sensors have been provided to alert the operator when cooling water temperatures exceed the limits recommended by the manufacturer. Protective interlocks in this system are acceptable if the SAR indicates that the interlocks are in conformance with EICSB Branch Technical Position-17.

2. The reviewer verifies that the EDECWS can be vented to assure that all spaces are filled with water. Statements in the SAR to the effect that the system design satisfies the above requirement are acceptable.
3. The reviewer verifies that system function will be maintained in the event of adverse environmental phenomena and loss of offsite power. The reviewer evaluates the system, using engineering judgment and the results of failure modes and effects analyses to determine that:
 - a. Failure of non-essential portions of the system or of other systems not designed to seismic Category I requirements 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 EDECWS, will not preclude essential functions. Reference to SAR sections 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 to the effect that the above conditions are met are acceptable.
 - b. The essential portions of the system are protected from the effects of floods, hurricanes, tornadoes, and internally and 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. 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.
4. The reviewer verifies that there are no high or moderate energy piping systems located close to the EDECWS or that the EDECWS is protected from the effects of postulated breaks in these systems. The means of providing such protection are given in Chapter 3 of the SAR and procedures to review the information presented are given in the standard review plans for that chapter.
5. The descriptive information, P&IDs, onsite emergency power supply drawings, and system analyses are reviewed to assure that essential portions of the system will function following design basis accidents, assuming a concurrent single active component failure. The reviewer evaluates the results of failure modes and effects analyses presented in the SAR to ensure the functioning of required portions of the system.
6. The performance requirements of the diesel engine are reviewed to determine the time available to provide cooling water to the diesels and the other systems that have to operate to assure onsite power capability.
7. The reviewer verifies that the EDECWS and the diesel generator can perform during periods when less than full electrical power generation is required.

IV. EVALUATION FINDINGS

The reviewer verifies 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 emergency diesel engine cooling water system includes all piping, valves, heat exchangers, and pump up to the points where the cooling water piping connects to the engine housings. The scope of review of the diesel engine cooling water system for the _____ plant included layout drawings, process flow diagrams, piping and instrumentation diagrams, and descriptive information for the system and auxiliary supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the emergency diesel engine cooling water system, and the requirements for continuous cooling during all conditions of plant operation. (CP)] [The review has determined that the design of the diesel engine cooling 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 diesel engine cooling 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, branch technical positions, and industry standards.

"The staff concludes that the design of the diesel engine cooling 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 System."
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 System."

7. Regulatory Guide 1.26, "Quality Group Classifications and Standards For Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.
8. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.
9. Branch Technical Positions APCSB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to Standard Review Plan 3.6.1, and MEB 3-1, "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment," attached to Standard Review Plan 3.6.2.
10. Branch Technical Position EICSB-17, "Diesel-Generator Protective Trip Circuit Bypasses."

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