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(Formerly NUREG-75/087)

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.2.7 FRACTURE PREVENTION OF CONTAINMENT PRESSURE BOUNDARY

REVIEW RESPONSIBILITIES

Primary - Materials Engineering Branch (MTEB)

Secondary - None

I. AREAS OF REVIEW

The reactor containment pressure boundary relates to the reactor containment system. The reactor containment system design must include the functional capability of enclosing the reactor system and of providing a final barrier against the release of radioactive fission products attendant postulated accidents. This SRP section reviews fracture prevention of the reactor containment pressure boundary materials.

The reactor containment system is addressed within the context of General Design Criterion (GDC) 51 of Appendix A of 10 CFR Part 50 and Section III, Subsection NE of the ASME Boiler and Pressure Vessel Code, as endorsed by 10 CFR Part 50, and stated by Standard Review Plan (SRP) Section 3.8.1, "Concrete Containment" and SRP Section 3.8.2, "Steel Containment." The reactor containment system, as addressed in the NRC licensing review process, includes (a) the containment vessel, (b) all penetration assemblies or appurtenances attached to the containment vessel, all piping, pumps and valves attached to the containment vessel, or to penetration assemblies out to and including the pressure boundary materials of any valves required to isolate the system and provide a pressure boundary for the containment function.[1]

The reactor containment pressure boundary, as addressed in the NRC licensing review process, consists of those ferritic steel parts of the reactor containment system which sustain loading and provide a pressure boundary in the performance of the containment function under the operating, maintenance, testing and

[1]For components which also may be part of the reactor coolant pressure boundary, the provisions of 10 CFR Part 50, §50.55a are also applicable. These aspects are considered in SRP Section 5.2.3.

Rev. 0 - July 1981

postulated accident conditions cited by GDC 51. Within this context, typically reviewed are the ferritic materials of components such as free-standing containment vessels, equipment hatches, personnel airlocks, heads of primary containment drywells, tori, containment penetration sleeves, process pipes, end closure caps and flued heads and penetrating-piping systems connecting to penetration process pipes and extending to and including the system isolation valves.

The Materials Engineering Branch will coordinate its licensing review with interfacing licensing reviews by the Structural Engineering Branch (SEB) as addressed by SRP Section 3.8.1, which addresses concrete containments and SRP Section 3.8.2, which addresses steel containments.

II. ACCEPTANCE CRITERIA

The MTEB review applies acceptance criteria based on meeting the relevant requirements of the following Commission regulations:

1. General Design Criterion 1, as it relates to the quality standards for design and fabrication

2. General Design Criterion 16, as it relates to the prevention of the release of radioactivity to the environment

3. General Design Criterion 51, as it relates to the reactor containment pressure boundary being designed with sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions (1) its ferritic materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized.

To meet the requirements of GDC 1, 16 and 51, ferritic containment pressure boundary materials should meet the fracture toughness criteria for Class 2 components identified in the Summer 1977 Addenda of Section III of the ASME Code. These criteria were selected to provide for a uniform review, consistent with the safety function of the containment pressure boundary within the context of Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water- Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants." The consistency is developed in that the containment system is addressed in the licensing review process as an engineered safety feature, as is, for example, the emergency core cooling system. Regulatory Guide 1.26 is silent with respect to the containment pressure boundary, but does assign Group B Quality Standard to the emergency core cooling system. Regulatory Guide 1.26 assigns correspondence of Group B Quality Standard to ASME Code Section III Class 2.

Mandatory fracture toughness testing of ASME Code Section III Class 2 materials was first identified in the Summer 1977 Addenda Code Class 2 rules. As a result, cases exist where Class 2 ferritic materials of the reactor containment pressure boundary were not fracture toughness tested, because the ASME Code Edition and Addenda in effect at the time the components were ordered, did not require that they be tested. The staff's assessment of the fracture toughness of materials that were not fracture toughness tested is based on the metallurgical characterization of these materials and fracture toughness data presented in NUREG-0577, "Potential for Low Fracture Toughness and Lamellar Tearing on PWR Steam Generator and Reactor Coolant Pump Supports," USNRC, October 1979 (Draft) and ASME Code Section III, Summer 1977

Addenda, Subsection NC. The metallurgical characterization of these materials, with respect to their fracture toughness, is developed from a review of how these materials were fabricated and what thermal history they experienced during fabrication. The metallurgical characterization of these materials, when correlated with the data presented in NUREG-0577 and the Summer 1977 Addenda of the ASME Code Section III, provides the technical basis for the staff's evaluation of the compliance with Code Class 2 requirements of the materials which were not fracture toughness tested.

III. REVIEW PROCEDURES

The licensing review process assesses the fracture toughness of the materials of the components of the reactor containment pressure boundary identified in Section I, within the context of compliance with the criteria for Class 2 components identified in the Summer 1977 Addenda of Section III of the ASME Code.

The reviewer addresses the information provided by the applicant for the materials of the components of interest. Such information should consist of construction drawings, piping system diagrams and related supplemental information, ASME Code Data Reports and certified material test reports.

For those ferritic materials for which fracture toughness data are unavailable, or are inappropriate, the reviewer addresses the applicant's assessment of their fracture toughness based on a metallurgical characterization developed from a review of how these materials were fabricated and what thermal history they experienced during fabrication. The reviewer addresses the applicant's correlation of this information with the fracture toughness data presented in NUREG-0577 and ASME Section III, Summer 1977 Addenda, Subsection NC. The reviewer addresses the applicant's justification of the acceptability of these materials within the context of the criteria for Class 2 materials as stated in the Summer 1977 Addenda, ASME Code Section III. The reviewer verifies that the Class 2 requirements of the Summer 1977 Addenda of ASME Section III code have been met by the applicant.

IV. EVALUATION OF FINDINGS

The reviewer verifies that information provided by the applicant through construction drawings, piping system diagrams and related supplemental information, ASME Code Data Reports and certified material test reports, is sufficient to support the statements and conclusions in the staff's safety evaluation report:

> Based on the licensing process review of the applicant's available fracture toughness data, metallurgical characterizations of the materials of interest developed from their fabrication and thermal histories and correlations of metallurgical histories with fracture toughness data presented in NUREG-0577 and ASME Code Section III, SUMMER 1977 Addenda, Subsection NC, the conclusion is made that the fracture toughness of the materials of the reactor containment pressure boundary meet the fracture toughness requirements invoked for ASME Code Section III Class 2 materials effective with the Summer 1977 Addenda."
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> The staff concludes that reasonable assurance has been provided that the materials of the reactor containment pressure boundary, under operating, maintenance, testing and postulated accident

conditions, will not undergo brittle fracture, that the probability of rapidly propagating fracture will be minimized, so that the requirements of General Design Criteria 1, 16, and 51 will be met.

V. IMPLEMENTATION

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

VI. REFERENCES

1. 10 CFR Part 50 Appendix A, General Design Criterion 1, "Quality Standards and Records."

2. 10 CFR Part 50 Appendix A, General Design Criterion 16, "Containment Design."

3. 10 CFR Part 50 Appendix A, General Design Criterion 51, "Fracture Prevention of Containment Pressure Boundary."

4. ASME Code Section III, Summer 1977 Addenda, Subsection NC.

5. NUREG-0577, "Potential for Low Fracture Toughness and Lamellar Tearing on PWR Steam Generator and Reactor Coolant Pump Supports," USNRC, October 1979 (Draft).

6. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."