NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

RIN 3150–AD57

Fracture Toughness Requirements for Light Water Reactor Pressure Vessels

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is amending its regulations for light-water-cooled nuclear power plants to clarify several items related to the fracture toughness requirements for reactor pressure vessels (RPV). The amendments will clarify the pressurized thermal shock (PTS) requirements, make changes to the Fracture Toughness Requirements and the Reactor Vessel Material Surveillance Program Requirements, and provide new requirements for thermal annealing of a reactor pressure vessel.

EFFECTIVE DATE: January 18, 1996.

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SUPPLEMENTARY INFORMATION: On October 4, 1994 (59 FR 50513), the NRC published in the Federal Register a proposed amendment to clarify several items related to fracture toughness requirements for reactor pressure vessels (RPV) and to add a new section on thermal annealing of a reactor vessel to 10 CFR Part 50.

Background

Maintaining the structural integrity of the reactor pressure vessel of light-water-cooled reactors is a critical concern related to the safe operation of nuclear power plants. To assure the structural integrity of RPVs, NRC regulations and regulatory guides have been developed to provide analysis and measurements methods and procedures to establish that each RPV has adequate safety margin for continued operation. Structural integrity of a RPV is generally assured through a fracture mechanics evaluation, including measurement or estimation of the fracture toughness of the materials which compose the RPV. However, the fracture toughness of the RPV materials varies with time. As the plant operates, neutrons escaping from the reactor core impact the vessel beltline materials (e.g. the materials that surround the reactor core), causing embrittlement of those materials. The NRC's regulations and regulatory guides related to RPV integrity provide the criteria and methods needed to estimate the extent of the embrittlement, to evaluate the consequences of the embrittlement in terms of the structural integrity of the RPV, and to provide methods to mitigate the deleterious effects of the embrittlement.

The NRC has several regulations and regulatory guides that establish criteria and procedures for assuring the structural integrity of RPVs. With the addition of the thermal annealing requirements in this rule and several regulatory guides, the regulatory documents contribute to a comprehensive set of regulations and regulatory guidance pertaining to RPV integrity.

This final rule adds requirements for thermal annealing of the RPV as a method for mitigating the effects of neutron irradiation (10 CFR 50.66) and amends the following:

1. The Pressurized Thermal Shock (PTS) rule (10 CFR 50.61).
2. Appendix G of 10 CFR Part 50, ''Fracture Toughness Requirements.''
3. Appendix H of 10 CFR Part 50, ''Reactor Vessel Material Surveillance Program Requirements.''

Overview of the Final Rule

PTS Rule (10 CFR 50.61)

This amendment to the PTS rule makes three changes:

1. The rule incorporates in total, and therefore makes binding by rule, the method for determining the reference temperature, RT_{NDT}, including treatment of the unirradiated RT_{NDT} value, the margin term, and the explicit definition of ''credible'' surveillance data, which is currently described in Regulatory Guide 1.99, Revision 2.
2. The section is restructured to improve clarity, with the requirements section giving only the requirements for the value for the reference temperature for end of life fluence, RT_{PTS}. The method for calculating RT_{PTS} is moved to a new paragraph of the rule.
3. Thermal annealing is identified as a method for mitigating the effects of neutron irradiation, thereby reducing RT_{PTS}.

Thermal Annealing Rule (10 CFR 50.66)

The thermal annealing rule, 10 CFR 50.66, provides a consistent set of requirements for the use of thermal annealing to mitigate the effects of neutron irradiation and replaces the requirements for annealing in the current Appendix G of 10 CFR Part 50. The final rule requires, prior to initiation of thermal annealing, submittal of a Thermal Annealing Report containing: (1) A Thermal Annealing Operating Plan, (2) a Requalification Inspection and Test Program, (3) a Fracture Toughness Recovery and Reembrittlement Trend Assurance Program, and (4) Identification of Unreviewed Safety Questions and Technical Specifications Changes. The report must be submitted at least 3 years before the date at which the limiting fracture toughness criteria in 50.61 and Appendix G to Part 50 would be exceeded. This 3-year period is specified to provide the NRC staff with sufficient time to review the thermal annealing program. Under § 50.66(a), the NRC will, within three years of submission of a licensee's Thermal Annealing Report, document its views on the plan, including whether thermal annealing constitutes an unreviewed safety question.

In order to provide for public participation in the regulatory process, Section 50.66(f)(1) requires that the NRC hold a public meeting a minimum of 30 days before the licensee starts to thermal anneal the reactor vessel. The Commission will notify and solicit comments from cognizant local and state governments, and will publish a notice in the Federal Register and in a forum, such as local newspapers, which is readily accessible to individuals in the vicinity of the site, in order to solicit comments from the public.

The thermal annealing operating plan must include an evaluation of the effects of temperature, and of mechanical and thermal stresses on the reactor and associated equipment such as containment, the biological shield, and attached piping, to demonstrate that the operability of the reactor will not be detrimentally affected. The bounding conditions of the temperatures and times used in this analysis define the proposed annealing conditions. If these conditions are exceeded during the vessel annealing, then the evaluation would no longer be valid, and the acceptability of the actual vessel annealing would have to be demonstrated as discussed below in the next paragraph.

Upon completion of the thermal annealing, the licensee must confirm in writing to the Director, Office of Nuclear Reactor Regulation (NRR), that the thermal annealing was performed in accordance with the Thermal Annealing Operating Plan and the Requalification Inspection and Test Program. Within 15 days of the licensee's written confirmation that the thermal annealing was completed in accordance with the