

U.S. Nuclear Regulatory Commission Public Meeting Summary

April 29-30, 2015

Title: Public Meeting on Comments Received on Three Draft Regulatory Guides Associated with the Performance-Based Emergency Core Cooling Systems Cladding Acceptance Criteria (Title 10 of The *Code of Federal Regulations* Section 50.46c) Proposed Rule

Meeting Identifier: 20150441

Date of Meeting: April 29-30, 2015

Location: Oak Ridge National Laboratory in Oak Ridge, TN

Type of Meeting: Category 3

Purpose of the Meeting(s): The purpose of the public meeting was to seek clarification on NRC-selected topics related to the public comments received on the draft regulatory guides associated with the Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.46c proposed rule. The three draft regulatory guides (DG) were DG-1261, "Conducting Periodic Testing for Breakaway Oxidation Behavior" (NRC's Agencywide Documents Access and Management System (ADAMS) Accession No. ML12284A324), DG-1262, "Testing for Post Quench Ductility" (ADAMS Accession No. ML12284A325), and DG-1263, "Establishing Analytical Limits for Zirconium-Based Alloy Cladding" (ADAMS Accession No. ML12284A323).

The discussions served to enhance the NRC staff and stakeholders' understanding of the comments received on these DGs. There was also an opportunity for meeting participants to view the equipment and facilities at Oak Ridge National Laboratory (ORNL) used in recent NRC sponsored post-quench ductility testing. The meeting notice can be found at ADAMS Accession No. ML15079A288.

General Details: Day 1 of the meeting was attended by 39 individuals including industry representatives and NRC staff, 15 of whom participated through audio teleconferencing and webinar. Day 2 of the meeting was attended by 38 individuals, 15 of whom participated through audio teleconferencing and webinar.

Summary of Presentations: The meeting slides and handouts are available in the ADAMS packages under Accession No. ML15107A348 and ML15124A942.

A table below provides the title, speaker and organization for each presentation made during the public meeting. The table includes the ADAMS Accession number for each presentation.

Title	Speaker, Organization	ML
1. Evaluating Ring Compression Test Results for Developing Analytical Limits	Michelle Bales, NRC/RES	ML15107A406
2. Recent PQD Results of Zircaloy-4	Yong Yan, ORNL	ML15107A387

	under LOCA Conditions		
3.	Ductility Determination Using Ring-Compression Tests	Mike Billone, Argonne National Laboratory	ML15111A204
4.	LOCA Round Robin and Related Research	Ken Yueh, Electric Power Research Institute	ML15124A840
5.	Draft Reg Guides and determining acceptable LOCA performance	Dave Mitchell, Westinghouse	ML15124A830
6.	GNF/GEH Perspective on DG-1261, 1262, and 1263	Kurshad Muftuoglu, General Electric Hitachi	ML15124A808
7.	Applicability of Figure 2 in DG-1263	Michelle Bales, NRC/RES	ML15107A352
8.	Summary of the technical basis for the definition of a new alloy	Ken Yueh, Electric Power Research Institute	ML15124A837
9.	Revisions to guidance on breakaway oxidation periodic testing	Michelle Bales, NRC/RES	ML15107A404
10.	Implementation of Periodic Breakaway Oxidation Testing	Andrew Atwood, Westinghouse	ML15124A826
11.	AREVA Breakaway Oxidation Testing Perspectives	Lisa Gerken, AREVA	ML15124A798
12.	50.46c Implementation: Cladding Hydrogen Uptake Models	Paul Clifford, NRC/NRR	ML15107A358
13.	AREVA Hydrogen Model Perspectives	Lisa Gerken, AREVA	ML15124A799
14.	Future Direction and Recap	Michelle Bales, NRC/RES	ML15124A803

A list of acronyms used in presentations or discussions can be found in ADAMS under Accession No. ML15124A818.

Public Participation Themes:

The summary below will include dominant points from the presentations and discussions at the public meeting. The last presentation of the meeting, “Future Direction and Recap” also captures dominant points from the meeting and provides initial thoughts on the path forward stemming from the meeting discussion.

The majority of the first day of the public meeting focused on the subject of how to interpret ring compression test (RCT) data to develop an analytical limit. The NRC received a number of comments on the guidance provided to interpret RCT data. The comments revealed that the guidance could benefit from additional discussion of expected data scatter, additional discussion of averaging measured strain values and additional discussion of determining the ductile-to-brittle transition.

In the morning of the first day, Michelle Bales presented (ADAMS Accession No. ML15107A406) a summary of the comments and some revisions that the NRC staff is considering to address the comments and provide additional discussion of key topics. Following Mrs. Bales's presentation, Yong Yan and Mike Billone presented their recent efforts on conducting RCTs as well as the evaluation of that data for post-quench ductility (PQD) determination.

Dr. Yan's presentation (ADAMS Accession No. ML15107A387) included discussion of "tight" vs. "loose" cracks in RCTs and how that dictates the possibility of measuring permanent strain vs. offset strain. Dr. Yan's presentation also included details of how he completed system calibration and benchmarking for his resistance furnace set up. This was a subject of interest to many participants because although the draft guidance mentioned multiple approaches to complete system calibration and benchmarking, limited details were provided for how to do this for a resistance furnace. Two corrections in the slide deck were noted during discussion of Dr. Yan's presentation. It was noted that axis labels on slide 25 were reversed and that the fourth column on slide 32 is "actual" not "target" Cathcart-Pawel equivalent cladding reacted (CP-ECR).

Dr. Billone's presentation (ADAMS Accession No. ML15111A204) included detailed discussion of the offset-strain-based ductility criterion. This was a subject of interest to many participants because most researchers rely on the offset strain values to determine the ductile-to-brittle transition (rather than the permeant strain values, which require the RCT to be terminated after the first significant load drop such that only a single "tight" crack forms). Following the presentation, participants asked whether the offset strain criterion provided in the draft guidance was machine specific. In other words, was the empirical correlation only appropriate when used in conjunction with the two Instron devices used for testing at Argonne National Lab, or was the correlation applicable to any setup? The question prompted a lot of discussion, but no resolution was reached during the meeting.

Ken Yueh of EPRI presented (ADAMS Accession No. ML15124A840) results of a seven lab round robin test program focused on oxidation and RCTs on pre-hydrided cladding, along with some of the lessons learned from lab-to-lab comparisons.

In the afternoon of the first day, one industry presentation continued along the same topic of how to interpret RCT data for analytical limits. Dave Mitchell from Westinghouse presented (ADAMS Accession No. ML15124A830) the results of testing at Westinghouse's labs. Mr. Mitchell made the case that even when an experimenter stays within the parameters outlined in the draft guides, different experimental setups will result in slightly different results. His presentation included data indicating that their test setup resulted in scatter in the data near the ductile-to-brittle transition that would not be easily interpreted following the draft guidance. He argued that the guidance and acceptance criterion should be supplemented to address expected data scatter.

The last presentation of the first day by Kurshad Muftuoglu from General Electric Hitachi (ADAMS Accession No. ML15124A808) included a few points related to the guidance for developing analytical limits from RCT data, but primarily focused on breakaway oxidation testing guidance. The points related to breakaway oxidation testing will be summarized below.

In the morning of the second day, Mrs. Bales presented (ADAMS Accession No. ML15107A352) a summary of the comments and some revisions that the NRC staff is considering to address the comments and provide additional discussion of key topics related to the applicability of Figure 2 in DG-1262. The NRC received a number of comments on the applicability of Figure 2, a plot of the CP-ECR ductile-to-brittle transition level as a function of cladding hydrogen content applicable to alloys tested in NRC's LOCA research program. The majority of the comments generally made the case that new cladding alloys similar to those used to develop the empirical correlation defined in Figure 2 should be allowed to use the limit defined in Figure 2 with limited or no alloy-specific testing. Mrs. Bales outlined revisions that the NRC staff is considering that would reduce the extent of testing, and importantly eliminate irradiated material testing, for new cladding alloys, provided they meet a number of defined characteristics. Mrs. Bales highlighted the need to develop a technical basis for the definition of "similar" alloy and the related fuel rod characteristics. A presentation made by Ken Yueh of EPRI (ML15124A837) offered a proposal for appropriate characteristics.

The discussion following Mrs. Bales's presentation indicated that the revisions would address a number of the comments on the draft guide, however some felt the revisions still did not go far enough to accommodate testing and licensing challenges. The concerns seemed to be related to specific cladding concepts and the NRC staff responded by expressing the need to provide regulatory guidance for an acceptable method of meeting the new performance-based rule language that addresses the needs of the unknown future. Others expressed concerns that even the reduced requirements for irradiated testing would pose challenges for the development of future cladding alloys. Namely, obtaining irradiated material for the tests needed to license a new alloy results in very long lead times for cladding development. Various meeting participants emphasized the potential benefit of outlining parallel activities or phased approaches to licensing new alloys when irradiated cladding testing is required.

Also in the morning of the second day, Mrs. Bales presented (ADAMS Accession No. ML15107A352) a summary of the comments, and some revisions that the NRC is considering to address these comments, received on the guidance for breakaway oxidation testing and analytical limit development. The discussion following Mrs. Bales's presentation indicated that the revisions would address a number of the comments on the draft guide; however there were a few residual concerns expressed. For one, the details of compliance for breakaway oxidation requirements outlined on slides 6-7 prompted a number of questions, indicating additional explanation of this topic in the regulatory guides is warranted. In addition, the appropriate test frequency and sample population were the subject of extensive debate. Representatives of the fuel cladding vendors expressed concern that setting the sample population for periodic testing to be a cladding production lot could mean that vendors have to conduct thousands of breakaway oxidation tests each year. The NRC staff expressed agreement with this concern and stated that they would like to identify a sample population or test frequency that did not result in the need for testing thousands of tests for breakaway oxidation. Vendor representatives provided rough estimates of the number of tests that would be associated with sample populations of reload batches and ingot batches. The NRC staff stated that they would consider these estimates when developing the final regulatory guidance for periodic testing for breakaway oxidation.

Andrew Atwood of Westinghouse (ADAMS Accession No. ML15124A826) and Lisa Gerken of AREVA (ML15124A798) made presentations expressing their organizations' perspectives on

the guidance for breakaway oxidation testing and analytical limit development. To some extent, the points raised in these two presentations were addressed in Mrs. Bales earlier presentation.

In the afternoon of the second day, Paul Clifford of the NRC staff presented optional, default hydrogen uptake models that the NRC staff is considering for incorporation into DG-1263. Hydrogen update models for Zircaloy-2, Zircaloy-4, ZIRLO™, Optimized ZIRLO™ and M5® were presented. Ms. Gerken of AREVA presented (ADAMS Accession No. ML15124A799) her organization's perspective on the proposed default hydrogen pickup models. Her presentation, as well as the general discussion, suggested that the default models are useful for near term implementation but that ultimately each vendor will likely pursue their own models to reduce the level of conservatism.

At the end of the meeting, Mrs. Bales provided a summary of the revisions being considered by the NRC staff and the key related discussion points that emerged in the meeting. The meeting participants noted a few additional points that needed to be added to the slides to capture the discussion and Mrs. Bales edited the presentation to reflect these points. The final version of the presentation (ADAMS Accession No. ML15124A803) reflects these additional points, and serves to outline the staff's initial thoughts on the path forward stemming from the meeting discussion.

Action Items/Next Steps:

- Complete revisions to three draft regulatory guides considering the public comments and public meeting discussions

Attachments:

- Meeting Attendee List

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**Accession Nos.: Pkg: ML15107A348 and ML15124A942; Notice ML15079A288; Summary ML15132A743
NRC-001**

OFFICE	RES/DSA/FSCB	DPR/PRMB/PM	DPR/PRMB/RS	DPR/PRMB/BC	DPR/PRMB/PM
NAME	MBales	ABone	GLappert	TInverso	ABone
DATE	5/14/2015	5/18/2015	5/19/2015	5/19/2015	5/19/2015

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List of Public Meeting Attendees

April 29, 2015

Name	Organization
Bruce Bevard	Oak Ridge National Laboratory
Robert Florian	Southern Nuclear Op. Co.
Lisa Gerken	AREVA
Alan Meginnis	AREVA
Kevin McCoy	AREVA
Jy-An Wang	Oak Ridge National Laboratory
Michael Iannantuono	GE Hitachi
Paul Clifford	NRC/NRR
Jeremy Dean	NRC/NRR
Yong Yan	Oak Ridge National Laboratory
Mike Billone	Argonne National Laboratory
Dan Lutz	GNF
Kurshad Muftuoglu	GE Hitachi
Miguel Armenta	Energy Northwest
Gordon Cleifton	NEI
Tom Eichenberg	T.V.A.
Thomas Rodack	Westinghouse
Ken Hewlett	Westinghouse
Andrew Mueller	Westinghouse
Andrew Atwood	Westinghouse
David Mitchell	Westinghouse
Ken Yueh	EPRI
Shanlai Lu	NRC/NRO
Alysia Bone	NRC/NRR
Michelle Bales	NRC/RES
John Alvis	Anatech
Ioan Arimescu	AREVA
Ly Celine	AREVA France
Kurt Flaig	Dominion
Ace Hoffman	Animated Software
Mitch Nissley	Westinghouse
Mathew Panicker	NRC/NRR
Joe Rashid	Anatech
Jim Smith	Westinghouse
Heinz Sonnenburg	GRS Germany
Alfred Strasser	ANT International
Harold Scott	NRC/RES
Ashley Guzzetta	NRC/NRR
Yang-Pi Lin	GNF
Marv Lewis	Public

List of Public Meeting Attendees

April 30, 2015

Name	Organization
Jy-An Wang	Oak Ridge National Laboratory
Thomas Rodack	Westinghouse
Robert Florian	Southern Nuclear Op. Co.
Alan Meginnis	AREVA
David Mitchell	Westinghouse
Lisa Gerken	AREVA
Miguel Armenta	Energy Northwest
Bruce Bevard	Oak Ridge National Laboratory
Michael Iannantuono	GE Hitachi
Tom Eichenberg	T.V.A.
Mike Billone	Argonne National Laboratory
Kurshad Muftuoglu	GE Hitachi
Dan Lutz	GNF
Yong Yan	Oak Ridge National Laboratory
Gordon Cleifton	NEI
Alysia Bone	NRC/NRR
Paul Clifford	NRC/NRR
Kevin McCoy	AREVA
Ken Yueh	EPRI
Andrew Mueller	Westinghouse
Ken Hewlett	Westinghouse
Andrew Atwood	Westinghouse
Jeremy Dean	NRC/NRR
Shanlai Lu	NRC/NRO
Michelle Bales	NRC/RES
John Alvis	Anatech
Ioan Arimescu	AREVA
Ly Celine	AREVA France
Kurt Flaig	Dominion
Ace Hoffman	Animated Software
Mitch Nissley	Westinghouse
Mathew Panicker	NRC/NRR
Joe Rashid	Anatech
Jim Smith	Westinghouse
Heinz Sonnenburg	GRS Germany
Alfred Strasser	ANT International
Harold Scott	NRC/RES
Ashley Guzzetta	NRC/NRR
Yang-Pi Lin	GNF
Marv Lewis	Public