



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

SECTION 4.5.2

REACTOR INTERNALS MATERIALS

REVIEW RESPONSIBILITIES

Primary - Materials Engineering Branch (MTEB)

Secondary - None

I. AREAS OF REVIEW

General Design Criteria 1 and 14 require that structures, systems, and components important to safety shall be designed, fabricated, and tested to quality standards commensurate with the importance of the safety functions to be performed.

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

1. Material Specifications

The review includes the material specifications for austenitic stainless steels, including weld materials, to be used for major components of the reactor internals and core support structures. These specifications should include, for boiling water reactors (BWR's), materials for shrouds, shroud supports, top guides, fuel support pieces, control rod drive tubes, jet pump assemblies, shroud head and steam separator assembly, and steam dryers; or for pressurized water reactors (PWR's), materials for the lower core support structures, including the core barrel, neutron shield pad assembly, core baffle, lower core plate, and core supports, the upper core support structures including the top support plate, beam sections, upper core plate, support columns, and guide tube assemblies, and the in-core instrumentation support structure.

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.

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. 20555.

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3. Nondestructive Examination of Wrought Seamless Tubular Products and Fittings

The review includes the information submitted by the applicant on the nondestructive examinations used for inspection of the subject product forms.

4. Austenitic Stainless Steel

Quantities of austenitic stainless steels, in a variety of product forms, are used for construction of components in the reactor internals. Unstabilized austenitic type stainless steels, which include American Iron and Steel Institute (AISI) Types 304 and 316 are normally used.

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 severe sensitization of the material, and to minimize exposure of the stainless steel to contaminants that could lead to stress-corrosion cracking. The review includes information submitted by the applicant in these areas, as described in Standard Review Plan 5.2.3, "Reactor Coolant Pressure Boundary Materials."

II. ACCEPTANCE CRITERIA

The acceptance criteria for the areas of review described in Section I of this plan are as follows:

1. Material Specifications

Permitted material specifications are those shown in the ASME Boiler and Pressure Vessel Code (hereafter "the Code"), Section III, NG-2121, and Tables 1-1.1 and 1-1.2 of Appendix I. These materials are described in detail in the Code, Section II, Parts A, B, and C.

2. Controls on Welding

The welds of components for reactor internals, fabricated in accordance with the Code, Section III, NG-4400, must meet the acceptance criteria shown in NG-5000.

3. Nondestructive Examination of Wrought Seamless Tubular Products and Fittings

The acceptance criteria for eddy-current and ultrasonic examination of wrought seamless tubular products and fittings are given in Regulatory Guide No. 1.66, "Nondestructive Examination of Tubular Products."

The acceptance criteria for radiographic examination of such products are given in the Code, Section III, NG-5320.

4. Austenitic Stainless Steels

The acceptance criteria for this area of review are given in item II.4 of Standard Review Plan 5.2.3, "Reactor Coolant Pressure Boundary Materials."

III. REVIEW PROCEDURES

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

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For the areas of review described in Section I of this plan, 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 major pressure-retaining component or part used in the reactor coolant boundary 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 the proposed exceptions.

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-4400. The controls on welding of austenitic stainless steels, discussed in Standard Review Plan 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-2551(d) specifies that examination by either radiographic or ultrasonic examination is acceptable.

However, Regulatory Guide 1.66, "Nondestructive Examination of Tubular Products" provides new calibration standards and procedures for ultrasonic examination which are considered more sensitive, and more consistently able to detect defects regardless of shapes or orientation. The reviewer verifies that ultrasonic examinations of the subject product form are specified to be in accordance with this Regulatory Guide.

4. Austenitic Stainless Steel

The materials and fabrication procedures used for reactor internals are reviewed. The specific area of review and review procedures follow closely those spelled out in Standard Review Plan 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 will minimize contamination with chloride and fluoride ions.

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

"The materials used for construction of components of the reactor internals have been identified by specification and found to be in conformance with the requirements of Section III of the ASME Code.

"The materials for reactor internals exposed to the reactor coolant have been identified and all of the materials are compatible with the expected environment, as proven by extensive testing and satisfactory performance. General corrosion on all materials is expected to be negligible.

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

"The controls imposed upon components constructed of austenitic stainless steel, as used in the reactor internals, satisfy the recommendations of Regulatory Guide No. 1.31, "Control of Stainless Steel Welding," Regulatory Guide No. 1.34, "Control of Electroslag Weld Properties," Regulatory Guide No. 1.44, "Control of the Use of Sensitized Stainless Steel," and Regulatory Guide No. 1.66, "Nondestructive Examination of Tubular Products." Material selection, fabrication practices, examination procedures, and protection procedures performed in accordance with these recommendations provide reasonable assurance that the austenitic stainless steel used for reactor internals will be in a metallurgical condition which precludes susceptibility to stress-corrosion cracking during service. Conformance with these Regulatory Guides constitutes an acceptable basis for meeting in part the requirements of General Design Criteria 1 and 14."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Plants."
2. ASME Boiler and Pressure Vessel Code, Section II, Parts A, B, and C, and Section III, American Society of Mechanical Engineers.

3. ASTM A-262-70, Practice E, "Copper-Copper Sulfate-Sulfuric Acid Test for Detecting Susceptibility to Intergranular Attack in Stainless Steels," Annual Book of ASTM Standards, Part 3, American Society for Testing and Materials.
4. Regulatory Guide 1.37, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water Cooled Nuclear Power Plants."
5. Regulatory Guide 1.44, "Control of the Use of Sensitized Stainless Steel."
6. Regulatory Guide 1.66, "Nondestructive Examination of Tubular Products."
7. Regulatory Guide 1.71, "Welder Qualification for Limited Accessibility Areas."
8. Standard Review Plan 5.2.3 and Branch Technical Position - MTEB No. 5-1, "Interim Position on Regulatory Guide 1.31, 'Control of Stainless Steel Welding'," appended to Standard Review Plan 5.2.3.

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