

**RULEMAKING ISSUE**  
(Notation Vote)

June 25, 2007

SECY-07-0104

FOR: The Commissioners

FROM: Luis A. Reyes  
Executive Director for Operations /RA/

SUBJECT: PROPOSED RULEMAKING — ALTERNATE FRACTURE TOUGHNESS  
REQUIREMENTS FOR PROTECTION AGAINST PRESSURIZED  
THERMAL SHOCK EVENTS (RIN 3150-AI01)

PURPOSE:

To obtain Commission approval to publish for public comment a proposed rule that would provide new fracture toughness requirements for pressurized water reactors (PWRs). This paper does not address any new commitments.

SUMMARY:

The enclosed proposed rule, Title 10 of the *Code of Federal Regulations*, Section 50.61a (10 CFR 50.61a), "Alternative Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events" (Enclosure 1), would amend the current regulations for PWRs by providing alternate fracture toughness requirements for protection against pressurized thermal shock (PTS) events. PWR licensees, including future holders of operating licenses and combined licenses, could choose to comply with the requirements of this new section as a voluntary alternative to the current PTS requirements of 10 CFR 50.61. The proposed amendment would reduce the regulatory burden on some licensees due to the unnecessarily conservative requirements of the current regulation while maintaining adequate safety. Several operating reactors that are projected to exceed the screening limits of 10 CFR 50.61 before the expiration of their renewed operating licenses would benefit from the new screening limits and correlations of 10 CFR 50.61a.

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BACKGROUND:

The PTS Rule (10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events") protects against brittle fracture of reactor vessels during severe cool-down events. This rule provides embrittlement correlations that licensees must use to determine a reference temperature for each vessel beltline material. The reference temperature is then compared to the rule's screening criterion. Licensees may not operate at a reference temperature in excess of the screening criterion without approval of the Nuclear Regulatory Commission's (NRC's) Director of the Office of Nuclear Reactor Regulation (NRR).

The screening criteria in the current rule are based on a conservative probabilistic fracture mechanics analysis developed in the 1980s. The analysis used conservative assumptions and a margin term to account for a limited data set and the limited computational resources and techniques available at that time. With the data and computational resources and analysis techniques available today, the NRC considers the screening criteria in the current rule to be unnecessarily conservative. Several licensees expect to exceed the current screening criteria before the expiration of their renewed operating licenses. Those licensees would need to take compensatory actions to avoid exceeding the screening criteria, which could result in costly analyses, modifications to the plant, reactor vessel thermal annealing, or cessation of plant operation.

The staff has completed a research program to provide the technical basis for 10 CFR 50.61a. This program is summarized in NUREG-1806, "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Limits in the PTS Rule (10 CFR 50.61): Summary Report," and NUREG-1874, "Recommended Screening Limits for Pressurized Thermal Shock (PTS)." The staff concluded that the risk of through-wall cracking due to PTS events is much lower than previously calculated. Thus, the screening criteria in 10 CFR 50.61 may impose an unnecessary burden on some licensees.

In SECY-06-0124, "Rulemaking Plan to Amend Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock," dated May 26, 2006 (ADAMS Accession No. ML060530624), the staff proposed to initiate a rulemaking to revise the existing regulation. In this paper, the staff provided four options for the Commission's consideration. The staff recommended that the Commission approve Option 3. Option 3 would allow licensees to voluntarily implement the less restrictive screening criteria based on the updated technical basis and insert the updated embrittlement correlation into 10 CFR 50.61 for regulatory consistency. Option 3 would apply the best available technology for 10 CFR 50.61 and 10 CFR 50.61a.

In response to SECY-06-0124, the Commission directed the staff to conduct a rulemaking as specified in Option 2 of the rulemaking plan in staff requirements memorandum (SRM) SRM-SECY-06-0124, dated June 30, 2006 (ADAMS Accession No. ML061810148). In Option 2, the staff would amend the regulation to allow licensees to voluntarily implement the less restrictive screening criteria based on the updated technical basis without implementing the updated embrittlement correlation in 10 CFR 50.61. In the SRM, the Commission requested the staff to seek early interaction with, and specific feedback from, stakeholders regarding the potential impacts (e.g., cost/benefit) of requiring all licensees to use the updated embrittlement correlation as described in Option 3. Further, the Commission directed the staff to assess the

impacts of the updated correlation, identifying which reactors would predict a higher embrittlement and if any regulatory action would be needed. The staff should consider requiring new plants use the best available embrittlement correlation. The staff should ensure that the probabilistic assumptions used in the technical basis are consistent with those used in other risk-informed initiatives and that plant aging effects have been reasonably considered over the extended plant lifetimes. Finally, the Commission specifically requested the staff to seek Advisory Committee on Reactor Safeguards (ACRS) comment on the most important aspects of the probabilistic basis.

#### DISCUSSION:

##### *Implementation of Option 2*

The proposed rulemaking would implement the Commission's direction to amend the regulations to allow licensees to voluntarily implement the requirements of the new PTS rule without implementing the updated embrittlement correlation in 10 CFR 50.61. The current mandatory PTS requirements of 10 CFR 50.61 would continue to apply for any current or future PWR licensee. The proposed rule would provide a new section, 10 CFR 50.61a, which licensees could choose to comply with as a voluntary alternative to the requirements of the current PTS rule. This new section would require the use of the updated embrittlement correlations and their corresponding screening criteria. Implementation of the new rule would involve a licensee choosing to comply either with 10 CFR 50.61 or with 10 CFR 50.61a. The NRC would not require current operating reactor licensees or licensees referencing certified reactor designs based on the current rule to take additional action if they choose to continue complying with 10 CFR 50.61. However, those licensees may choose to voluntarily implement 10 CFR 50.61a as an alternative to compliance with 10 CFR 50.61. A future reactor licensee can choose to comply with either regulation in its request for an operating license or combined construction/operating license.

##### *Stakeholder Interaction and Feedback*

The staff did not seek early interaction with stakeholders on a possible requirement for all licensees to use the updated embrittlement correlation. The staff determined that requiring licensees to use the updated embrittlement correlation would be considered a backfit under 10 CFR 50.109. The staff believes that such backfitting would not fall under any of the three 10 CFR 50.109(a)(4) exceptions to preparation of a backfit analysis. In addition, based on available information, the staff believes that such backfitting could not be justified, using a quantitative methodology, as a substantial increase in protection of public health and safety and whose costs are justified in light of this increased level of protection. As a result, the staff did not pursue early interactions with stakeholders on a possible requirement for all licensees to use the updated embrittlement correlation. However, the proposed rule does request public comment on the possibility of imposing the updated embrittlement correlation in 10 CFR 50.61. The staff believes that the public comment process will provide adequate stakeholder feedback on the proposed rule. The staff understands that the Commission may decide, in its consideration of the draft proposed rule, that backfitting of the updated embrittlement correlation should be based upon qualitative factors. For example, in SRM-SECY-93-086, dated June 30, 1993, the Commission stated that a demonstration of a "substantial increase in safety" could be based upon consideration of qualitative factors.

If the Commission wishes to retain the option of adopting a final rule imposing the updated embrittlement correlation in 10 CFR 50.61 without the need for further renoticing, then the staff recommends, consistent with the June 30, 1993, SRM as well as applicable law on renoticing of proposed rules, that the backfitting discussion in the Federal Register Notice for the draft proposed rule in this paper be further modified to add a backfit analysis of such a requirement. The backfit analysis would rely upon qualitative factors in demonstrating that there is a substantial increase in safety from imposing the updated embrittlement correlation in 10 CFR 50.61, and that the costs of imposing the updated embrittlement correlation are justified in light of the increase in safety. However, it should be noted that if the Commission directs the staff to develop such a qualitative backfit analysis prior to the publication of the draft rule, this can be expected to have a significant impact on the staff's schedule for the publication of the draft rule. Furthermore, the staff's efforts may conclude that such a qualitative backfit analysis does not demonstrate a substantial increase in safety.

#### *Detailed Assessment of the Impact of the Updated Correlation*

The staff evaluated reactors that were projected to be above or near the current PTS screening criteria in 10 CFR 50.61. Table 1 identifies the reactors that are projected to be above the current PTS screening criteria using the embrittlement correlation in the current PTS rule and/or the updated embrittlement correlation. All reference temperature for pressurized thermal shock ( $RT_{PTS}$ ) values are projected to the end of an extended operating period (60 years of operation). The  $RT_{PTS}$  values for the limiting materials for Beaver Valley Unit 1 and Three Mile Island Unit 1 are projected to exceed the current PTS screening criteria using the current PTS rule embrittlement correlation, but remain below the current PTS screening criteria using the updated embrittlement correlation. The  $RT_{PTS}$  values for the limiting materials for Palisades, Point Beach Unit 2, Indian Point Unit 3, and Diablo Canyon Unit 1 are projected to exceed the current PTS screening criteria using both the current PTS rule embrittlement correlation and using the updated embrittlement correlation. The limiting material for Salem Unit 1 changes from an axial weld to a plate. The axial weld  $RT_{PTS}$  values are projected to exceed the current PTS screening criteria using the current PTS rule embrittlement correlation, but remain below the current PTS screening criteria using the updated embrittlement correlation. The plate  $RT_{PTS}$  values are projected to remain below the current PTS screening criteria using the current PTS rule embrittlement correlation, but exceed the current PTS screening criteria using the updated embrittlement correlation. The  $RT_{PTS}$  values for the limiting material for Fort Calhoun (axial welds) are projected to remain below the current PTS screening criteria using the current PTS rule embrittlement correlation, but exceed the current PTS screening criteria using the updated embrittlement correlation.

**Table 1 - Comparison of  $RT_{PTS}$  Values Using the Embrittlement Correlation in the Current PTS Rule, 10 CFR 50.61, and the Updated Embrittlement Correlation at the End of the Renewed License Period**

Plant	Limiting Reactor Vessel Material	PTS Screening Criteria in 10 CFR 50.61 (°F)	$RT_{PTS}$ Value <sup>1</sup> Using Correlation in 10 CFR 50.61 (°F)	$RT_{PTS}$ Value <sup>2</sup> Using Updated Correlation (°F)
Beaver Valley Unit 1	Plate	270	290	255
Palisades	Axial Weld	270	287	283
Palisades	Circ Weld	300	302	278
Point Beach Unit 2	Circ Weld	300	315	307
Three Mile Island Unit 1	Axial Weld	270	289	253
Three Mile Island Unit 1	Circ Weld	300	316	265
Indian Point Unit 3	Plate	270	280	292
Salem Unit 1	Axial Weld	270	278	252
Salem Unit 1	Plate	270	256	277
Fort Calhoun	Axial Weld 1	270	256	282
Fort Calhoun	Axial Weld 2	270	245	282
Diablo Canyon Unit 1	Axial Weld	270	283	273

<sup>1</sup>  $RT_{PTS}$  values are calculated using the methodology in 10 CFR 50.61.

<sup>2</sup>  $RT_{PTS}$  values are calculated using Equations 1 and 2 in 10 CFR 50.61; where the  $\Delta RT_{NDT}$  is calculated using equations 5, 6, and 7 in the proposed 10 CFR 50.61a and the standard deviation for  $\Delta RT_{NDT}$  is the standard deviation of the residuals for the updated embrittlement correlation (from Table 5 in the proposed 10 CFR 50.61a).

The staff also evaluated the limiting materials for other units not included in the table. The staff evaluated the following reactors with reactor vessel materials that are projected to be near the PTS screening criteria in 10 CFR 50.61: Surry Unit 1, Oconee Unit 2, Turkey Point Units 3 and 4, H.B. Robinson Unit 2, Ginna, Calvert Cliffs Unit 1, Watts Bar Unit 1, Sequoyah Unit 1, and North Anna Units 1 and 2. The  $RT_{PTS}$  values for these plants' limiting materials are projected to remain below the current PTS screening criteria using both the current PTS rule embrittlement correlation and the updated embrittlement correlation.

In its evaluation of operating reactors, the staff observed that reactor vessel forgings with underclad cracks could have  $RT_{PTS}$  and  $RT_{MAX-X}$  values at the end of their licenses that are near the screening criteria in both 10 CFR 50.61 and 10 CFR 50.61a (Note:  $RT_{MAX-X}$  is the equivalent term for  $RT_{PTS}$  in 10 CFR 50.61a.). This condition occurs when surveillance data is used to determine the  $RT_{PTS}$  values. The staff has reviewed all of the operating reactors that are

susceptible to underclad cracking and has determined that the only reactor vessel of potential concern is the Watts Bar Unit 1 reactor vessel. Watts Bar Unit 1 is the only operating reactor vessel fabricated with forgings that are susceptible to underclad cracks and has its forging material in its reactor vessel surveillance program. Watts Bar Unit 1 is projected to approach the PTS screening criteria in 10 CFR 50.61 at the expiration of its license. At this time, Watts Bar Unit 1 has insufficient surveillance data to determine if the issue is relevant to its reactor vessel. When the licensee for Watts Bar Unit 1 removes, tests, and reports the results of its next surveillance capsule, the staff will evaluate the data to determine if the Watts Bar Unit 1 reactor vessel is projected to exceed the screening criteria in 10 CFR 50.61 or 10 CFR 50.61a. However, Table 2 indicates that, without considering surveillance data, Watts Bar Unit 1 is not projected to exceed the screening criteria in 10 CFR 50.61a. The staff does not believe that underclad cracking will be a concern for newly fabricated reactor vessels, because licensees who follow the guidance in Regulatory Guide 1.43, "Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components," should comply with the requirements in 10 CFR 50.61a. Reactor vessels fabricated in accordance with this regulatory guide should not be susceptible to underclad cracking in their forgings.

**Table 2 - Impact of the Proposed Voluntary Rule, 10 CFR 50.61a, on Reactor Vessels Projected to be Above the Screening Criteria in Table 1**

Plant	Limiting Reactor Vessel Material	PTS Screening Criteria in 10 CFR 50.61a (°F)	RT <sub>MAX-X</sub> Value <sup>1</sup> Using Correlation in 10 CFR 50.61a (°F)
Beaver Valley Unit 1	Plate	356	212
Beaver Valley Unit 1	Plate + Axial Weld	538	424
Palisades	Axial Weld	269	220
Palisades	Plate + Axial Weld	538	408
Palisades	Circ Weld	312	215
Point Beach Unit 2	Circ Weld	312	245
Three Mile Island Unit 1	Axial Weld	269	187
Three Mile Island Unit 1	Plate + Axial Weld	538	271
Three Mile Island Unit 1	Circ Weld	312	198
Indian Point Unit 3	Plate	356	249
Indian Point Unit 3	Plate + Axial Weld	538	498
Salem Unit 1	Axial Weld	269	234
Salem Unit 1	Plate	356	234
Salem Unit 1	Plate + Axial Weld	538	468
Fort Calhoun	Axial Weld 1	269	219

Plant	Limiting Reactor Vessel Material	PTS Screening Criteria in 10 CFR 50.61a (°F)	RT <sub>MAX-X</sub> Value <sup>1</sup> Using Correlation in 10 CFR 50.61a (°F)
Fort Calhoun	Axial Weld 2	269	219
Fort Calhoun	Plate + Axial Weld	538	361
Diablo Canyon Unit 1	Axial Weld	269	210
Diablo Canyon Unit 1	Plate + Axial Weld	538	355
Kewaunee	Circ Weld	312	252
Watts Bar Unit 1	Forging	246	206

<sup>1</sup> RT<sub>MAX-X</sub> values are calculated using the methodology in the proposed 10 CFR 50.61a.

The Kewaunee reactor vessel's RT<sub>PTS</sub> value was projected to be near the current PTS screening criteria at the end of the extended operating period. However, this RT<sub>PTS</sub> value was determined using a plant-specific embrittlement correlation with a methodology not in accordance with the methodology in 10 CFR 50.61. The licensee received approval for an exemption (ADAMS Accession No. ML011210180) from the rule. The updated embrittlement correlation, from a technical standpoint, cannot be directly imposed on the licensee-developed methodology due to the differences in methodologies. Hence, the staff did not include Kewaunee in its evaluation of the effects of using the updated embrittlement correlation on its RT<sub>PTS</sub> value. The staff will discuss with the licensee for Kewaunee its plant-specific methodology for determining its RT<sub>PTS</sub> value and whether this method will need to be changed based on the updated embrittlement correlation. The impact of using 10 CFR 50.61a on the Kewaunee reactor vessel is shown in Table 2.

All other operating PWRs have projected RT<sub>PTS</sub> values so far below the current PTS screening criteria that the updated embrittlement correlation would have no regulatory impact with respect to compliance with the rule. However, if the NRC were to impose the updated embrittlement correlation on all PWR licensees, the regulatory impact would include expenditure of licensee resources to update and maintain documentation of each licensee's compliance with the updated embrittlement correlation.

The staff has determined that imposition of the new embrittlement correlation within the existing rule would have a substantive, negative regulatory impact on only Ft. Calhoun. The staff will discuss their assessment with the licensee and recommends taking the appropriate action on a plant-specific basis. In addition, although the limiting material may change at Salem Unit 1, its licensee would still be expected to voluntarily implement 10 CFR 50.61a because the plant has at least one material that exceeds the 10 CFR 50.61 criteria regardless of which embrittlement correlation is used. The voluntary implementation of 10 CFR 50.61a would require the licensee to evaluate all of their reactor vessel beltline materials.

Table 2 assesses the impact of the proposed rule (10 CFR 50.61a) on the limiting materials in the same reactor vessels as identified in Table 1, with the addition of Kewaunee and Watts Bar Unit 1. Table 2 provides the applicable screening criteria and the projected  $RT_{MAX-X}$  values for the reactor vessels to the end of an extended operating period (60 years of operation).  $RT_{MAX-X}$  is defined in 10 CFR 50.61a and is the material property parameter that is calculated based on the projected amount of radiation embrittlement. The proposed regulations in 10 CFR 50.61a require that the  $RT_{MAX-X}$  values be compared to the screening criteria. Because all  $RT_{MAX-X}$  values in Table 2 are below the screening criteria, the staff expects that all of these licensees would be able to demonstrate that their reactor vessels will be able to comply with 10 CFR 50.61a, should they choose to implement 10 CFR 50.61a as proposed.

### *Probabilistic Assumptions*

The staff used a systematic process to develop probabilistic assumptions and inputs adopted in the technical basis analyses to identify the significant sources of uncertainty in the calculations and, whenever possible, to address and quantify those sources. The staff applied available, standard probabilistic risk assessment practices to identify and represent uncertainties. Thus, the probabilistic assumptions are consistent, where appropriate, with those used in other risk-informed initiatives.

The proposed rulemaking also considers neutron irradiation embrittlement effects over extended plant lifetimes. The technical basis for this rulemaking evaluates plant fracture toughness against PTS events well beyond a 60-year lifetime.

### *ACRS*

The staff was requested to seek ACRS comment on the most important aspects of the probabilistic basis. The staff has interacted with the ACRS during the development of the technical basis for the rulemaking, as well as prior to requesting Commission approval of the proposed rule. The ACRS, in a letter dated April 10, 2007 (ADAMS Accession No. ML071000105), has decided to defer their review of the proposed rule until after public comments have been considered. However, the ACRS has also asked the staff to plan to discuss the proposed rule with the ACRS subcommittee after publishing the proposed rule in the *Federal Register*. The staff plans to discuss the proposed rule with the ACRS subcommittee and consider their comments with any public comments received on the proposed rule.

### SCHEDULE:

The staff plans to publish this proposed rule in the *Federal Register* in August 2007. After consideration of public comments, the staff plans to submit the final rule to the Commission for consideration in March 2008. This schedule was approved by the Executive Director for Operations on January 12, 2007.

RESOURCES:

Total resources required are 2.5 FTE and \$50,000 for FY2007 and 1.7 FTE and \$35,000 for FY2008. For NRR, approximately 2.1 FTE and \$50,000 are needed for this rulemaking for FY 2007 through FY 2008. Of this amount, 1.2 FTE and \$50,000 are budgeted for FY2007, and 0.9 FTE is budgeted for FY 2008. For the Office of Nuclear Regulatory Research, 1.5 FTE and \$110,000 are needed for this rulemaking for FY 2007 through FY 2008. Of this amount, 1.0 FTE and \$75,000 are budgeted for FY2007, and 0.5 FTE and \$35,000 are pending approval for FY 2008. For the Office of General Counsel, 0.1 FTE per year is budgeted for FY 2007 through FY 2008. For the Office of Information Services, 0.1 FTE per year is budgeted for FY 2007 through FY 2008. For the Office of Administration, 0.1 FTE per year is budgeted for FY 2007 through FY 2008.

RECOMMENDATIONS:

The staff recommends that the Commission take the following three steps:

1. Approve for publication in the *Federal Register* the proposed amendment to 10 CFR Part 50 (Enclosure 1).
2. Certify that this rule, if promulgated, will not have a significant economic impact on a substantial number of small entities in order to satisfy requirements of the Regulatory Flexibility Act (5 U.S.C. 605(b)).
3. Take note of the following:
  - a. The proposed rule will be published in the *Federal Register* for a 75-day comment period.
  - b. A draft regulatory analysis has been prepared (Enclosure 2).
  - c. A draft environmental assessment and finding of no significant impact has been prepared (Section VII of Enclosure 1).
  - d. This proposed rule creates new information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). The staff will submit this rule to the Office of Management and Budget (OMB) for review and approval of the paperwork requirements (Section VIII of Enclosure 1). A draft OMB supporting statement has been prepared (Enclosure 3).
  - e. The Chief Counsel for Advocacy of the Small Business Administration will be informed of the certification regarding the economic impact on small entities and the reasons for the certification as required by the Regulatory Flexibility Act (Section XVII of Enclosure 1).
  - f. The appropriate Congressional committees will be informed.
  - g. The Office of Public Affairs will issue a press release.

COORDINATION:

The Office of the General Counsel has no legal objection to the proposed rule. The Office of the Chief Financial Officer has reviewed the proposed rule for resource implications and has no objections. The Office of Information Services has reviewed the proposed rule and has no objections to the changes in information collection requirements. The ACRS and the Committee to Review Generic Requirements (CRGR) have deferred their review of the proposed rule until after public comments have been considered. The ACRS and CRGR will have the opportunity to review this rulemaking at the final rule stage.

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Executive Director  
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Enclosures:

1. Federal Register Notice
2. Draft Regulatory Analysis
3. Draft OMB Supporting Statement

COORDINATION:

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*/RA/*

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## Enclosures:

1. Federal Register Notice
2. Draft Regulatory Analysis
3. Draft OMB Supporting Statement

\* concurred via e-mail

\*\* concurred via memo

**ADAMS Accession Number: ML070570525****WITS 200600298**

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