



**UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001**

June 22, 2011

Mr. R. W. Borchardt
Executive Director for Operations
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: DRAFT REGULATORY GUIDES DG-1261, DG-1262, AND DG-1263

Dear Mr. Borchardt:

During the 584th meeting of the Advisory Committee on Reactor Safeguards, June 8-10, 2011, we were provided with an overview of the 10 CFR 50.46c rulemaking activities and reviewed draft regulatory guides supporting the proposed rule. These Guides were: DG-1261, "Conducting Periodic Testing for Breakaway Oxidation Behavior;" DG-1262, "Testing for Postquench Ductility;" and DG-1263, "Establishing Analytical Limits for Zirconium-Based Alloy Cladding." Our Materials, Metallurgy, and Reactor Fuels Subcommittee also reviewed these draft Guides during a meeting on May 10, 2011. During these reviews, we had the benefit of discussions with representatives of the NRC staff and Electric Power Research Institute (EPRI) and had the benefit of the documents referenced.

RECOMMENDATIONS

1. Draft Guides (DGs) DG-1261, DG-1262, and DG-1263 should be issued for public comment.
2. Although additional issues have arisen since the initiation of 10 CFR 50.46c rulemaking, publication of the proposed rule should not be delayed.
3. The staff should make arrangements for Argonne National Laboratory (ANL) to participate in the round-robin test program to demonstrate the reliability of the DG-1262 test procedures.

BACKGROUND

In our report of May 23, 2007, we summarized the current understanding of the various phenomena governing the embrittlement of fuel cladding during loss-of-coolant accidents (LOCAs). In addition, we stated that acceptable methodologies to analyze fuel and cladding behavior during a LOCA should be described in Regulatory Guides specific to zirconium-alloy-clad oxide fuels.

We stated in our December 18, 2008, report that there are sufficient data and understanding of the cladding embrittlement phenomena to justify and proceed with rulemaking. Further, we stated that the rule should include an optional testing program to allow licensees to demonstrate

compliance with post-quench-ductility (PQD) criteria on an alloy-specific and temperature-specific basis. We also stated that a round-robin test program would be beneficial in the validation of the test procedures used to demonstrate compliance with PQD and breakaway-oxidation criteria. These recommendations have been adopted by the staff.

Since that time, the staff has issued an Advance Notice of Proposed Rulemaking and has received and addressed public comments. The staff has also expanded the PQD and breakaway oxidation empirical databases, developed three draft regulatory guides, and moved specific acceptance criteria from the proposed rule to the DGs. New items are being considered for introduction into the rulemaking process. These include an expanded technical basis for treatment of the fuel rod burst region and an evaluation of fuel fragmentation and dispersion. The performance-based nature of the proposed rule may accommodate perturbations caused by these additional phenomena. We are concerned that inclusion of additional scope at this time will further delay issuance and publication of the proposed rule. This should be avoided.

DISCUSSION

The primary objective of proposed rule 10 CFR 50.46c is to ensure core coolability during and following a design basis LOCA by assuring adequate fuel cladding ductility and fracture resistance. NRC research has shown that the severity of cladding embrittlement during a LOCA is dependent on the time-temperature transient experienced during the event and the concentration of hydrogen in the cladding. During large break LOCAs, the peak cladding temperatures are high and the embrittlement is rapid. During small break LOCAs, the peak cladding temperatures are lower and durations are longer, but embrittlement can still occur due to the phenomenon known as breakaway oxidation.

DG-1263 addresses the requirements in proposed rule 10 CFR 50.46c that specified acceptable analytical limits on peak cladding temperature and time at elevated temperature be established corresponding to the measured ductile-to-brittle transition for zirconium alloy fuel cladding. An acceptable experimental method to determine the ductile-to-brittle transition is provided in DG-1262. Such measurements must be reliable and not subject to significant lab-to-lab variability. For this reason, EPRI is leading an industry round-robin program to demonstrate repeatability and consistency of the test results obtained using the procedures established by ANL and described in DG-1262. However, this program is not fully responsive to our December 18, 2008, recommendation because ANL did not test the identical cladding being tested by the industry labs and is not participating in the round-robin. Although prior testing by ANL indicates that lot-to-lot cladding variability does not significantly affect measured ductility, it is important that this be demonstrated unequivocally. The staff should make arrangements for ANL to participate in the industry round-robin test program.

Time and temperature limits for the onset of breakaway oxidation are measured using the experimental techniques described in DG-1261. The analysis methods described in DG-1263 determine the total accumulated time that the cladding is predicted to remain above a given temperature during a LOCA. This must be less than the time determined for the onset of breakaway oxidation. The breakaway oxidation phenomenon can be influenced by variations in cladding surface roughness or contamination. Consequently, DG-1261 also defines acceptable methods for periodic testing and reporting consistent with the proposed requirements in 10 CFR 50.46c.

DG-1261, DG-1262, and DG-1263 provide appropriate guidance to ensure adequate cladding ductility following a LOCA and should be issued for public comment. We look forward to reviewing the draft final guides after the staff has reviewed and addressed public comments.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

References:

1. Draft Regulatory Guide DG-1261, "Conducting Periodic Testing for Breakaway Oxidation Behavior," DG-1262, "Testing for Postquench Ductility," and DG-1263 "Establishing Analytical Limits for Zirconium-Based Alloy Cladding," 04/20/2011 (ML111100271)
2. Memorandum to Edwin M. Hackett, "Transmittal of Draft 10 CFR 50.46c Proposed Rule Language," 04/06/11 (ML110970042), "Draft Rule Language for 10 CFR 50.46c," 04/06/2011 (ML110970044)
3. Letter to Dale E. Klein, "Proposed Technical Basis for the Revision to 10 CFR 50.46 LOCA Embrittlement Criteria for Fuel Cladding Materials," 05/23/2007 (ML071430639)
4. Letter to Dale E. Klein, "Technical Basis and Rulemaking Strategy for the Revision of 10 CFR 50.46(b) Loss-of-Coolant Accident Embrittlement Criteria for Fuel Cladding Materials," 12/18/2008 (ML083460310)

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Letter to Mr. R. W. Borchardt, EDO, NRC, from Said Abdel-Khalik, Chairman, ACRS, dated June 22, 2011

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