

REGULATORY AUDIT PLAN FOR JANUARY 18, 2023,
TO SUPPORT REVIEW OF PRESSURIZED WATER REACTOR
OWNERS GROUP TOPICAL REPORT PWROG-21001-P/NP, REVISION 0,
HYDROGEN-BASED TRANSIENT CLADDING STRAIN LIMIT
DOCKET NO. 99902037

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) PWROG-21001-P/NP, Revision 0, "Hydrogen-Based Transient Cladding Strain Limit." By letter dated July 28, 2022 (Agencywide Documents Access and Management System Accession No. ML22209A254), PWROG requested NRC review and approval for referencing in regulatory actions per the NRC TR program. The purpose of this TR is to establish a new, alternative fuel performance design limit for transient cladding strain. The TR will facilitate PWROG licensees' use of a data-driven, performance-based design limit when performing transient cladding strain analyses. This is an alternative limit which, after NRC approval, can be used in lieu of the current one percent transient cladding strain limit established in Section 4.2, "Fuel System Design," of NUREG-0800, "Standard Review Plan [(SRP)] for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (ADAMS Accession No. ML070740002).

This TR is applicable to Westinghouse Electric Company nuclear steam supply system (NSSS) and Combustion Engineering NSSS PWROG members that use Westinghouse Performance Analysis and Design Model (PAD5) fuel performance models for ZIRLO® and/or Optimized ZIRLO™ high performance fuel cladding material.

The NRC staff has proposed to conduct a regulatory audit on January 18, 2023, to enhance 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 and will help to focus on the NRC staff's requests for additional information (RAIs), 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

Regulatory guidance for the review of fuel system materials and designs and adherence to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, "General Design Criteria [(GDC)] for Nuclear Power Plants," GDC-10, "Reactor design," GDC-27, "Combined reactivity control systems capability," and GDC-35, "Emergency core cooling," is provided in SRP Section 4.2. In accordance with SRP Section 4.2, the objectives of the fuel system safety review are to provide reasonable assurance that: (1) the fuel system is not damaged as a result of normal operation and anticipated operational occurrences (AOOs), (2) fuel system damage is never so severe as to prevent control rod insertion when it is required, (3) the number of fuel rod failures is not underestimated for postulated accidents, and (4) coolability is always maintained.

Specifically, SRP Section 4.2, paragraph II.1.B.vi, discusses the treatment of pellet-cladding interaction (PCI) and pellet-cladding mechanical interaction (PCMI) phenomena. Specifically, it states that no criterion currently exists for fuel failure resulting from PCI or PCMI, but that two related criteria should be applied: (1) the strain of the cladding during a transient should not exceed 1 percent; and (2) fuel melting should be avoided. The PWROG is requesting to replace the 1 percent transient cladding strain (TCS) limit described in first criterion with a hydrogen-based TCS described in PWROG-21001-P.

3.0 REGULATORY AUDIT SCOPE

The NRC staff would like the PWROG to make available the appropriate staff with detailed knowledge of the submitted PWROG TR, supporting methodology, and supporting documents used in the development of the TR.

The PWROG is requested to have the presentations and documents related to the areas of focus listed. The documentation could be provided by presentations, documents, and calculation details. 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.

The deliberations during the audit, along with the original contents of the TR, will be used to generate RAIs to complete the comprehensive review of the TR.

3.1 List of Items for Audit Discussion

1. PCMI is established to be a biaxial phenomenon (i.e., the cladding is placed under both axial and radial stress). [[]]
2. In the proposed hydrogen-based transient cladding strain limit, [[]]
3. It is stated on page 6-2 of Enclosure 1 to PWROG letter dated July 28,2022 (hereafter called as PWROG submittal) that [[]]
4. Section 4.1, "PAD5 Fuel Performance Models," of Enclosure 1 to PWROG submittal states, "Specifically, the [uniform elongation] UE limit is a function of both the hydrogen content and cladding temperature..." Please clarify how the proposed TCS limit is a function of temperature.

5. Section 4.2, "Cladding Temperature," of Enclosure 1 to PWROG submittal describes that the cladding outer temperature is used to determine TSS. **[[]]**
Please elaborate on where this assumption is employed.
6. Section 4.2 of Enclosure 1 to PWROG submittal states that **[[]]**
7. When restarting after an AOO where cladding plastic strain was accumulated as a result of the AOO, how are the cladding strain hardening and possible opening of the fuel-cladding gap taken into account? In addition, how is further cladding strain measured or accounted for? Is the accumulated strain during the AOO subtracted from the proposed limit, such that the new transit cladding strain limit would be reduced for subsequent AOOs?
8. The TSS changes when the hydrogen in the cladding is undergoing precipitation and when it is undergoing dissolution. Please explain how this difference is accounted for.
9. Please elaborate on how the proposed TCS limit integrates with existing methodologies (e.g., PAD5).
10. Please elaborate on the justification of the use of 10 CFR 50.59(c)(2)(viii) to implement the proposed TCS limit. Specifically, please walk the staff through the assessment that would be performed per NEI 96-07 and highlight which sections of the NEI guidance this would fall under.
11. Please clarify which specific Condition II events the proposed TCS limit is planned to be applied to.

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 (through Teams or on the phone). The NRC staff also requests the PWROG to be prepared to discuss the questions listed above and, if applicable, have the supporting documents related to the above topics available. The documents 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

Area of Review	Assigned Auditor
Technical Reviewer	Joseph Messina (NRC/NRR)
Technical Reviewer	Patrick Raynaud (NRC/RES)
Project Manager	Siva P. Lingam (NRC/NRR)

5.0 LOGISTICS

The audit will be conducted virtually on January 18, 2023, starting at 8:00 a.m. eastern standard time, and concluding at 12:00 p.m. approximately.

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:

January 18, 2023

8:00 a.m. 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
12:00 p.m. Exit the Audit

6.0 DELIVERABLES

At the conclusion of the audit, the NRC staff will provide a summary of audit results for each of the topics defined in the audit scope. The NRC Regulatory Audit Report will be issued within 90 days of the completion of the audit.