U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 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 of the safety functions to be performed. The steam and feedwater systems consist of NRC Quality Group B or C (ASME Code, Section III, Class 2 or 3) components.

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 5.4.2.1.) The Class 2 and 3 components of the steam and feedwater systems include those portions beyond the outermost containment isolation valves in boiling water reactors (BWR's) and the secondary coolant system of pressurized water reactors (PWR's), except for those portions of the steam generator that come in contact with the primary coolant.

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 PWR's, as well as carbon or low alloy steel portions of steam and feedwater lines in both PWR's and BWR's.

2. Materials Selection and Fabrication for Class 2 and 3 Components

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

For austenitic stainless steel components, the following points are reviewed:

a. The steps taken to control the use of sensitized stainless steel.

b. The controls placed on the composition of any nonmetallic external thermal insulation.

c. The controls placed on the welding procedures.

d. For all components, the qualification procedures for welds in areas of limited accessibility are reviewed.

e. For carbon or low alloy steel components, the controls placed on the welding procedures are reviewed.

II. ACCEPTANCE CRITERIA

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:

NB-2300 - "Fracture Toughness Requirements for Materials"

NB-2331 - "Test Requirements and Acceptance Standards - Material for Vessels"

NB-2332 - "Test Requirements and Acceptance Standards - Material for Piping (Pipe, Tubes, and Fittings), Pumps and Valves Excluding Bolting Materials." Paragraph NB-2332(b) states additionally that pressure-retaining materials (other than bolting) with nominal thickness over 2-1/2 in. must meet the requirements of NB-2331, and that the lowest service temperature must be not lower than the nil-ductility transition reference temperature, RT_{NDT}, plus 100°F unless a lower temperature is justified by following methods similar to those contained in Article G-2000 of Section III.

NC-2310 of the Summer 1972 Addenda to Section III - "Impact Testing (Class 2)"

ND-2310 of the Summer 1972 Addenda to Section III - "Impact Testing (Class 3)"

2. Materials Selection and Fabrication for Class 2 and 3 Components

The mechanical properties of materials specified for use in Class 2 and Class 3 components must be either as stated in Appendix I to Section III of the Code, or alternately, as indicated in Parts A, B, and C of Section II of the Code.

The following criteria are applicable to all austenitic stainless steel components:

a. Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel," describes acceptable criteria for preventing stress corrosion of stainless steel components of the steam and feedwater systems. Furnace-sensitized material should not be used, and methods described in this guide should be followed for cleaning and protecting austenitic stainless steels from contamination during handling and storage, testing materials prior to fabrication, and determining the degree of sensitization that occurs during welding.

b. The composition of nonmetallic thermal insulation for the austenitic stainless steel components should be controlled as described in Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel." Concentrations of leachable contaminants should be controlled as specified in position C.2.b and Figure 1 of this guide, especially with regard to sodium silicate inhibitor concentrations, to minimize the probability of stress-corrosion cracking of these components when the insulation is moistened.

c. Regulatory Guide 1.31, "Control of Stainless Steel Welding," describes acceptable criteria for assuring the integrity of welds in stainless steel components. The control of delta ferrite content of weld filler metal described in this guide has been modified by Branch Technical Position MTEB 5-1 (Ref. 12), which details acceptable standards for delta ferrite content of weld metal.

The following criteria are applicable to all components:

d. Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility," provides the following criteria for assuring the integrity of welds in remote areas where inspection is difficult:
   (1) The performance qualification should require testing of the welds when conditions of accessibility to production welds are less than 30 to 35 cms (12-14 inches) in any direction from the joint.
   (2) Requalification is required for different accessibility conditions or when other essential variables listed in the Code, Section IX, are changed.

e. Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants," and ANSI Standard N45.2.1-1973, "Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants," describe acceptable procedures for cleaning and handling Class 2 and 3 components of the steam and feedwater systems.

The following criterion is applicable to all carbon or low alloy steel components, in addition to the above-cited fracture toughness criteria:

f. Regulatory Guide 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel," describes acceptable criteria for supplementing Section IX of the Code, to prevent crack formation in the underbead areas and heat-affected zones of welds in these materials. The welding procedures should be qualified at the minimum preheat temperature, and production welds should be monitored to verify that the limits on preheat and interpass temperature are maintained.

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 Section II are met the reviewer examines the areas listed in Section 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 Section II.1. It should be noted that Code Case 1576, and NC-2310 and ND-2410 of the 1974 Edition of Section III state that the lowest service temperature for Class 2 and Class 3 components must be not lower than RT_{NDT} + 30°F. This is unacceptable to the staff.

2. Materials Selection and Fabrication for Class 2 and 3 Components

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

For austenitic stainless steel components, the following procedures are followed:

a. The reviewer examines the methods of controlling sensitized stainless steel and determines that they comply with the acceptance criteria stated in Section II.2.a, especially with respect to cleaning and protection from contamination during handling and storage, verification of nonsensitization of the material, and qualification of welding procedures. If alternative methods of testing qualification welds for degree of sensitization are proposed by the applicant, the reviewer determines if these are satisfactory, based on the degree to which the alternate methods provide the needed results and on MTEB positions taken on previous applications. The reviewer may ask the applicant to justify technically his departures from the above-cited criteria. Alternative tests of qualification welds that have been previously accepted by the MTEB include the use of ASTM A-393-63 for determining the degree of sensitization of the heat affected zones of the qualification welds, and the use of ASTM A-262-70, as amended by Westinghouse Process Specification 84201 MW, for qualifying welds and testing raw materials for nonsensitization.

b. The reviewer determines whether nonmetallic thermal insulation will be used on any austenitic stainless steel components of the steam and feedwater systems, and verifies that the leachable impurities in this insulation lie within the "acceptable analyses" area of Figure 1 of Regulatory Guide 1.36, as discussed in Section II.2.b.

c. The reviewer examines the methods of controlling and measuring the amount of delta ferrite in stainless steel weld deposits, in accordance with the criteria stated in Section II.2.c, especially with respect to the filler metal acceptance procedures for delta ferrite content, and the examination of production welds for average content of delta ferrite.

d. The reviewer determines that the methods for qualifying welders for making welds in remote areas, and the methods for monitoring and certification of production welds in remote areas are in accordance with the acceptance criteria stated in Section II.2.d.

e. The reviewer determines that the methods for cleaning and handling the Class 2 and 3 components are in accordance with acceptance criteria stated in Section II.2.e.

f. For all carbon or low alloy steel components, the reviewer verifies that the minimum preheat and interpass temperatures for welding are specified in accordance with Section II.2.f.

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 review plan and that his evaluation supports conclusions of the following type, to be included in the staff's safety evaluation report:

> "The mechanical properties of materials selected for Class 2 and 3 components of the steam and feedwater systems satisfy Appendix I of Section III of the ASME Boiler and Pressure Vessel Code, or Parts A, B, or C of Section II of the Code. The fracture toughness properties of ferritic materials satisfy the requirements of the Code and minimum service temperatures for these materials are set at 100°F above the nil-ductility transition reference temperatures.
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> "The controls imposed upon austenitic stainless steel are in accordance with Regulatory Guide 1.31, "Control of Stainless Steel Welding," and Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel." Fabrication and heat treatment practices performed in accordance with these recommendations provide reasonable assurance that stress-corrosion cracking will not occur during the design life of the plant. The controls placed upon concentrations of leachable impurities in nonmetallic thermal insulation used on austenitic stainless steel components of the steam and feedwater systems are in accordance with Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel."
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> "The welding procedures used in limited access areas conform to Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility." The onsite cleaning and cleanliness controls during fabrication satisfy the positions 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 N45.2.1-1973, "Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants." The precautions taken in controlling and monitoring the preheat and interpass temperatures during welding of carbon and low alloy steel components conform to Regulatory Guide 1.50, "Control of Preheat Temperature for Welding Low-Alloy Steel."
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> "Conformance with the codes, standards, and Regulatory Guides mentioned constitutes an acceptable basis for assuring the integrity of steam and feedwater systems, and for meeting in part the requirements of General Design Criterion 1."

V. 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, Articles NB, NC, and ND, Appendix I and Appendix G; Section II, Parts A, B, and C; and Section IX; American Society of Mechanical Engineers.

ANSI Standard N45.2.1-1973 (Draft 2, Rev. 0), "Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants," November 15, 1973.

4. ASTM A-262-70, Practice E, "Copper-Copper Sulfate-Sulfuric Acid Test for Detecting Susceptability to Intergranular Attack in Stainless Steel," Annual Book of ASTM Standards, Part 3, American Society for Testing and Materials.

5. ASTM A-393-63, "Recommended Practice for Conducting Acidified Copper Sulfate Test for Intergranular Attack in Austenitic Stainless Steel," Annual Book of ASTM Standards, Part 3, American Society for Testing and Materials.

6. Process Specification 84201 MW, "Corrosion Testing of Wrought Austenitic Stainless Steel," Westinghouse Electric Corporation.

7. Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel."

8. Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Nuclear Power Plants,"

9. Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel."

10. Regulatory Guide 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel."

11. Standard Review Plan 5.4.2.1, "Steam Generator Materials."

12. Branch Technical Position MTEB 5-1, "Interim Position on Regulatory Guide 1.31, 'Control of Stainless Steel Welding'," appended to Standard Review Plan 5.2.3.

SRP 10.4.1