



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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January 12, 2024

Mr. Dewey Olinski
Executive Director, PWR Owners Group,
Program Management Office
Westinghouse Electric Company
1000 Westinghouse Drive, Suite 172
Cranberry Township, PA 16066

SUBJECT: REGULATORY AUDIT PLAN FOR THE REVIEW OF TOPICAL REPORT
PWROG-18068-NP, REVISION 1, "USE OF DIRECT FRACTURE TOUGHNESS
FOR EVALUATION OF REACTOR PRESSURE VESSEL INTEGRITY"
(EPID L-2021-TOP-0027)

Dear Mr. Olinski:

By letter dated July 17, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21209A933), the Pressurized Water Reactor Owners Group (PWROG) submitted Topical Report (TR) PWROG-18068-NP, Revision 1, "Use of Direct Fracture Toughness for Evaluation of Reactor Pressure Vessel Integrity," for U.S. Nuclear Regulatory Commission (NRC) review and approval. The PWROG TR approval will provide NRC licensees the opportunity to reference regulatory actions per the NRC TR program.

The purpose of the TR is to provide an alternative methodology to the Reactor Pressure Vessel material integrity requirements which are available in Title 10 of the *Code of Federal Regulations*, Appendix G to Part 50, "Fracture Toughness Requirements," Section 50.60, "Acceptance Criteria for Fracture Prevention Measures for Lightwater Nuclear Power Reactors for Normal Operation," and Section 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events."

For additional clarification and closeout of the PWROG-18068 draft responses to NRC's requests for additional information (RAIs) dated March 22, 2022 (ADAMS Accession No. ML21209A933), the NRC staff plans to conduct an on-site regulatory audit at NRC headquarters in Rockville, MD on January 17, 2024, from 8:00 am to 4:00 pm (Eastern Standard Time (EST)) with an additional date of January 18, 2024, from 8:00 am to 12:00 pm EST, if needed. The details of the NRC regulatory audit plan are provided in the enclosure to this letter.

D. Olinski

- 2 -

If you have any questions, please contact me at 301-415-1186 or via e-mail at Leslie.Fields@nrc.gov

Sincerely,

/RA/

Leslie Fields, Senior Project Manager
Licensing Projects Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 99902037

Enclosure:
Regulatory Audit Plan

REGULATORY AUDIT PLAN FOR THE REVIEW OF TOPICAL REPORT
PWROG-18068-NP, REVISION 1, "USE OF DIRECT FRACTURE TOUGHNESS FOR
EVALUATION OF REACTOR PRESSURE VESSEL INTEGRITY"
PRESSURIZED WATER REACTOR OWNERS GROUP
DOCKET NO. 99902037 (EPID L-2021-TOP-0027)

1.0 BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) staff is currently engaged in a review of a Pressurized Water Reactor Owners Group (PWROG) Topical Report (TR) entitled, PWROG-18068-NP, Revision 1, "Use of Direct Fracture Toughness for Evaluation of Reactor Pressure Vessel Integrity." By letter dated July 17, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21209A933), PWROG submitted the TR for NRC review and approval to allow PWROG members the opportunity to reference regulatory actions per the NRC TR program. The purpose of the TR is to provide an alternative methodology to the reactor pressure vessel material integrity requirements which are available in Title 10 of the *Code of Federal Regulations*, Appendix G to Part 50, "Fracture Toughness Requirements," Section 50.60, "Acceptance Criteria for Fracture Prevention Measures for Lightwater Nuclear Power Reactors for Normal Operation," and Section 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events."

On August 4 and October 11, 2023, the NRC staff held a two-part public meeting (ADAMS Accession No. ML23270B859) with the PWROG and industry to discuss PWROG's draft responses to the NRC staff's requests for additional information (RAIs) (ADAMS Accession No. ML22084A246) .

The NRC staff plans to conduct a regulatory audit on January 17, 2024, to enhance the technical understanding of the submitted documentation. This audit will help the NRC staff better understand the TR supporting documentation and analysis results through interaction with PWROG's technical experts in addition to helping finalize the NRC staff RAI phase of the review, where docketed information is needed to complete the review. The proposed audit will be held in accordance with the Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits," dated October 31, 2019 (ADAMS Accession No. ML19226A274).

2.0 REGULATORY AUDIT BASES

The following regulations apply to the proposed alternative.

10 CFR 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock," requires reference temperature of the reactor vessel materials be within specific values to prevent pressurized thermal shock on the reactor vessel materials.

10 CFR Part 50, Appendix G, requires specific fracture toughness of reactor vessel materials and specific pressure-temperature limits.

10 CFR Part 50, Appendix H, "Reactor Vessel Material Surveillance Requirements," requires surveillance capsules containing RPV material specimens be installed inside the RPV to monitor the embrittlement of the RPV materials.

3.0 REGULATORY AUDIT SCOPE

The NRC staff would like the PWROG to make available the appropriate personnel with detailed knowledge of the submitted PWROG TR, supporting methodology, supporting documents used in the development of the TR, and final responses to the NRC staff's requests and revised TR.

Based on public meeting discussions, the NRC staff will focus on the final responses to the NRC staff's RAIs, as listed in Section 3.1 of this audit plan, and the revised TR available to the NRC staff prior to the audit. The following are the planned major areas of focus for detailed discussion and document review. Additional information needs to be identified during the audit and will be communicated to the designated point of contact.

3.1 List of Items for Audit Discussion

Box.com portal uploaded with the proposed responses to the following discussion items and the corresponding changes to the TR before the audit discussion. The following list of discussion items is based on the PWROG's draft responses to the RAIs (ADAMS Accession No. ML23180A161) that were identified as needing further clarification at the end of the public meeting held on October 11, 2023. The PWROG provided an associated draft markup of the TR (ADAMS Accession No. ML23180A190) with the draft responses.

The list of discussion items is divided into two parts. The first part is focused on items that may need significant discussion. The second part are items that, based on the discussions during the public meetings, are expected to have minimal discussion.

(1) Items That May Need Significant Discussion

a. RAI 07a

- i. Clarification is needed in the following sentence of the draft response: "*If multiple data sets for the heat of interest include both MTR and PWR irradiations, the MTR irradiation(s) will not be used, unless the MTR data quality is significantly superior to the PWR irradiated data.*" Specifically, the phrase "...unless MTR data quality is significantly superior to the PWR irradiated data" needs a definition and an acceptance criterion.
- ii. In Table C-6 of the draft TR markup, the BR2-MTR data is not used (weighting factor is set to zero). This appears to be consistent with the sentence of the draft response cited above. Clarify the following hypothetical cases:
 1. If only the BR2-MTR data is available, it will obviously not be used since MTR data requires at least one PWR data validation material, Is this observation correct?
 2. If the BR2-MTR data is available and only one PWR data available (for example, Kewaunee T), would the BR2-MTR data be used?

b. RAI 21a

- i. Clarification is needed on how uncertainty due to material variability is accounted for in the TR methodology. Potential ways to account for this uncertainty due to material variability are (a) addition of a margin term due to material variability uncertainty; (b) through a procedure/testing method that addresses material variability uncertainty; or (c) through a screening method. The inhomogeneity screening in ASTM E1921 included in the TR methodology addresses the material variability uncertainty of the particular dataset that is tested, not the entire material of concern, i.e., the reactor pressure vessel.

c. RAI 24

- i. The draft response is still too general and not adequate to capture the complexity of how the final T_0 value is determined for all cases (e.g., multiple MTR/multiple PWR, one MTR data/multiple PWR data, irradiated, unirradiated); a flowchart or step-by-step procedure would help navigate through the complexity.

(2) Items That Need General Discussion

a. RAI 01

- i. The MTR value (e.g., BR2-MTR in Appendix C example in the draft TR markup) should be within 50% of the PWR irradiated validation material (e.g., Capsule A-35 in the Appendix C example in the draft TR markup).

b. RAI 02a, b

- i. The “n” value from Table T-11b in NUREG-1475 referenced in the draft response should be the number of heats.
- ii. The NRC staff needs clarification what the “95% bound” imply when/if irradiated data is used to develop generic values.

c. RAI 09

- i. Clarification is needed regarding terminology only (not methodology). In many instances, parameters are differentiated by only small subscripts (e.g., the “ $SD_{ETCRPVadj}$ ” term in Equation 11 in the draft TR markup), and thus difficult to follow differences in the parameters. A terminology page or glossary section would be helpful with this clarification.

d. RAI 11d

- i. Clarification is needed on whether linear adjustments are appropriate considering fluence effects are or could be non-linear. Also, clarification is needed on whether there is value in weighting data sets when combined based on the amount of adjustment required for each data set rather than weighting them equally. This is related to RAI 07a.

- ii. On page C-5 (last sentence) of the draft TR markup, the increase should be 2.1% not 1.5%.
 - iii. In Table C-4 of the draft TR markup, there should be no 1.5% increase in the predicted ΔT_{30} of MTR data because it is not consistent with the proposed equation for adjusting high-flux (i.e., MTR) data (Equation 9). Instead, Table C-6 of the draft TR markup should see 1.5% increase for MTR data: $0.015 \times (297.4) + 299.6$ to be consistent with Equation 9.
- e. RAI 11f
- i. Clarification is needed on this sentence in the draft response: *“Likewise, if the Equation 8 inequality is not met and multiple data sets are available from separate independent MTR irradiations, then the MTR irradiation which resulted in the most representative result will be used.”* It seems that to imply to use only one heat if you have multiple heats. Is the one heat selected the one that is most representative? What is the criteria for most representative?
- f. RAI 13a
- i. Justification is needed that shows the conservatism of the $\Delta T_0 - T_{\Delta 30}$ correlation model used in the TR methodology.
- g. RAI 13b
- i. Clarification is needed on the linearity (or non-linearity) of the plot of absolute T_0 versus absolute T_{30} .
- h. RAI 19b
- i. Clarification is needed to address T_0 uncertainty when material inhomogeneity is detected. The draft response seems to address boundedness instead of uncertainty. If exception to inhomogeneity screening in ASTM E1921 is taken, such as when it is believed that this screening is too conservative, a basis for why it is too conservative needs to be provided. Otherwise, the screening for inhomogeneity in ASTM E1921 needs to be followed.
- i. RAI 20a
- i. Clarification is needed in the first sentence in Section 4.4.2 of the draft TR markup because it is not clear what is done if adjustments do not exceed the standard deviation of the ETC.
 - ii. Clarification is needed on the definitions of many new parameters/terms in Section 4.4.2 of the draft TR markup.
 - iii. Clarification is need in one of the examples in Appendix C of the draft TR markup that show how Equation 12 in Section 4.4.2 of the draft TR markup works.

- j. RAI 20d
 - i. Clarification is needed on how the $\sigma_{\text{adjustment}}$ term (formerly $\sigma_{\text{additional}}$) “double counts” the uncertainties.
- k. RAI 23
 - i. Clarification is needed on the scope of interaction (if any) of the TR methodology with Code Case N-830-1.
- l. RAI 25b
 - i. Table C-9 in the draft response needs to be included in the revised TR.

3.2 Supporting Information from PWROG

The PWROG is requested to make the appropriate personnel or contractors who are familiar with the proposed TR available for the audits (in person, through Microsoft Teams, or on the phone). The NRC staff also requests that PWROG be prepared to discuss the items listed in Section 3.1 of this plan and, if applicable, have the related supporting documents available for review, which could be provided electronically. The NRC staff may require the PWROG to provide appropriate documents to the NRC docket that would enable an accelerated and effective review of the TR.

4.0 TEAM AND REVIEW ASSIGNMENTS

Reviewer Expertise	Assigned Auditor
Technical Reviewer	David Dijamco (NRC/NRR)
Technical Reviewer	John Tsao (NRC/NRR)
Technical Reviewer	Robert Tregoning (NRC/RES)
Project Manager	Leslie Fields (NRC/NRR)

5.0 LOGISTICS

The audit will be conducted at NRC headquarters in Rockville, MD on January 17, 2024, starting at 8:00 a.m. EST, and concluding at approximately 4:00 p.m.

The PWROG should provide the documentation that may aid discussion on the specific topics of interest.

Please note that the following proposed schedule is subject to change:

- 8:00 a.m. Start Virtual Meeting - Introductions, Audit Activities, Goals, and Logistics
- 8:15 a.m. PWROG and NRC Staff to Discuss TR Documentation
- 8:30 a.m. NRC Staff to Review the TR Documentation
- 10:00 a.m. Break
- 10:15 a.m. NRC Staff to Review the TR Documentation
- 10:45 a.m. NRC/PWROG Discussion
- 4:00 p.m. Exit the Audit

6.0 DELIVERABLES

At the conclusion of the audit, the NRC staff will provide a summary report of the audit discussions listed in the audit scope. The NRC regulatory audit report will be issued within 90 days of the completion of the audit.

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(EPID L-2021-TOP-0027) DATED JANUARY 12, 2024

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