

August 29, 2003

Mr. Robert H. Bryan, Chairman  
Westinghouse Owners Group  
Tennessee Valley Authority  
Mail Code LP4J-C  
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Chattanooga, TN 37402-2801

SUBJECT: RESPONSE TO COMMENTS FROM THE WESTINGHOUSE OWNERS GROUP (WOG) ON THE SAFETY EVALUATION FOR WCAP-15604-NP, REV. 1, "LIMITED SCOPE HIGH BURN-UP LEAD TEST ASSEMBLIES" (TAC NO. MB0591)

Dear Mr. Bryan:

By letter dated April 8, 2003, the Westinghouse Owners Group (WOG) provided comments on the safety evaluation (SE) for WCAP-15604-NP, Rev. 1, "Limited Scope High Burn-up Lead Test Assemblies." This letter responds to those comments.

#### Comment #1

In Section 1.0 of the SE, there is a discussion of "current lead rod average burnup limit of 62 GWD/MTU." This reference to 62 GWD/MTU also appears in other places in the SE. It would be preferable for the SE to refer to "burnup limits" throughout the SE as opposed to providing a numerical value, so that the SE would apply to the appropriate licensing basis for the utility. We request that the SE be rewritten to remove references to specific burnup limits.

#### Response

The NRC staff agrees with removing the 62 GWD/MTU burnup limit. The phrase "current licensed burnup limit" will be used in place of the numerical value.

#### Comment #2

A sentence in Section 2.2 of the SE states "Oxidation can lead to significantly increased fuel rod internal pressure on the outer surface of the cladding." We believe that "outer" should really be "inner" in this sentence and ask that this correction be made.

Response

The NRC staff agrees that this sentence is incorrect. During the final stages of preparation, this sentence was incorrectly modified by administrative staff. The sentence has been revised to reflect the original intent.

Comment #3

At the end of the first paragraph in Section 2.3 of the SE, the following sentence states: "As stated in the TR, if the pool-side examinations yield anomalous results, the licensee would inform the NRC and hot cell examinations would be considered." This statement is taken from a response to an RAI [request for additional information] and is out of content. The TR commits the utility to provide the NRC with copies of the pre-and post-irradiation examination results that are provided by the vendor to the utility. But there is no provision for special reporting of anomalous results. A logical conclusion based on the SER statement is that hot cell examinations would be considered whenever an anomalous measurement is recorded. The topical does not commit to such examinations nor was this the intent. Hot cell examinations on a limited scope LTA [limited test assembly] would be the exception, rather than the rule. We ask that the SER be reworded to eliminate the requirement, "hot cell examinations would be considered."

Response

The NRC staff agrees that hot cell examinations on a limited scope LTA would be the exception and would only be "considered" if anomalous conditions warrant further investigation. The statement in the SE is not out of context with the RAI response and will remain as written. It is expected that anomalous results be denoted in the required post-irradiation report. No further notification is required by this topical report.

Additional Comment

The transmittal letter for Reference 1 contains a condition which states: "modify the topical report to remove references to 'no changes to tech specs required'". If this is a condition for approval, it should be contained in the SE.

Response

The NRC staff agrees that any requirement for a license amendment should be clarified in the SE. Change pages to the SE are enclosed which clearly denote this point. It is expected that the final version of Topical Report WCAP-15604-P-A capture this condition of applicability. The NRC staff does not perceive this requirement to be a regulatory burden. An amendment adding this topical report to the technical specifications would be readily approved.

R. Bryan

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Please replace pages 1, 4, 8, and 9 of the SE that was enclosed with the January 8, 2003, letter with the enclosed revised pages. The accepted version of the topical report shall incorporate (1) this letter, (2) the January 8, 2003, letter and the SE, including the revised pages, between the title page and the abstract, (3) all requests for additional information from the staff and all associated responses, and (4) a "-A" indicating an NRC approved report, after the identifier of the report.

Sincerely,

*/RA/*

Herbert N. Berkow, Director  
Project Directorate IV  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Enclosure: Pages 1, 4, 8, and 9 of SE

Project No. 694

cc w/encl:

Mr. Hank A. Sepp, Manager  
Regulatory Compliance and Plant Licensing  
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Mr. Gordon Bischoff, Manager  
Owners Group Program Management Office  
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Pittsburgh, PA 15230-0355

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Sincerely,  
*/RA/*  
Herbert N. Berkow, Director  
Project Directorate IV  
Division of Licensing Project Management  
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\*For previous concurrences see attached ORC  
NRR-106

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-15604-NP, REV. 1

"LIMITED SCOPE HIGH BURN-UP LEAD TEST ASSEMBLIES"

WESTINGHOUSE OWNERS GROUP

PROJECT NO. 694

1.0 BACKGROUND

Over the last few years, the NRC staff has been developing guidelines for the use of lead test assemblies (LTAs). In doing so, the staff has engaged in several public meetings and exchanged written correspondence with representatives of the industry. The objective was to develop a set of guidelines that would provide a structured process for regulating lead test assemblies while maintaining safety. Following such guidelines will help ensure uniformity in data collection, make evaluation of new properties or limits more predictable, and ensure a structured process for data feedback to the NRC staff. The guidelines will be consistent with the NRC performance goals of maintaining safety, increasing public confidence, improving regulatory efficiency and effectiveness and reducing unnecessary regulatory burden.

By letter dated November 29, 2001 (Reference 1), the Westinghouse Owners Group (WOG) submitted Topical Report (TR) WCAP-15604-NP, Rev. 1, "Limited Scope High Burn-up Lead Test Assemblies" for NRC review and approval. The submittal was the result of the industry and NRC staff discussions about the need for lead test assembly guidelines. The document is intended to provide the basis for the operation of a limited number of fuel assemblies to rod burnups greater than the current licensed lead rod average burnup limit. In this context, "burnup limits" refer to the maximum burnup for which a particular fuel design methodology has been validated. The maximum burnup would be 75 GWD/MTU. The rationale is to provide a means to incrementally generate data to populate the range between the current lead rod average burnup limit and the proposed future burnup limit with fuel that has been irradiated under both nominal and limiting conditions (i.e., fuel that has experienced normal or possibly limiting fuel duty). While the WOG submitted the TR, it was developed by representatives of the entire U.S. commercial reactor power industry and is intended to apply to all pressurized water reactors (PWR) and boiling water reactors (BWR) facilities. By letter dated November 21, 2000 (Reference 2), the Nuclear Energy Institute (NEI), requested that the TR be reviewed generically for the entire industry. The NRC staff has reviewed this report accordingly and all conclusions apply to the entire commercial nuclear power industry.

The NRC staff finds this minimum set of examinations acceptable because the parameters most likely to be limiting with higher burnup will be characterized prior to the cycle in which the LTA burnups would exceed current burnup limits. The fuel rod design criteria that are limiting at end-of-life and could be potentially challenged for these high burnup fuel assemblies are cladding oxidation, rod internal pressures, fatigue, and growth. Fatigue analyses typically show 30-50 percent margin to the cumulative fatigue usage factor of 1.0. Therefore, fatigue is not the limiting criterion at these high-burnup levels. As will be explained below, rod internal pressure can be related to cladding oxidation. This leaves cladding oxidation and growth, which will be measured and compared with the predicted values for the irradiation exposure that the lead test assembly rods have experienced before the "test" cycle.

Clad oxidation can lead to significantly increased fuel rod internal pressures. Above certain oxidation levels, the impacts on rod internal pressure and the significant impacts on the cladding pressure limit characteristics could result in the rod internal pressure criterion being exceeded. Therefore, if oxidation is kept to a minimum, the fuel rod internal pressure criterion is less limiting than simply the oxidation criterion by itself. Also, at higher levels of oxidation, spalling of the oxide layer can lead to the formation of hot spots forming on the bare cladding surface. Accelerated oxidation at the hot spots can produce through-wall holes. In addition to oxidation causing increases in rod internal pressures, crud deposition has a similar effect since crud is a poor conductor of heat. Keeping crud deposition to a minimum also reduces the impact on rod internal pressures.

The visual examination will provide an additional check to assure that the fuel is operating as expected. It will verify that no pre-spallation or blistering is present and that the crud deposition is as expected for the burnup level.

Post-irradiation examinations (PIEs) are the key inspections/examinations that provide data to substantiate fuel performance behavior. These inspections/examinations are typically performed off the critical path of an outage, allowing extensive measurements to be taken. Most PIEs are pool-side inspections. Hot cell examinations will occasionally be done when deemed appropriate by the vendor or utility. PIEs will provide the majority of data points for the fuel characteristics that must be demonstrated to ultimately achieve higher burnup licensing limits. As with the pre-characterization examinations, the NRC staff determined that a minimum set of tests should be performed for an assembly to be considered part of the limited scope LTA program. After discussion, the applicant agreed to the same minimum set of tests as for pre-characterization. However, since PIEs need to be carefully planned and scheduled with the respective plants, and since the plant supplies personnel in an auxiliary role, it is desirable to obtain all the necessary data in one PIE rather than several separate PIEs. Therefore, even though a minimum set of PIEs is defined and agreed on, numerous other inspections and measurements will most likely be done during one PIE, since repeated PIEs are costly, inefficient and may not keep dose as-low-as-reasonably achievable (ALARA).

The NRC staff finds the proposed set of tests acceptable because these tests will provide data on the parameters most likely to be affected by higher burnup. Comparisons of the pre- and post-characterization data will provide a measure of the effect of the incremental burnup from below the current licensed burnup limit to the burnup of the particular fuel rod. In particular, the cladding oxidation provides a check of the corrosion model used in the fuel performance codes and provides a check of the metal wastage and wall thinning effects.

#### 4.0 CONDITIONS

1. If the COLR analytical methods listed in the licensee's Technical Specifications were approved up to a specified burnup limit, a license amendment is required to add this topical report to that list in order for licensees to be able to use this topical report.
2. The number of fuel assemblies with fuel rods exceeding the current lead rod average burnup shall be limited to a total of nine in PWRs and thirty-two in BWRs. No fuel rods shall exceed peak rod burnups greater than 75 GWD/MTU.
3. The fuel shall be typical production fuel and be pre-characterized before operation above the current lead rod average burnup limit. The fuel may also be an LTA that was characterized during fabrication and was designed to test aspects of the fuel assembly but was not initially identified as a high burnup LTA. The latter fuel shall be pre-characterized before operation above the current lead rod average burnup limit. The fuel clad material is an NRC-approved clad material.
4. The pre-characterization of the fuel shall consist of at least the following examinations: clad oxidation, rod/assembly growth, and visual examinations for PWRs, and clad oxidation, rod/assembly growth, channel bow, and visual examinations for BWRs.
5. The post-irradiation examinations of the fuel shall consist of at least the following examinations: clad oxidation, rod/assembly growth, and visual examinations for PWRs, and clad oxidation, rod/assembly growth, channel bow, and visual examinations for BWR's burn-up limits. Current or modified fuel performance methods and codes shall be used.
6. The fuel shall be evaluated against and must meet all current design criteria even though the current analytical methodologies may not be approved for use at the higher burnups.
7. For all fuel rods in the LTAs, the predicted oxidation shall be less than 100 microns on a best-estimate basis with prediction of no blistering or spallation based on current data.
8. A licensee using the limited scope high burnup LTA program shall submit two reports to the NRC for information.

The first report shall be a notification of intent to irradiate LTAs above the current maximum burnup limit. It shall contain at least the following information:

- Licensee name
- Plant name
- Cycle and date when the LTA shall be inserted
- Number of LTAs
- Location of the LTAs
- Anticipated pre-and post-cycle burnups for each LTA
- Purpose of LTAs

- Estimated dates for pre-and post-irradiation characterizations or the results of the pre-characterization and an estimation of the date for the post-irradiation characterization
- Estimated date of second report
- Statement that the LTAs will not be irradiated if Conditions 5 and 6 are not met or if the pre-characterization examinations show anomalous results

The second report shall give the results of the pre-and post-irradiation examinations. It shall consist of at least the following information:

- Licensee name
- Plant name
- Assembly identification number
- Specific measurements - actual data and predictions
- Comment section

## 5.0 REFERENCES

1. Letter from Robert H. Bryan, Chairman, Westinghouse Owners Group, to NRC Document Control Desk, dated November 29, 2001.
2. Letter from David J. Modeen, Nuclear Energy Institute, to Gary M. Holahan, Director, Division of Systems Safety and Analysis, NRC, dated November 21, 2000.
3. Memorandum to Commissioners from L. Joseph Callan, "Agency Program Plan for High-Burnup Fuel," dated July 6, 1998.
4. Letter from Robert H. Bryan, Chairman, Westinghouse Owners Group, to NRC Document Control Desk, dated February 1, 2002.

Principal Contributors: Margaret S. Chatterton  
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Date: January 8, 2003