



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

SECTION 10.3

MAIN STEAM SUPPLY SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

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

I. AREAS OF REVIEW

The main steam supply system (MSSS) for both boiling water reactor (BWR) and pressurized water reactor (PWR) plants transports steam from the nuclear steam supply system to the power conversion system and various safety-related or non-safety-related auxiliaries. Portions of the MSSS may be used as a part of the heat sink to remove heat from the reactor facility during certain operations and may also be used to supply steam to drive engineered safety feature pumps. The MSSS may also include provisions for secondary system pressure relief in PWR plants.

The MSSS for the BWR direct cycle plant extends from the outermost containment isolation valves up to (but not including) the turbine stop valves, and includes connected piping of 2-1/2 inches nominal diameter or larger up to and including the first valve that is either normally closed or is capable of automatic closure during all modes of reactor operation. The MSSS for the PWR indirect cycle plant extends from the connections to the secondary sides of the steam generators up to (but not including) the turbine stop valves, and includes the containment isolation valves, safety and relief valves, connected piping of 2-1/2 inches nominal diameter or larger up to and including the first valve that is either normally closed or capable of automatic closure during all modes of operation and the steam line to the auxiliary feedwater pump turbine.

1. The APCSB reviews the MSSS to determine which, if any, portions of the system are essential for safe shutdown of the reactor or for preventing or mitigating the consequences of accidents. The system is reviewed to verify that:
  - a. A single malfunction or failure of an active component would not preclude safety-related portions of the system from functioning as required during normal operations, adverse environmental occurrences, and accident conditions, including loss of offsite power.

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 USNRC STANDARD REVIEW PLAN
 

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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. 20546.

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- b. Appropriate quality group requirements and seismic design requirements are met for safety-related portions of the system.
  - c. Failures of non-seismic Category I equipment or structures, or pipe cracks or breaks in high and moderate energy piping will not preclude essential functions of safety-related portions of the system.
  - d. The system is capable of performing multiple functions such as transporting steam to the power conversion system, providing heat sink capacity or pressure relief capability, or supplying steam to drive safety system pumps (e.g., turbine-driven auxiliary feedwater pumps), as may be specified for a particular design.
2. The APCS reviews the MSSS with regard to measures provided to limit blowdown of the system in the event of a steam line break.
  3. The APCS also reviews the design of the MSSS with respect to the following:
    - a. The functional capability of the system to transport steam from the nuclear steam supply system as required during all operating conditions.
    - b. The capability to detect and control system leakage, and to isolate portions of the system in case of excessive leakage or component malfunctions.
    - c. The capability to preclude accidental releases to the environment.
    - d. Provisions for functional testing for safety-related portions of the system.
  4. The applicant's proposed technical specifications are reviewed for operating license applications as they relate to areas covered in this plan.

Secondary reviews are performed by other branches and the results used by the APCS to complete the overall evaluation of the system. The secondary reviews are as follows. The RSB identifies essential components associated with the main steam supply system inside the primary containment that are required for normal operations and accident conditions, establishes shutdown cooling load requirements versus time, determines the appropriate seismic and quality group classifications for system components and verifies the design transient used in establishing the flow capacity and set point(s) of steam generator relief and safety valves. 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), the probable maximum flood (PMF), and tornado missiles. The MEB reviews and seismic qualification of components and confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The MTEB verifies 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 reviews the electrical portions of the MSSS with respect to the adequacy design, installation, inspection, and testing of essential electrical components and instrumentation and control functions.

## II. ACCEPTANCE CRITERIA

Acceptability of the design of the main steam supply system, 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 MSSS will be the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience.

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

1. General Design Criterion 2, as related to safety-related portions of the system 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 safety-related portions of the system 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 34, as related to the system function of transferring residual and sensible heat from the reactor system in indirect cycle plants.
4. Regulatory Guide 1.26, as related to the quality group classification of the system.
5. Regulatory Guide 1.29, as related to the seismic design classification of system components.
6. Branch Technical Positions APCSB 3-1 and MEB 3-1, as related to breaks in high and moderate energy piping systems outside containment.

## 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 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 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.

The review procedures below are written for typical main steam supply systems for both direct and indirect cycle plants. The reviewer will select and emphasize material from this plan, as may be appropriate for a particular case.

1. There are significant differences in the design of the main steam supply system for an indirect cycle (PWR) plant as compared to that for a direct cycle (BWR) plant. Further, different portions of the MSSS are safety-related in different plant designs, although the safety functions of the system are much the same in all PWR plants, and also in all BWR plants. The first step in the review of the MSSS, then, is to determine which portions are designed to perform a safety function. For this purpose, the system is evaluated to determine the components and subsystems necessary for achieving safe reactor shutdown in all conditions or for performing accident prevention or mitigation functions.
2. The reviewer determines that essential (safety-related) portions of the MSSS are correctly identified and are isolable to the extent required from non-essential portions of the system. The system description and piping and instrumentation diagrams (P&IDs) are reviewed to verify that they clearly indicate the physical division between each portion. System arrangement drawings are reviewed to identify the means provided for accomplishing system isolation.
3. The SAR is reviewed to verify that essential portions of the MSSS are designed to Quality Group B or higher and seismic Category I requirements, and to verify that the design classifications specified meet the acceptance criteria. In general, the main steam lines from the steam generators to the containment isolation valves in PWR plants are classified seismic Category I and Quality Group B, and the main steam lines in BWR plants from the outer containment isolation valves to the main steam system shutoff valves or the turbine stop valves are classified seismic Category I and Quality Group B. In this regard APCS B will use the results of the RSB review under Standard Review Plan (SRP) 3.2.2.
4. The SAR is reviewed to assure that design provisions have been made to permit appropriate functional testing of system components important to safety. It is acceptable if the SAR delineates a testing and inspection program and the system drawings show any test recirculation loops and special connections around isolation valves that would be required by this program.
5. The system description, safety evaluation, component table, and P&IDs are reviewed to verify that the system has been designed to:
  - a. Provide the necessary quantity of steam to any turbine-driven safety system pumps. The reviewer refers to the pump performance curves and verifies that the design is capable of providing the required steam flow to the turbine so that an adequate supply of water can be pumped. (OL)
  - b. Assure safe plant operation by including appropriate design margins for pressure relief capacity and set points for the secondary system, and for removal of decay heat during various accident conditions, as may be applicable in a particular case. The review is done on a case-by-case basis, and system acceptability is based on a

comparison of system flow rates, heat loads, maximum temperatures, and heat removal capabilities to those of similarly designed systems for previously reviewed plants. For PWR's the design is reviewed to verify system capability for controlled cool-down to about 350°F to allow actuation of RHR system.

- c. Provide leakage detection means for steam or radioactivity leakage from the system in the event of a steam line break. Radioactivity monitors or temperature and pressure sensors are acceptable means for initiating signals to close the main steam line isolation valves and/or turbine stop valves to limit the release of steam during a steam line break accident.
  - d. Assure that in the event of a postulated break in a main steam line in a PWR plant, the design will preclude the blowdown of more than one steam generator, assuming a concurrent single component failure. In this regard the turbine stop and control valves are considered to be functional. The reviewer should verify that the main steam isolation valves and turbine stop and bypass valves can close against maximum steam flow.
6. The reviewer verifies that the system is designed so that essential functions will be maintained, as required, in the event of adverse environmental phenomena, certain pipe breaks, or loss of offsite power. The reviewer uses engineering judgment and the results of failure modes and effect analyses to determine that:
- a. Failure of non-seismic Category I portions of the MSSS or of other systems 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 MSSS, do not preclude operation of the essential portions of the MSSS. 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 that confirm that the above conditions are met are acceptable.
  - b. Essential portions of the MSSS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles. Flood protection and missile protection criteria are evaluated under the standard review plans for Chapter 3 of the SAR. The locations and the design of the system and structures are reviewed to determine that the degree of protection provided is adequate. 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 winds, flooding, and tornado missiles is acceptable.
  - c. Essential portions of the MSSS are protected from the effects of high and moderate energy line breaks and cracks, including pipe whip, jet forces and environmental effects. Layout drawings are reviewed to assure that no high or moderate energy piping systems are close to essential portions of the MSSS, 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 procedures for reviewing this information are given in the corresponding review plans.

- d. Essential components and subsystems necessary for safe shutdown can function as required in the event of loss of offsite power. The SAR is reviewed to verify that for each MSSS component or subsystem affected by a loss of offsite power the system functional capability meets or exceeds minimum design requirements. Statements in the SAR and results of failure modes and effects analyses are considered in assuring that the system meets these requirements. This is an acceptable verification of system functional reliability.
7. The descriptive information, P&IDs, MSSS drawings, and failure modes and effects analyses in the SAR 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 analyses 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 requirements are met for each accident situation for the required time spans. For each case the design is acceptable if minimum system requirements are met.

#### 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 main steam supply system (MSSS) includes all components and piping from the outermost containment isolation valves to the turbine stop valves. The scope of review of the main steam supply system for the \_\_\_\_\_ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the MSSS 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 safety-related portions of the MSSS and system performance requirements for normal, abnormal, and accident conditions. (CP)] [The review has determined that the design of safety-related portions of the MSSS 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, design criteria, and design bases for the main steam supply system and 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 main steam supply 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 34, "Residual Heat Removal."
4. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.
5. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.
6. Branch Technical Positions APCS 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.

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