

POLICY ISSUE INFORMATION

June 23, 2000

SECY-00-0140

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: REEVALUATION OF THE PRESSURIZED THERMAL SHOCK RULE
(10 CFR 50.61) SCREENING CRITERION

PURPOSE:

To summarize staff work to revisit the technical basis of the Pressurized Thermal Shock Rule and describe the staff's intended approach to reassess the rule's screening criterion.

BACKGROUND:

In the late 1970s, the staff identified an issue concerning the integrity of embrittled pressurized water reactor (PWR) pressure vessels that involved a rapid cooldown of the inside wall of the vessel, accompanied by either sustained high reactor coolant system pressure or a subsequent repressurization of the system. The identification of this issue, termed pressurized thermal shock (PTS), resulted in the development of a proposed rule. This proposed rule was provided to the Commission in SECY-82-465 (Pressurized Thermal Shock) and received subsequent Commission approval. The Pressurized Thermal Shock Rule, 10 CFR 50.61, was established in 1983 as an adequate protection rule. The rule included a specified numerical value of a materials parameter (RT_{PTS}) which would be used as a screening criterion, above which licensees would be required to demonstrate that their pressure vessels could be operated safely (Section 2 of the attachment summarizes key elements of the rule). RT_{PTS} is a measure of the material toughness of the vessel at the end of its licensed life and the ability of the vessel materials to withstand a PTS event.

The screening criterion (i.e., acceptable value of RT_{PTS}) was set, in part, based on judgements regarding what frequency of vessel failure due to PTS was acceptable. The frequency of a through-wall crack, which was taken to be equivalent to reactor vessel failure and core damage, was estimated in SECY-82-465 to be in the range of 6×10^{-6} to 1×10^{-5} per reactor year. If a licensee determines that the screening criterion is to be exceeded, and no "reasonably practicable" programs for reducing the neutron fluences experienced by the vessel were found,

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then the rule requires the performance of a plant-specific safety analysis. Regulatory Guide 1.154 describes one acceptable method for performing this analysis. This method is a probabilistic analysis involving extensive thermal-hydraulic and fracture mechanics calculations. If the plant-specific analysis results in a through-wall crack frequency less than 5×10^{-6} per reactor year, then plant operation could continue. It is important to note that in establishing the screening criterion, a detailed assessment of containment performance during PTS events was not made.

Since the rule was established, the staff has accumulated considerable experience with application of the rule and regulatory guide and performed extensive research on the key technical issues underlying the rule. With respect to the regulatory guide, this experience has shown that it is difficult to use. Analyses performed as part of this research suggested that the rule could have conservatism which could be reduced while still providing reasonable assurance of adequate protection to public health and safety. As such, the staff initiated a program in 1999 to revisit the technical bases for the PTS Rule, and, if appropriate, to propose a revision to the rule and the regulatory guide. This revisitation and possible rule revision are intended to:

- Continue to provide reasonable assurance of adequate protection;
- Improve the realism of the rule by incorporating these research results as well as current methods in thermal-hydraulics and probabilistic risk assessment, and reflecting current agency guidance on the use of risk information in regulatory activities;
- Reduce licensee burden by eliminating unnecessary conservatism in the rule, and by clarifying the implications of the research results for those PWRs which could approach the screening criterion; and
- Provide for public participation during the revisitation of the technical basis and any subsequent rulemaking.

Since the PTS rule was established, the Commission also has established new guidance which, while not directed specifically at PTS events, is germane to setting the acceptable frequency of core damage from PTS events and thus to the PTS screening criterion. Most recently, a draft framework has been developed for applying this guidance to risk-informed changes to the technical requirements of Part 50, as described in SECY-00-0086 (Status Report on Risk-Informing the Technical Requirements of 10 CFR 50 (Option 3)). As discussed below, the staff intends to use this framework to reassess the PTS screening criterion.

DISCUSSION:

In the past several years, the staff has completed a considerable amount of research pertinent to the analysis of PTS events. This research includes work on the size, density, and location of flaws in the vessel, the effects of neutron irradiation on materials, and methods for performing probabilistic fracture mechanics calculations. Section 3 of the attachment summarizes this research. In 1999, the staff initiated a program to apply this research to revisit the technical

basis and, if appropriate, to propose a revision to the PTS Rule. This program has the following key elements (which are discussed in more detail in Section 4 of the attachment):

- Identify Initiating Events and Estimate Their Frequency This element provides information on the types of initiating events which could lead to PTS events, and the frequencies of these events. The staff will review previous PTS studies, review more recent PRAs and operational events to identify new initiators, and estimate the frequencies of these initiators.
- Thermal Hydraulics The thermal hydraulics element will provide the reactor vessel downcomer temperature and pressure boundary conditions for the fracture mechanics analysis, using state-of-technology computer models.
- Probabilistic Fracture Mechanics The probabilistic fracture mechanics element of the staff's work will provide estimates of the probabilities of through-wall cracks for each of the sets of initiators and thermal hydraulic conditions identified in previous elements. This work will make use of the extensive research performed by the staff (Section 3 of the attachment details these improvements).
- Reassess Probabilistic Aspects of PTS Screening Criterion In parallel with the development of revised technical information on PTS events and their frequencies and consequences, the staff is reassessing the basis for the "acceptable" frequency of such events. This reassessment is discussed in more detail below.
- Calculate PTS Through-Wall Crack Frequency The frequency of a through-wall crack, which is considered to be equivalent to vessel failure and core damage, will be estimated in this element. This frequency will consider all initiators identified in the first element and their frequencies, thermal hydraulic information, and probabilistic fracture mechanics information. A simple analysis (involving less than six staff-months of effort) of the impact of such vessel failures on containment performance will also be performed as part of this element. Uncertainties in these frequencies will be estimated.
- Re-evaluate PTS Screening Criterion The staff will develop recommendations for new values of RT_{PTS} , using the results of the PTS analyses and the reassessment of the probabilistic aspects of the screening criterion.
- Propose Technical Basis for Revision to 10 CFR 50.61 The information created and assembled in previous tasks will be integrated into a form which will support a new version of the rule and regulatory guide. When completed, this material will be provided to the Commission with a recommendation on whether or not to proceed with rulemaking, as well as the priority of this rulemaking relative to other risk-informed Part 50 rulemakings.

By present schedules, this program will be completed in early FY2002.

A considerable amount of guidance on the use of risk assessment in regulation has been established since the PTS rule was established. This guidance is provided in the Regulatory

Analysis Guidelines, the Safety Goal and PRA Policy Statements, Regulatory Guide 1.174, and other documents. The staff has used this guidance to develop a draft framework, described in SECY-00-0086, for risk-informing the technical requirements of Part 50.

As also described in SECY-00-0086, the staff intends to test and update, as needed, this framework using regulations associated with hydrogen control (10 CFR 50.44) and with special treatment requirements. The staff now intends to reevaluate the PTS Rule's screening criterion using the SECY-00-0086 framework, and use this reevaluation as a third test. This framework includes consideration of containment performance and offsite risk via the use of a large early release frequency guideline. As noted above, containment performance was not assessed in detail during the development of the original rule. In work completed so far on reevaluating the screening criterion, the staff has identified two particular issues which will require further evaluation:

- The spectrum of possible failure modes of a reactor pressure vessel under pressurized thermal shock conditions and the effects of vessel failure on containment could be very difficult to characterize and analyze, making comparisons with the LERF guideline difficult, at best. The staff also notes that while safety related systems in nuclear power plants are designed with redundancy, there is no redundancy for the reactor pressure vessel. Developing the models and data necessary to consider the impact of reactor vessel failure on containment integrity could be cost prohibitive. Therefore, while the staff believes there is conservatism that can be removed from the existing PTS Rule, the staff also considers it appropriate to do a scoping study on the containment performance issues associated with a PTS-related vessel failure to better determine the scope and nature of the issues and the feasibility of addressing these as part of this effort. Addressing containment performance is consistent with defense-in-depth considerations and could provide an alternative path for assessing this issue. If it turns out not to be feasible to address these issues, then it may be necessary that the PTS effort continue on the basis that vessel failure leads to containment failure and that the frequency of vessel failure should be limited to 1×10^{-6} per reactor year in order to meet established guidelines for large early release frequency. Additional information on assessing containment performance for PTS events is provided in the attachment, Section 4, discussion on PTS through-wall crack frequency.
- Revisitation of the technical basis of the PTS Rule provides an early test of the SECY-00-0086 framework in the context of possible modifications of an adequate protection rule. The staff believes that this test will provide important information to refine the framework and its subsequent application to other possible rule changes to make them more risk-informed.

The staff will provide updates to the Commission on the progress in the reevaluation of the rule's technical basis and the issues noted above as key milestones are completed. Policy issues identified will be brought to the Commission on an expedited basis for resolution.

RESOURCES:

The resources needed to develop the technical basis for a potential modification of the PTS rule are included in the FY2000 RES budget and the proposed FY2001 RES budget. These budgets include a limited amount of funding to assess containment performance, as noted above. However, if extensive new accident or radioactive release analyses are found to be necessary and feasible, additional resources will have to be prioritized using the Planning, Budgeting, and Performance Management (PBPM) process. NRR resources to perform the subsequent rulemaking, if approved by the Commission, will be considered in the FY2002 budget for rulemakings, according to the priority of this rule change relative to other rulemaking activities. RES funds to provide technical support for this rulemaking are included in the RES FY2002 budget.

COORDINATION:

The Office of General Counsel has reviewed this paper and has no legal objections. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objections. The staff is providing the ACRS with periodic briefings on the overall program to revisit the PTS Rule technical basis and the approach being taken with respect to the staff's reassessment of the screening criterion.

/RA/

William D. Travers
Executive Director
for Operations

Attachment:

Pressurized Thermal Shock Rule Analysis Requirements and Acceptance Criteria,
Related Improvements in Analysis Methods and Data, and Staff Plans to Revisit the
Rule's Technical Basis

NAME: g:\secy-ptsaccrcrit-edo.wpd

* Previously concurred

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AS REQUESTED:	NOTE & RETURN:	PREPARE REPLY:
COORDINATION:	PER CONVERSATION:	

FOR PARALLEL CONCURRENCE:

MEMORANDUM TO: The Commission
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