



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

SECTION 10.4.7

CONDENSATE AND FEEDWATER SYSTEM

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

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

I. AREAS OF REVIEW

The condensate and feedwater system (CFS) provides feedwater at the required temperature, pressure, and flow rate to the reactor for boiling water reactor (BWR) plants and to the steam generators for pressurized water reactor (PWR) and high temperature gas-cooled reactor (HTGR) plants. Condensate is pumped from the main condenser hotwell by the condensate pumps, passes through the low pressure feedwater heaters to the feedwater pumps, and then is pumped through the high pressure feedwater heaters to the nuclear steam supply system.

APCSB reviews the CFS from the condenser outlet to the connection with the nuclear steam supply system and to the heater drain system. For indirect cycle plants, there are also interfaces with the secondary water makeup system and the auxiliary feedwater system. The CFS is used for normal shutdown. The only part of the CFS classified as safety-related, i.e., required for safe shutdown or in the event of postulated accidents, is the feedwater piping from the steam generators to, and including, the outermost containment isolation valve for indirect cycle plants.

1. The APCSB reviews the characteristics of the CFS with respect to the capability to supply adequate feedwater to the nuclear steam supply system as required for normal operation and shutdown.
2. The APCSB review determines that an acceptable design has been established for:
  - a. The interfaces of the CFS with the auxiliary feedwater system (PWR), the reactor core isolation cooling system (BWR), and the condensate cleanup system.
  - b. The feedwater system (PWR), including the auxiliary feedwater system piping entering the steam generator, with regard to possible fluid flow instabilities (e.g., water hammer) during normal plant operation as well as during upset or accident conditions.

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**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. 20508.

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- c. The detection of major system leaks that could affect the functional performance of safety-related equipment.
2. The APCSB reviews the applicant's proposed technical specifications for operating license applications as they relate to areas covered in this plan.

Secondary review evaluations 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 EICSB will, upon request, review the feedwater control system (BWR) or steam generator level control system (PWR). The RSB reviews the system for appropriate seismic and quality group classifications. Upon request, the SEB determines the acceptability of design analyses, procedures, and criteria used to establish the structural adequacy of devices or restraints as they may relate to significant water hammer forces in system piping, the MEB reviews test programs and the operability of components that may be affected by water hammer and confirms that piping and components are designed in accordance with applicable codes and standards, and the MTEB verifies that inservice inspection requirements are met for system components that may be affected by forces from water hammer.

## II. ACCEPTANCE CRITERIA

Acceptability of the condensate and feedwater system, as described in the applicant's safety analysis report (SAR), is based on the criteria below and on the degree of similarity of the design to that of previously reviewed and approved plants.

1. Regulatory Guide 1.26, as related to the quality group classification of safety-related system components.
2. Regulatory Guide 1.29, as related to the seismic design classification of safety-related system components.
3. 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 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 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 reviewer will select and emphasize material from this review plan as may be appropriate for a particular case.

1. The SAR is reviewed to determine that the system description and diagrams delineate the function of the condensate and feedwater system under normal and abnormal conditions. The reviewer verifies the following:
  - a. The system has been designed to function as required for all modes of operation. The results of failure modes and effects analyses presented in the SAR, if any, are used in making this determination.
  - b. The system piping is designed to preclude hydraulic instabilities from occurring in the piping for all modes of operation. As appropriate, the reviewer evaluates the results of model tests and analyses that are relied on to verify that water hammer will not occur, or proposed tests of the installed system that are intended to verify design adequacy.
  - c. The outermost containment isolation valves and all downstream piping to the nuclear steam supply system are designed in accordance with seismic Category I and appropriate quality group requirements, as determined by RSB.
  - d. Breaks in system components or piping will not result in adverse effects on the functional performance of essential systems or components. The means for providing such protection will be given in Section 3.6 of the SAR and procedures for reviewing the information presented are given in the corresponding review plans.
  - e. The CFS design is such that the plant can be safely shut down using the auxiliary feedwater system or the reactor core isolation cooling system, if required.
  - f. The CFS design, or other plant systems, provide the capability to detect and control leakage from the system.
  - g. Measures will be taken, as appropriate, to protect personnel from any toxic effects of chemicals used for feedwater treatment.

#### 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 condensate and feedwater system includes all components and equipment from the condenser outlet to the connection with the nuclear steam supply system and to the heater drain system, [secondary water makeup system, and auxiliary feedwater system interfaces. (PWR's only)]. The scope of the review of the condensate and feedwater system for the \_\_\_\_\_ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and supporting systems essential to its operation. [The review has determined the adequacy of the applicant's proposed design criteria and bases for the condensate and feedwater system and the requirements for system performance for all conditions of plant operation. (CP)] [The review has determined that the design of the condensate and feedwater system and supporting systems is in conformance with the design criteria and design bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's design criteria and design bases for the condensate and feedwater system and supporting systems to applicable regulatory guides, staff technical positions, and industry standards.

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

#### V. REFERENCES

1. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," Revision 1.
2. Regulatory Guide 1.29, "Seismic Design Classification," Revision 1.
3. 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.

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