

Revisions to guidance on breakaway oxidation periodic testing

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Background



- The proposed rulemaking for 10 CFR 50.46c included mandatory cycle-specific testing and reporting requirements for a cladding alloy's breakaway oxidation behavior.
- DG-1261 included guidance on conducting tests to identify the onset of breakaway oxidation and DG-1263 included guidance related to periodic confirmation of breakaway oxidation times.
- The NRC received a number of comments on the proposed rule on the subject of periodic testing and reporting for breakaway oxidation. Comments received from EPRI and fuel vendors recommended removing the periodic testing and reporting requirements in favor of vendor test programs for breakaway oxidation.
- The NRC is considering **replacing** the mandatory cycle-specific testing and reporting requirements in the proposed rule with requirements and guidance on **approved vendor breakaway oxidation test programs**.

Objective of Today's Discussion



- Provide an outline of possible additions to DG-1263 to address vendor test programs and determination of an appropriate test frequency for breakaway oxidation periodic testing
- Seek clarification on the proposed vendor test programs for breakaway oxidation before considering specific revisions to DG-1263.



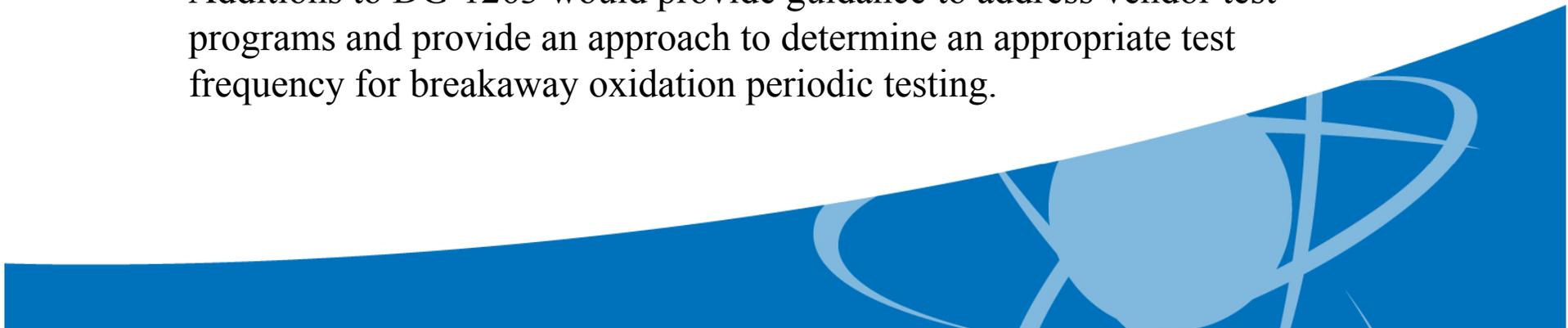
Proposal

- Mandatory cycle-specific testing and reporting requirements would not be included in the final rule.
- The rule would specify:

“An analytical limit corresponding to the measured onset of breakaway oxidation must be determined and specified for each zirconium-alloy cladding material loaded into a reactor. The onset of breakaway oxidation must be measured and periodically confirmed using an NRC-approved experimental technique capable of determining the effect of composition changes or manufacturing changes on the onset of breakaway oxidation. The frequency of confirmatory testing must be sufficient to ensure that there is reasonable assurance that fuel is being manufactured consistent with the specified analytical limit.”

Proposal *continued*

- The objective of periodic testing would be to confirm that the breakaway oxidation results provided when a cladding alloy is first reviewed and approved remain valid over the production life-cycle of that alloy.
- Vendors would submit breakaway oxidation test programs to the NRC for review and approval.
- The key subject for review and approval of a vendor test program would be the demonstration that the frequency of confirmatory testing is sufficient “*to ensure that there is reasonable assurance that fuel is being manufactured consistent with the specified analytical limit.*”
- Additions to DG-1263 would provide guidance to address vendor test programs and provide an approach to determine an appropriate test frequency for breakaway oxidation periodic testing.



Proposal *continued*



- With this approach, there are three aspects to compliance:
 1. Vendors revise existing, approved fuel design requirements topical report (TR) to include an explicit, alloy-specific minimum time to breakaway oxidation (analytical limit for 50.46c(g)(1)(iii)).
 2. This TR would refer to an approved breakaway test program including frequency of confirmatory testing.
 3. Licensees would reference, either directly or indirectly (e.g., GESTAR), fuel design requirements in Technical Specifications COLR approved methodologies.



Proposal *continued*

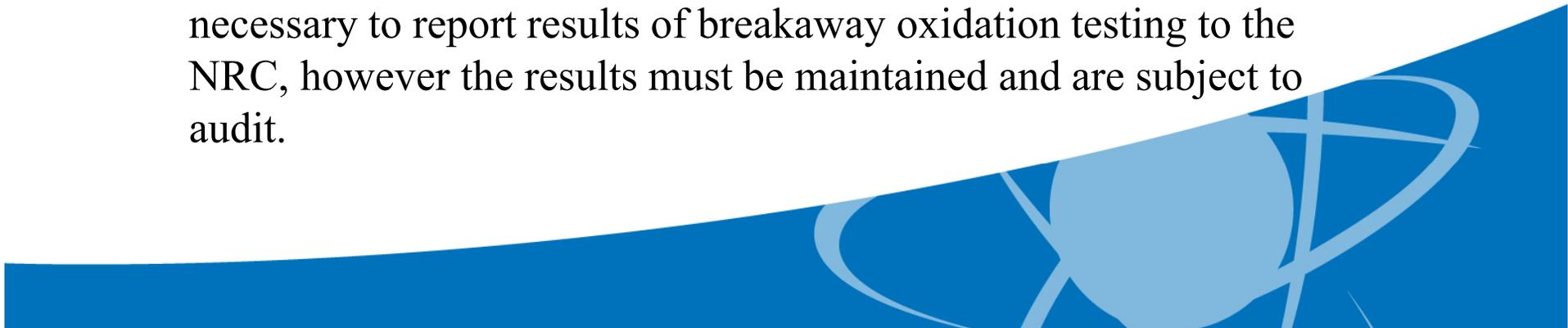


- Vendors should put minimum time to breakaway in source material vendor specifications (similar to YS) and/or manufacturing Quality Control procedures. However, the licensing hook relies on approved TR specified within TS.
- Future changes to frequency of confirmatory testing would necessitate a revision to fuel design requirements TR. Its allowed outside of 50.46c, but requires NRC review.
- Table 1 of DG-1261 would be removed.



General Approach

- Provide specific default periodicity recommendation in guidance.
- Provide guidance that it is acceptable to build in a “learning” feature to the test program.
 - In other words, the guidance will state that it is reasonable for vendor test programs to evolve and relax over time according to pre-established, test-results-driven parameters.
- Provide guidance regarding the explicit incorporation of breakaway oxidation testing and measurement into tech. specs and or 10 CFR Appendix B quality assurance programs.
- Provide guidance regarding reporting to specify that it is not necessary to report results of breakaway oxidation testing to the NRC, however the results must be maintained and are subject to audit.



Possible Approach

Default Periodicity Recommendation Mirror ASTM standards

- ASTM Standard B811 – 13 provides, “Standard Specification for Wrought Zirconium Alloy Seamless Tubes for Nuclear Reactor Fuel Cladding”
- Section 10 on sampling states, “For certification purposes, a minimum of *two random sample tubes shall be taken from each lot* for laboratory tests.
- **Lot size** is defined as follows, “a lot shall consist of all tubes of the same size, shape, condition, and finish produced from the same ingot by the same reduction schedule and heat treatment. The final heat treatment shall be in a single furnace charge.”
- **Mill finish** tubes are defined as follows, “tubes that have received all finishing operations subsequent to final anneal, which potentially affects tube mechanical, dimensional, or surface condition. These operations include, but are not limited to, pickling, cleaning, outer and inner surface abrasive conditioning, and straightening.

Possible Approach

Default Periodicity Recommendation Mirror ASTM standards

Corrosion Properties: (8.2 in B811 – 13)

A corrosion test in steam shall be performed in accordance with Test Method G2/G2M. The specimens tested shall be representative of the mill finish condition unless otherwise stated by the purchaser.

Acceptance Criteria:

Mass Gain—Specimens shall exhibit a mass gain of not more than 2.2 g/m² in a 72-h test or 3.8 g/m² in a 336-h test.

Post-Test Visual Appearance—Mill finish specimens shall be free of white or brown corrosion products in excess of the acceptance standards mutually agreed between the manufacturer and the purchaser. Specimens etched per Test Method G2/G2M (if stated by the purchaser) shall exhibit a continuous black lustrous oxide film and shall be free of white or brown corrosion products in excess of standards.

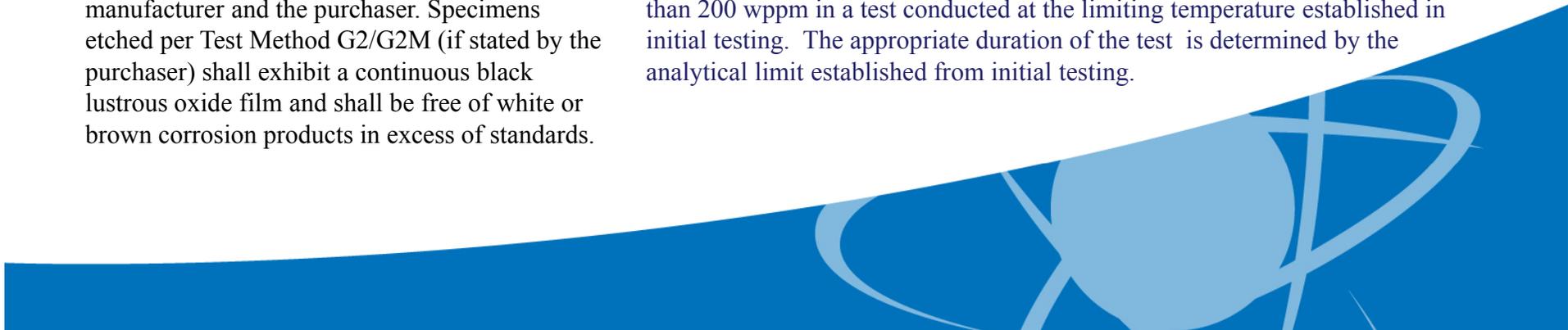
Breakaway Oxidation Properties:

A breakaway oxidation test in steam shall be performed in accordance with DG-1261. The appropriate test temperature and duration is determined by the analytical limit established from initial testing. The specimens tested shall be representative of the mill finish condition unless otherwise stated by the purchaser.

Acceptance Criteria:

Post-Test Visual Appearance—Mill finish specimens shall exhibit a continuous black lustrous oxide film and shall be free of white or brown corrosion products in excess of the acceptance standards mutually agreed between the manufacturer and the purchaser. Alternatively, the hydrogen content of specimens that do not exhibit a continuous black oxide film may be measured for demonstration that breakaway oxidation did not occur, see below.

Hydrogen pick up—Specimens shall exhibit a hydrogen pickup of not more than 200 wppm in a test conducted at the limiting temperature established in initial testing. The appropriate duration of the test is determined by the analytical limit established from initial testing.



Possible Approach

Default Periodicity Recommendation Mirror

ASTM standards



Resampling (See section 11 in B811 – 13)

1. If any specimen exhibits obvious surface contamination or improper preparation disqualifying it as a truly representative specimen, it shall be discarded and replaced by a new specimen.
- 2 If the results of the tube inspection of a lot are not in conformance with the requirements of this specification, the lot may be reworked at the option of the manufacturer, provided the rework steps are within the previously approved process.
 - 2.1 The reworked tubes shall be inspected for conformance to this specification.
 - 2.2 Reworked lot shall be resampled for tests affected by the rework in accordance with Section 10.
- 3 If any sample fails to conform to the specification requirement, the test for the nonconforming attribute shall be performed on specimens taken from twice as many random sample tubes as originally used.
 - 3.1 All test results, including the original test results, shall be reported to the purchaser.
 - 3.2 Only one set of resampling is permitted, and all results of resampling shall conform to the specification requirements for the characteristic tested.

Other Revisions Being Considered



- Revise DG-1263 to state that periodic testing may be performed for the period of time defined by the analytical limit and that it is not necessary to continue testing for longer time periods and until breakaway oxidation is observed for periodic demonstration.
- Revise DG-1263 to specify that a total of 3 repeat tests, which are conducted at the temperature and for the period of time defined by the analytical limit, that do not show breakaway oxidation occurs is adequate for periodic testing.



Conclusion

- The NRC received a number of comments on the proposed rule on the subject of periodic testing and reporting for breakaway oxidation. Comments received from EPRI and fuel vendors recommended removing the periodic testing and reporting requirements in favor of vendor test programs for breakaway oxidation, however few details were provided to discern the content of the vendor test.
- The NRC is considering revising DG-1263 to add guidance for the development of acceptable vendor test programs, particularly guidance related to the determination of an appropriate test frequency. The NRC would like to seek clarification on the proposed vendor test programs for breakaway oxidation before considering specific revisions to DG-1263.

