

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

Pressurized Thermal Shock; Reports on the Technical Basis and Public Workshop

AGENCY: Nuclear Regulatory Commission.

ACTION: Notice of availability; notice of workshop.

SUMMARY: The Nuclear Regulatory Commission (NRC) is making available reports documenting the technical basis for a proposed revision of the NRC's pressurized thermal shock regulations. The NRC will also be conducting a two-day public workshop on this topic. The workshop is open to the public and all interested parties may attend.

DATES: The NRC is not soliciting comments at this time; however, NRC will request formal public comments when a notice of proposed rulemaking is published in the Federal Register.

The public workshop will be: September 7, 2006, from 8:30 a.m. – 12:00 p.m., Room T10-A1, and from 1:00 p.m. – 4:45 p.m., Room T9-A1; September 8, 2006, from 9:30 a.m. – 3:45 p.m., Room T9-A1. If you plan to attend the workshop you are encouraged to preregister in order to facilitate security check-in on the day of the meeting.

ADDRESSES: Documents related to the proposed technical basis can be accessed electronically at <http://www.nrc.gov/reading-rm/adams/web-based.html>. From this site, you can access ADAMS, which provides text and image files of the NRC's publicly available documents. If you do not have access to ADAMS or if you experience problems accessing documents in ADAMS, contact the NRC's Public Document Room (PDR) reference staff by telephone at 1-800-397-4209 or 301-415-4737, or by email to [PDR@nrc.gov](mailto:PDR@nrc.gov). These documents may also be viewed on public computers located in the NRC's Public Document Room, Room O1-F21, One

White Flint North, 11555 Rockville Pike, Rockville, Maryland, 20852. The PDR reproduction contractor will provide hard copies of the documents for a fee.

FOR FURTHER INFORMATION CONTACT: Dr. Mark T. Kirk, Office of Nuclear Regulatory Research, Component Integrity Branch, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (301) 415-6015, facsimile 301-415-5074; e-mail [MTK@nrc.gov](mailto:MTK@nrc.gov).

SUPPLEMENTARY INFORMATION: During the operation of a nuclear power plant, the walls of the reactor pressure vessel (RPV) are exposed to neutron radiation, resulting in localized embrittlement of the vessel steel and weld materials in the core area. If an embrittled RPV had an existing flaw of critical size and certain postulated severe system transients were to occur, the flaw could very rapidly propagate through the vessel, resulting in a through-wall crack and challenging the integrity of the RPV. The postulated severe transients of concern, known as pressurized thermal shock (PTS) events, are characterized by a rapid cooling (i.e., thermal shock) of the internal RPV surface in combination with repressurization of the RPV. The coincident occurrence of critical-size flaws, embrittled vessel steel and weld material, and a severe PTS transient is a very low-probability event. Additionally, only a few currently operating pressurized-water reactors are projected to closely approach the current statutory limit on the level of embrittlement, as set forth in Title 10, Section 50.61, of the Code of Federal Regulations (10 CFR 50.61), “Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events,” during their planned operational life.

Advancements in our understanding and knowledge of materials behavior, our ability to realistically model plant systems and operational characteristics, and our ability to better evaluate PTS transients to estimate loads on vessel walls led NRC to conclude that the earlier analysis, conducted in the course of developing the PTS Rule in the 1980s, contained significant conservatism. Consistent with the NRC’s Strategic Plan and the strategy to use realistically conservative, safety-focused research programs to resolve safety-related issues,

the NRC's Office of Nuclear Regulatory Research (RES) undertook a project in 1999 to develop a technical basis to support a risk-informed revision of 10 CFR 50.61. Two central features of the research approach include a focus on the use of realistic input values and models and an explicit treatment of uncertainties (using currently available uncertainty analysis tools and techniques). This approach improved significantly upon that employed to establish the embrittlement limits in 10 CFR 50.61, which originally included intentional and unquantified conservatism in many aspects of the analysis and treated uncertainties implicitly by incorporating them into the models.

In early 2005, RES completed a series of reports that describe in detail the results of the project initiated in 1999. The information in these reports demonstrates that even through the period of license extension, the likelihood of vessel failure attributable to PTS is extremely low ( $10^{-8}$ /year). These results provide evidence that the statutory embrittlement limit established in 10 CFR 50.61 can be modified significantly to reduce unnecessary conservatism without affecting safety. This is possible because the operating reactor fleet has little probability of exceeding the limits on the frequency of reactor vessel failure, as they relate to NRC guidelines on core damage frequency and large early release frequency during either the currently licensed lifetime or the period of license extension.

In early 2005, the RES reports were discussed with the NRC's Advisory Committee on Reactor Safeguards (ACRS) during a series of public meetings. Following these meetings, the ACRS sent letters to the NRC expressing the view that RES had developed a sound technical basis for a risk-informed revision of 10 CFR 50.61. More recently (June – October 2005) staff from the NRC's Office of Nuclear Reactor Regulation (NRR) reviewed this technical basis and found it acceptable to begin the rulemaking process contingent upon the following three prerequisites:

- (1) Commission approval of the rulemaking plan, and dedication of resources

- (2) Successful resolution of outstanding technical issues identified in the existing technical basis
- (3) Making the technical basis documents available to the public

This notice addresses prerequisite number 3.

### **Public Availability of Reports**

The following table provides the document titles and Agencywide Documents Access and Management System (ADAMS) accession numbers for all of the reports that, collectively, comprise the proposed technical basis for risk-informed revision of 10 CFR 50.61. The NRC staff recommends that persons interested in obtaining an overview of the technical basis and the recommended revisions to 10 CFR 50.61 focus their attention first on ADAMS Accession #ML061580318. Interested persons can find more detailed information in the other supporting documents.

| Topical Area   | ADAMS ML#   | Author & Title   |
|--|-------------|--|
| Previous Results                                       | ML030090626 | Kirk, M.T., "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Criteria in the PTS Rule (10 CFR 50.61)," December 2002.  |
| Current Results Summary                                | ML061580318 | Kirk, M.T., et al., "Technical Basis for Revision of the Pressurized Thermal Shock (PTS) Screening Limit in the PTS Rule (10 CFR 50.61): Summary Report," NUREG-1806, Vol. 1.  |
| Probabilistic Risk Assessment & Human Factors Analysis | ML992710066 | Sui, N., "Uncertainty Analysis and Pressurized Thermal Shock: An Opinion," September 3, 1999.  |
|  | ML061580379 | Whitehead, D.W., and A.M. Kolaczowski, "PRA Procedures and Uncertainty for PTS Analysis," NUREG/CR-6859.   |
|  | ML042880452 | Kolaczowski, A.M., et al., "Oconee Pressurized Thermal Shock (PTS) Probabilistic Risk Assessment (PRA)," September 28, 2004.   |
|  | ML042880454 | Whitehead, D.W., et al., "Beaver Valley Pressurized Thermal Shock (PTS) Probabilistic Risk Assessment (PRA)," September 28, 2004.  |
|  | ML042880473 | Whitehead, D.W., et al., "Palisades Pressurized Thermal Shock (PTS) Probabilistic Risk Assessment (PRA)," October 6, 2004.   |
|  | ML042880482 | Whitehead, D.W., et al., "Generalization of Plant-Specific Pressurized Thermal Shock (PTS) Risk Results to Additional Plants," December 14, 2004.  |
|  | ML042880476 | Kolaczowski, A.M. et al., "Estimates of External Events Contribution to Pressurized Thermal Shock (PTS) Risk," October 1, 2004.  |
| Thermal Hydraulics                                     | ML050390012 | Bessette, D.E., "Thermal-Hydraulic Evaluation of Pressurized Thermal Shock," NUREG-1809.   |
|  | ML043570429 | Reyes, J.N., et al., "Scaling Analysis for the OSU APEX-CE Integral System Test Facility," NUREG/CR-6731.  |
|  | ML043570405 | Reyes, J.N., et al., "Final Report for the OSU APEX-CE Integral System Test Facility Test Results," NUREG/CR-6856.   |
|  | ML043570394 | Fletcher, C.D., D.A. Prelewicz, and W.C. Arcieri, "RELAP5/MOD3.2.2 Gamma Assessment for Pressurized Thermal Shock Applications," NUREG/CR-6857.  |
|  | ML061100488 | Chang, Y.H.J., A. Mosleh, and K. Almenas, "Thermal-Hydraulic Uncertainty Analysis in Pressurized Thermal Shock Risk Assessment: Methodology and Implementation on Oconee-1, Beaver Valley, and Palisades Nuclear Power Plants," NUREG/CR-6899. |
|  | ML043570385 | Arcieri, W.C., R.M. Beaton, C.D. Fletcher, and D.E. Bessette, "RELAP5 Thermal-Hydraulic Analysis To Support PTS Evaluations for the Oconee-1, Beaver Valley-1, and Palisades Nuclear Power Plants," NUREG/CR-6858.                             |
|  | ML061170401 | Arcieri, W.C., C.D. Fletcher, and D.E. Bessette, "RELAP5/MOD3.2.2 Gamma Results for the Palisades 1D Downcomer Sensitivity Study," August 31, 2004.  |
|  | ML042880480 | Junge, M., "PTS Consistency Effort," October 6, 2004.  |

| Topical Area                     | ADAMS ML#   | Author & Title  |
|----------------------------------|-------------|---|
| Probabilistic Fracture Mechanics | ML061580343 | Kirk, M.T., et al., "Probabilistic Fracture Mechanics: Models, Parameters, and Uncertainty Treatment Used in FAVOR Version 04.1," NUREG-1807.   |
|                                  | ML051790410 | Simonen, F.A., S.R. Doctor, G.J. Schuster, and P.G. Heasler, "A Generalized Procedure for Generating Flaw-Related Inputs for the FAVOR Code," NUREG/CR-6817, Rev. 1.  |
|                                  | ML061580369 | Williams, P.T., T.L. Dickson, and S. Yin, "Fracture Analysis of Vessels - Oak Ridge, FAVOR v04.1: Computer Code: Theory and Implementation of Algorithms, Methods, and Correlations," NUREG/CR-6854.                                |
|                                  | ML061580375 | Dickson, T.L., P.T. Williams, and S. Yin, "Fracture Analysis of Vessels - Oak Ridge, FAVOR v04.1, Computer Code: User's Guide," NUREG/CR-6855.  |
|                                  | ML061580358 | Malik, S.N.M., "FAVOR Code Versions 2.4 and 3.1: Verification and Validation Summary Report," NUREG-1795.   |
|                                  | ML042960391 | Dickson, T.L., and S. Yin, "Electronic Archival of the Results of Pressurized Thermal Shock Analyses for Beaver Valley, Oconee, and Palisades Reactor Pressure Vessels Generated with the 04.1 Version of FAVOR," October 15, 2004. |
|                                  | ML061580349 | Kirk, M.T., et al., "Sensitivity Studies of the Probabilistic Fracture Mechanics Model Used in FAVOR," NUREG-1808.  |

## Public Workshop

The NRC will conduct a public workshop on September 7–8, 2006, at NRC Headquarters, 11545 Rockville Pike, Rockville, Maryland. The purpose of this workshop is to inform the public of the reports detailed in the preceding section of this notice. A preliminary agenda for the workshop follows. If you plan to attend this meeting you are urged to contact Dr. Mark Kirk via email to [MTK@nrc.gov](mailto:MTK@nrc.gov) at least 3 business days before the meeting date so that your name can be included on the list of attendees and so you can be advised of any revisions to the agenda. You are strongly encouraged to communicate via email, as this will facilitate the most efficient response to your inquiry.

## Preliminary Agenda

Thursday September 7, 2006  
8:30 a.m. – 12:00 p.m., Room T10-A1  
1:00 p.m. – 4:45 p.m., Room T9-A1

| Start Time | Stop Time | Duration [min] | Topic   | Presenter / Moderator |
|------------|-----------|----------------|---|-----------------------|
| 8:30       | 9:00      | 30             | Background of PTS Project (Overview, Objectives, Reviews Performed to Date) | Kirk                  |
| 9:00       | 9:30      | 30             | Status and Plan for Rulemaking  | Mencinsky             |
| 9:30       | 9:45      | 15             | Overview of Reports   | Kirk                  |
| 9:45       | 10:15     | 30             | Questions from Public Regarding Reports and Regulatory Process              | Hardies               |
| 10:15      | 10:30     | 30             | Break   |                       |
| 10:30      | 11:00     | 30             | Modeling Approach: Overview   | Kirk                  |
| 11:00      | 11:30     | 30             | Modeling Approach: Risk Assessment and Human Factors                        | Kolaczowski           |
| 11:30      | 12:00     | 30             | Modeling Approach: Thermal-Hydraulics                                       | Bessette              |
| 12:00      | 1:00      | 60             | Lunch   |                       |
| 1:00       | 1:30      | 30             | Modeling Approach: Fracture Mechanics and Material Embrittlement            | Kirk                  |
| 1:30       | 2:00      | 30             | Questions from the Public Regarding Modeling Approach                       | Hardies               |
| 2:00       | 3:30      | 90             | Summary of Results from Baseline Analysis of Three Plants                   | Kirk                  |
| 3:30       | 3:45      | 15             | Break   |                       |
| 3:45       | 4:45      | 60             | Questions from Public Regarding Baseline Analysis                           | Hardies               |

Friday September 8, 2006  
9:30 a.m. – 3:45 p.m., Room T9-A1

| Start Time | Stop Time | Duration [min] | Topic   | Presenter / Moderator |
|------------|-----------|----------------|---|-----------------------|
| 9:30       | 10:30     | 60             | Summary of Study Generalizing the Results to All Domestic PWRs  | Kirk                  |
| 10:30      | 11:00     | 30             | Questions from the Public Regarding Generalization  | Hardies               |
| 11:00      | 11:30     | 30             | Proposed Allowable Through-Wall Cracking Frequency Limit  | Siu                   |
| 11:30      | 11:45     | 15             | Questions from the Public Regarding Through-Wall Cracking Frequency Limit                                       | Hardies               |
| 11:45      | 1:00      | 75             | Lunch   |                       |
| 1:00       | 1:30      | 30             | Proposed Material Embrittlement-Based Reference Temperature Limits for Use in a Revised Version of 10 CFR 50.61 | Kirk                  |
| 1:30       | 2:00      | 30             | Questions from Public Regarding Reference Temperature Limits  | Hardies               |
| 2:00       | 3:00      | 60             | General Questions from Public   | Hardies               |
| 3:00       | 3:15      | 15             | Break   |                       |
| 3:15       | 3:45      | 30             | Summary   | Hardies               |

Dated at Rockville, Maryland, this \_4th\_\_\_ day of August, 2006.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION,

\_\_\_\_\_/RA/\_\_\_\_\_  
James T. Wiggins, Deputy Director  
Office of Nuclear Regulatory Research



