



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

10.3.6 STEAM AND FEEDWATER SYSTEM MATERIALS

REVIEW RESPONSIBILITIES

Primary - Materials Engineering Branch (MTEB)

Secondary - None

I. AREAS OF REVIEW

General Design Criterion 1 requires that systems important to safety shall be designed to quality standards commensurate with the importance to safety of the functions to be performed. General Design Criterion 35 requires suitable interconnections, leak detection, isolation, and contaminant capabilities be provided to assure that the safety system function (i.e., emergency core cooling) can be accomplished, assuming a single failure.

The following areas relating to the general materials considerations for ASME Boiler and Pressure Vessel Code (hereafter "the Code"), Section III, Class 2 and 3 components of the steam and feedwater systems are reviewed. The review procedures for materials considerations for steam generators are given in Standard Review Plan Section 5.4.2.1. The class 2 and 3 components of the main steam and feedwater systems shall be as defined in Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water, Steam, and Radioactive Waste Containing Components of Nuclear Power Plants." Class 1 component materials are covered in Standard Review Plan Section 5.2.3, "Reactor Coolant Pressure Boundary Materials."

1. Fracture Toughness of Class 2 and 3 Components

The fracture toughness properties and requirements for Class 2 and 3 components are reviewed. Typical components in this review include steam generator shells in PWRs, as well as carbon or low alloy steel portions of steam and feedwater lines in both PWRs and BWRs.

2. Materials Selection and Fabrication

- a. The materials selected for all Class 2 and 3 components and their fabrication are reviewed.

Rev. 2 - July 1981

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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 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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- b. For all components the following points are reviewed:
  - (1) The qualification procedures for welds in areas of limited accessibility are reviewed.
  - (2) The cleaning procedures are reviewed.
  - (3) For tubular products, the nondestructive examination procedures are reviewed for conformance with the ASME Code.
- c. For carbon or low alloy steel components, the controls placed on the welding procedures are reviewed.

MTEB will coordinate other branches' evaluations that interface with the overall review of steam and feedwater system materials as follows: Mechanical Engineering Branch reviews 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. The review for Quality Assurance is coordinated and performed by the Quality Assurance Branch as part of its primary review responsibility for SRP Section 17.0.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

## II. ACCEPTANCE CRITERIA

The applicable rules and basic acceptance criteria pertinent to the areas of this section of the Standard Review Plan are:

### 1. 10 CFR Part 50, §50.55a - Codes and Standards

This rule requires that structures, systems, and components shall be designed, fabricated, erected, constructed, tested, and inspected in accordance with the requirements of applicable codes and standards commensurate with the importance of the safety function to be performed. (Ref. 1).

### 2. 10 CFR Part 50, Appendix A:

a. General Design Criterion 1 - "Quality Standards and Records." This criterion requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also requires that appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit. (Ref. 2)

b. General Design Criterion 35 - "Emergency Core Cooling." This criterion requires that a system be provided to supply abundant emergency core cooling such that damage to reactor core components is minimal following any loss of reactor coolant. It also requires that the system

will have containment capabilities to assure that the emergency core cooling function can be accomplished, assuming a single failure. For pressure containing components of a critical nature, their containment capability, i.e., their structural integrity, including freedom from brittle fracture, can only be assured by requiring minimum fracture toughness performance of the materials of which they are fabricated. This is a standard industrial practice which is frequently used in construction codes of significant steel structures.

3. 10 CFR Part 50, Appendix B - "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." This appendix establishes quality assurance requirements for the design, construction, and operation of those structures, systems, and components of nuclear power plants that prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. (Ref. 5)

The following Regulatory Guides provide information, recommendations, and guidance and in general describe a basis acceptable to the staff that may be used to implement the requirements of 10 CFR Part 50, §50.55a; 10 CFR Part 50, Appendix A, General Design Criteria 1 and 35; 10 CFR Part 50, Appendix B.

- a. Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Nuclear Power Plants." This guide describes methods acceptable to the staff for prevention of intergranular and stress corrosion cracking of austenitic stainless steel and nickel-base alloy components.
- b. Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility." This guide describes methods acceptable to the staff for providing better control of welder technique in production welding.
- c. Regulatory Guide 1.85, "Code Case Acceptability ASME Section III Materials." This guide lists those ASME Section III Code Cases that are generally acceptable to the NRC staff.

Specific criteria necessary to meet the relevant requirements of the Commission regulations identified above are as follows:

1. Fracture Toughness of Class 2 and 3 Components

The fracture toughness properties of the ferritic materials of these components must meet the following requirements of the Code, Section III, of edition and addenda as invoked by Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

NC-2300 - "Fracture Toughness Requirements for Materials" (Class 2)  
ND-2300 - "Fracture Toughness Requirements for Materials" (Class 3)

2. Materials Selection and Fabrication

- a. (1) The materials specified for use in Class 2 and 3 components must conform to Appendix I to Section III of the Code, and to Parts A, B, and C of Section II of the Code.

- (2) Regulatory Guide 1.85, "Code Case Acceptability ASME Section III Materials," describes acceptable code cases that may be used in conjunction with the above specifications.
- b. The following criteria are applicable to all components:
- (1) Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility," provides the following criteria for assuring the integrity of welds in locations of restricted direct physical and visual accessibility.
    - (a) The performance qualification should require testing of the welds when conditions of accessibility to production welds are less than 30 to 35 cm (12-14 inches) in any direction from the joint.
    - (b) Requalification is required for different accessibility conditions or when other essential variables listed in the Code, Section IX, are changed.
    - (c) The qualification and requalification tests required by 2.c(1)(a) and (b) above may be waived provided that the joint is to be 100% radiographed or ultrasonically examined after completion of the weldment. Examination procedures and acceptance standards should meet the requirements of the ASME Code Section III. Records of the examination reports and radiographs should be retained and made part of the Quality Assurance documentation of the completed weld.
  - (2) Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants," and ANSI Standard N 45.2.1-1973, "Cleaning of Fluid Systems and Associated Components During Construction Phase of Nuclear Power Plants," describe acceptable procedures for cleaning and handling Class 2 and 3 components of the steam and feedwater systems. Vented tanks with deionized or demineralized water are an acceptable source of water for final cleaning or flushing of finished surfaces. The oxygen content of the water in these vented tanks need not be controlled.
  - (3) Acceptance criteria for nondestructive examination of tubular products are given in the ASME Code, Section III, Paragraphs NB/NC/ND 2550 through 2570.

### III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case. To ascertain that the acceptance criteria given in subsection II of this SRP section are met, the reviewer examines the areas listed in subsection I for the required information, in accordance with the following procedures:

### 1. Fracture Toughness of Class 2 and 3 Components

The reviewer determines which components of the steam and feedwater systems will be made of carbon or low alloy steels, and determines that their fracture toughness properties are in conformance with subsection II.1 of this SRP section.

### 2. Materials Selection and Fabrication

The reviewer determines that the materials proposed for the steam and feedwater systems are in conformance with Appendix I to Section III and to parts A, B, or C of Section II of the Code.

- a. The reviewer determines that the methods for qualifying welders for making welds in locations of restricted direct physical and visual accessibility, and the methods for monitoring and certification of production welds in such areas are in accordance with the acceptance criteria stated in subsection II.2.b(1) of this SRP section.
- b. The reviewer determines that the methods for cleaning and handling the Class 2 and 3 components are in accordance with acceptance criteria stated in subsection II.2.b(2) of this SRP section.
- c. The reviewer verifies that the tubular products are examined in accordance with acceptance criteria stated in subsection II.2.b(3) of this SRP section.

### 3. General

If the information contained in the safety analysis report or the plant Technical Specifications does not comply with the appropriate acceptance criteria, or if the information provided is inadequate to establish such compliance, a request for additional information is prepared and transmitted. Such requests identify not only the necessary additional information, but also the changes needed in the SAR or the Technical Specifications. Subsequent amendments received in response to these requests are reviewed for compliance with the acceptance criteria.

### IV. EVALUATION OF FINDINGS

The reviewer verifies that sufficient information has been provided in accordance with the requirements of this SRP section and that his evaluation supports conclusions of the following type to be included in the staff's safety evaluation report:

The staff concludes that the main steam and feedwater system materials are acceptable and meet the relevant requirements of 10 CFR Part 50, §50.55a, General Design Criteria 1 and 35, and Appendix B to 10 CFR Part 50. This conclusion is based on the following:

The applicant has selected materials for Class 2 and 3 components of the steam and feedwater systems that satisfy Appendix I of Section III of the ASME Boiler and Pressure Vessel Code, and meet the requirements of Parts A, B, or C of Section II of the Code. The applicant has also met the recommendations of Regulatory Guide 1.85 which describes acceptable code cases that may be used in conjunction with this industry standard.

When required, the fracture toughness properties of ferritic steel materials satisfy the requirements of the Code. Where the Code allowed fracture testing to be optional, the applicant provided reasonable justification for not requiring fracture toughness testing of ferritic steel components of the main steam and feedwater systems. These fracture toughness tests and mechanical properties required by the Code provide reasonable assurance that ferritic materials will have adequate safety margins against the possibility of nonductile behavior or rapidly propagating fracture.

The applicant has met the requirements of Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility," by meeting the regulatory positions in Regulatory Guide 1.71 or providing and meeting an alternative to the regulatory positions in Regulatory Guide 1.71, that the staff has reviewed and found to be acceptable. The onsite cleaning and cleanliness controls during fabrication satisfy the position given in Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants," and the requirements of ANSI Standard N 45.2.1-1973, "Cleaning of Fluid Systems and Associated Components During Construction Phase of Nuclear Power Plants."

## V. IMPLEMENTATION

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

Except in those cases in which the applicant proposes 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.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

## VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 1, "Quality Standards and Records."
2. ASME Boiler and Pressure Vessel Code, Section III, subsection NB, NC, and ND, and Appendix I, Section II, Parts A, B, and C; and Section IX; American Society of Mechanical Engineers.
3. Standard Review Plan Section 5.4.2.1, "Steam Generator Materials."
4. Standard Review Plan Section 5.2.3, "Reactor Coolant Pressure Boundary Materials."
5. Regulatory Guide 1.85, "Code Case Acceptability ASME Section III Materials."
6. Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility."

7. Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Nuclear Power Plants."
8. ANSI Standard N 45.2.1-1973, "Cleaning of Fluid Systems and Associated Components During Construction Phase of Nuclear Power Plants."
9. 10 CFR Part 50, §50.55a, "Codes and Standards." |
10. 10 CFR Part 50, Appendix A, General Design Criterion 35, "Emergency Core Cooling." |
11. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." |