



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

4.5.2 REACTOR INTERNAL AND CORE SUPPORT MATERIALS

REVIEW RESPONSIBILITIES

Primary - Materials Engineering Branch (MTEB)

Secondary - None

I. AREAS OF REVIEW

Section 50.55a, "Codes and Standards," and General Design Criterion 1, Appendix A, 10 CFR Part 50 requires that structures, systems, and components important to safety shall be designed, fabricated, and tested to quality standards commensurate with the importance of the safety function to be performed. The purpose of this SRP section is to review and evaluate the adequacy of the materials selected for the construction of the reactor internal and core support structures, and to assure that these regulations are met for those structures.

The Materials Engineering Branch (MTEB) reviews the materials specification, component design, fabrication and inspection to assure structural integrity in compliance with Section 50.55a and General Design Criterion 1 of 10 CFR Part 50. The Chemical Engineering Branch (CMEB) reviews areas of corrosion and compatibility of these materials with the expected environment during service as part of its primary review responsibility of SRP Section 5.2.3.

The following areas in the applicant's safety analysis report (SAR) relating to reactor internal and core support materials are reviewed:

1. Material Specifications

The review includes the specifications for the materials, including weld materials, to be used for major components of the reactor internals which consist of the core support structures and the internal structures. The reactor internal and core support structures are all structures and components within the pressure vessel other than the fuel and control assemblies, and instrumentation.

Rev. 2 - July 1981

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.

The adequacy and suitability of the materials specified for the above applications are reviewed in terms of their mechanical properties, stress corrosion resistance, and fabricability.

2. Controls on Welding

The review includes the controls on welding of materials used for reactor internals.

3. Nondestructive Examination of Wrought Seamless Tubular Products and Fittings

The review includes information submitted by the applicant on the nondestructive examinations procedures used for inspection of each product form.

4. Austenitic Stainless Steel

Austenitic stainless steel is primarily used for the construction of the reactor internal and core support structures. Unstabilized austenitic stainless steel, such as Types 304 and 316, is normally specified.

Since these compositions are susceptible to stress corrosion cracking when exposed to certain environmental conditions, process controls must be exercised during all stages of component manufacturing and reactor construction to avoid sensitization of the material, and to minimize exposure of the stainless steel to contaminants that lead to stress-corrosion cracking. The review includes information submitted by the applicant in these areas, as described in SRP Section 5.2.3, "Reactor Coolant Pressure Boundary Materials."

5. Other Materials

Materials other than austenitic stainless steels are reviewed and evaluated in terms of their mechanical properties, corrosion resistance, and fabricability.

II. ACCEPTANCE CRITERIA

The design, fabrication, and testing of the materials used in the reactor internal and core support structure are reviewed and evaluated to meet code and standards commensurate with the safety function to be performed so that the relevant requirements of Section 50.55a and General Design Criterion 1 are met. The specific acceptance criteria necessary to meet these relevant requirements are as follows:

1. Material Specifications

For core support and reactor internal structures, the permitted material specifications are those given in the ASME Boiler and Pressure Vessel Code (hereafter "the Code"), Section III, NG-2000. These materials are described in detail in Parts A, B, and C of Section II of the Code.

Additional permitted materials are those shown in ASME Code Cases approved for use by Regulatory Guide 1.85, "Code Case Acceptability, ASME Section III Materials."

2. Controls on Welding

The welds of components for core support structures and reactor internals are fabricated in accordance with the Code, Section III, NG-4000, and must meet the examination and acceptance criteria shown in NG-5000.

3. Nondestructive Examination of Wrought Seamless Tubular Products and Fittings

Examination shall be in accordance with the requirements of ASME Code Section III, NG-2500.

The acceptance criteria shall be in accordance with the requirements of ASME Code Section III, NG-5300.

4. Austenitic Stainless Steels

The acceptance criteria for this area of review are given in SRP Section 5.2.3, "Reactor Coolant Pressure Boundary Materials."

Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel," describes acceptance criteria for preventing intergranular corrosion of stainless steel components. Furnace sensitized material should not be allowed, and methods described in this guide should be followed for cleaning and protecting austenitic stainless steel from contamination during handling, storage, testing, and fabrication, and for determining the degree of sensitization that occurs during welding. Regulatory Guide 1.31, "Control of Ferrite Content in Stainless Steel Weld Metal," describes acceptable criteria for assuring the integrity of welds in stainless steel components.

5. Other Materials

All materials used for reactor internals must be selected for their compatibility with the reactor coolant, as described in Subarticles NG-2160 and NG-3120 of Section III of the Code. The tempering temperature of martensitic stainless steels and the aging temperature of precipitation-hardened stainless steels should be specified to provide assurance that these materials will not deteriorate in service. Acceptable heat treatment temperatures are aging at 1050°F - 1100°F for Type 17-4 PH and tempering at 1050°F for Type 410 stainless steel.

Other materials shall have similar appropriate heat treat and fabrication controls in accordance with strength and compatibility requirements.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

For the areas of review described in subsection I of this SRP section, the review procedure is as follows:

1. Material Specifications

The list of the materials of construction of the components of the reactor internals that are exposed to the reactor coolant is reviewed.

The material specifications for each component or part used in the reactor internals are compared with the acceptable specifications listed in the Code, Sections II and III, as shown in the acceptance criteria. Any exceptions to the Code materials specifications are clearly identified. The reviewer evaluates the basis for the exceptions, taking into account precedents set in earlier cases, and determines the acceptability of such materials.

2. Controls on Welding

The information submitted by the applicant is reviewed to provide assurance that welding of materials used for components of the reactor internals is in accordance with the procedures of the Code, Section III, NG-4000. The controls on welding, discussed in SRP Section 5.2.3, are considered applicable to welding of reactor internals, and information in this area is verified. The reviewer assures that any special welding process or welding control conforms to the qualification requirements of the Code, Section IX, or that justification is made for any deviation.

3. Nondestructive Examination of Wrought Seamless Tubular Products

The information submitted by the applicant is reviewed to determine methods used for nondestructive examination. The Code, Section III, NG-2500 specifies that examination by either radiographic or ultrasonic examination is acceptable.

4. Austenitic Stainless Steel

The materials and fabrication procedures used for reactor internals are reviewed. The areas of review and review procedures follow those spelled out in SRP Section 5.2.3, "Reactor Coolant Pressure Boundary Materials." Environmental conditions must be controlled and welding procedures must be such that the probability of sensitization and microfissuring is reduced. In addition, the reviewer verifies that the material and reactor coolant compositions have been selected to assure compatibility, and that the fabrication and cleaning controls imposed on stainless steel components are designed to prevent contamination with chloride and fluoride ions.

5. Other Materials

The material specifications and fabrication procedures are reviewed to verify that the heat treatment and welding controls are appropriate for the material. The reviewer verifies that the fabrication and cleaning controls will preclude contamination of nickel base alloys by chloride ions, fluoride ions, or lead.

6. Additional Information Request

If the information contained in the SAR does not comply with the appropriate acceptance criteria, or if the information provided is inadequate to establish such compliance, the reviewer prepares a request for additional information for transmittal to Project Management. Such requests not only identify the additional information required, but also specify the changes needed in the SAR or the plant Technical Specifications to meet acceptance criteria. Subsequent amendments received in response to these requests are reviewed for compliance with the acceptance criteria.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient and adequate information has been provided to satisfy the requirements of the 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 materials used for the construction of the reactor internal and core support structure are acceptable and meet the requirements of General Design Criterion 1 and Section 50.55a of 10 CFR Part 50. This conclusion is based upon the following considerations:

The applicant has met the requirements of GDC 1 and Section 50.55a of 10 CFR Part 50 with respect to assuring that the design, fabrication, and testing of the materials used in the reactor internal and core support structure are of high quality standards and adequate for structural integrity. The controls imposed upon components constructed of austenitic stainless steel satisfy the recommendations of Regulatory Guide 1.31, "Control of Ferrite Content in Stainless Steel Weld Metal," and Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel."

The materials used for construction of components of the reactor internal and core support structure have been identified by specification and found to be in conformance with the requirements of NG-2000 of Section III and Parts A, B, and C of Section II of the ASME Code. In addition, the applicant has met the guidelines, of Regulatory Guide 1.85 by using materials of construction that are approved for use by ASME Code cases. As proven by extensive tests and satisfactory performance, the specified materials are compatible with the expected environment and corrosion is expected to be negligible.

The controls imposed on the reactor coolant chemistry provide reasonable assurance that the reactor internal and core support structure will be adequately protected during operation from conditions which could lead to stress corrosion of the materials and loss of component structural integrity.

The material selection, fabrication practices, examination and testing procedures, and control practice performed in accordance to these recommendations provide reasonable assurance that the materials used for the reactor internal and core support structure will be in a metallurgical condition to preclude inservice deterioration. Conformance with requirements of the ASME Code and the recommendations of the regulatory guide constitutes an acceptable basis for meeting in part the requirements of General Design Criterion 1 and Section 50.55a of 10 CFR Part 50.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the staff's plan for implementing this section of the Standard Review Plan.

Except in those cases in which the applicant proposes an acceptable alternate 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 Criteria for Nuclear Plants."

2. 10 CFR Part 50, §50.55a, "Codes and Standards."
3. Regulatory Guide 1.31, "Control of Ferrite Content in Stainless Steel Weld Metal."
4. Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel."
5. Regulatory Guide 1.85, "Code Case Acceptability, ASME Section III Materials."
6. ASME Boiler and Pressure Vessel Code, Section II, Parts A, B, and C, Section III, and Section IX, American Society of Mechanical Engineers.
7. SRP Section 5.2.3, "Reactor Coolant Pressure Boundary Materials."