

April 27, 2001

MEMORANDUM TO: William D. Beckner, Acting Chief  
Generic Issues, Environmental, Financial  
and Rulemaking Branch  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

FROM: Peter C. Wen, Project Manager/**RA**  
Generic Issues, Environmental, Financial  
and Rulemaking Branch  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF APRIL 12, 2001, MEETING WITH THE NUCLEAR  
ENERGY INSTITUTE AND THE EPRI MATERIALS RELIABILITY  
PROGRAM REGARDING CONTROL ROD DRIVE MECHANISM  
NOZZLE CRACKING ISSUES

On April 12, 2001, members of the NRC staff and representatives from the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI) Materials Reliability Program (MRP), various licensees, and members of the public participated in a public meeting held at the Nuclear Regulatory Commission (NRC) offices in Rockville, Maryland. The purpose of the meeting was to discuss the generic implications of the recent detection of circumferential cracks in the pressurized water reactor (PWR) control rod drive mechanism (CRDM) nozzle reactor pressure vessel (RPV) upper head penetrations and weldments at Oconee Unit 3. Attachment 1 lists attendees at the meeting. To facilitate discussion a letter was sent to NEI prior to the meeting. The letter, dated April 5, 2001, (ADAMS Accession No. ML010950534), was from Dr. Brian Sheron, Associate Director, Office of Nuclear Reactor Regulation (NRR), to Mr. Alex Marion, Director, Engineering, NEI, and contained a list of discussion topics.

Following opening remarks by Dr. Brian Sheron, Mr. Mike Tuckman (MRP/Duke Energy Corporation), and Mr. Alex Marion, Mr. Larry Mathews, Chairman of MRP's Alloy 600 Issue Task Group (ITG), gave the overview of the MRP's presentation and the background of the subject issue. Mr. Mathews indicated that MRP is performing a survey among its members regarding the inspection frequency and the extent of the reactor vessel head visual inspection. The preliminary survey results presented during this meeting indicated that not all PWR licensees have inspected all CRDM nozzle penetrations. Mr. Mathews also indicated that the effects of the recent crack findings in the CRDM nozzle penetrations will be incorporated into a final safety assessment with the V. C. Summer Alloy 600 hot leg cracking assessment. Mr. Mathews' presentation materials are in Attachment 2.

Mr. Mike Robinson of Duke Energy Corporation (licensee for the Oconee Units) discussed the operational experience of Oconee Units 1 and 3 in finding RPV head penetrations cracking. His discussion included background information, investigations performed, summary of indications and characterizations, repair plans, and nuclear safety significance. His presentation materials are in Attachment 3. The major points are as follows:

- The licensee identified small amounts of boron accumulation at the base of several CRDM nozzles at Oconee Unit 3 during a recent planned maintenance outage. A similar problem was found at Unit 1 last year.
- The licensee performed extensive surface dye-penetrant test (PT), eddy current (EC) and ultrasonic test (UT) examinations on those CRDMs suspected of leaking. The inspection results indicated that in addition to axial cracks, there were two circumferential cracks above the weld at Nozzles 50 and 56.
- The root cause of identified cracks is primary water stress corrosion cracking (PWSCC).
- The licensee is working with NEI, EPRI, and industry groups on inspection and repair techniques. The identified leaking CRDM nozzles were all repaired.
- The licensee's safety assessment indicated that the CRDM nozzles would leak well before the cracks reached the point of complete nozzle failure.

Mr. Stephen Fyfitch of Framatome ANP discussed the integrity assessment for RPV head penetration nozzles at Babcock & Wilcox (B&W) design plants. He discussed B&W plant RPV CRDM nozzle design, issue background, summary of recent cracking incidents at Oconee Units 1 and 3 and Arkansas Nuclear One Unit 1, evaluations of cracking, assessment of operating plants, and a review of the existing plant loss of coolant accident (LOCA) and non-LOCA safety analyses. His major conclusion was that, although cracks could develop in CRDM nozzles, the leakage resulting from these cracks would be detected well before catastrophic nozzle failure. He reached this conclusion by referencing a previous Framatome safety assessment report which indicated that it would take at least six years for an ID-initiated surface flaw to grow through-wall and extend to two inches above the weld and a recent safety assessment which indicates that it would take more than three years for a flaw that had initiated at the CRDM Nozzle OD surface (above the weld) to grow through-wall. He also stated that, based on available crack growth rate data, the crack growth through the J-groove weld would be rapid. He stated that utilities with B&W-designed plants comply with 10 CFR 50.55a, "Codes and Standards," and continue to meet the intent of GDC-14, GDC-30, and GDC-31. His presentation materials are in Attachment 4.

Finally, Mr. Larry Mathews, Chairman of the MRP's Alloy 600 ITG, provided an overview of MRP activities and proposed schedule, and summarized the MRP's presentation. He discussed inspection planning, NDE issues, inspection guidance for plants with near-term outages and future plans. He indicated that the MRP plans to submit its preliminary safety assessment of the generic implications of the cracking issue for staff review by April 27, 2001. (Subsequent to the meeting, it was clarified that the safety assessment for the CRDM nozzle circumferential cracking would be issued by May 11, 2001.)

The staff provided the following comments on the MRP's presentation:

- The staff is concerned about the circumferential cracks identified at CRDM nozzles at Oconee Unit 3. Circumferential cracking poses a more serious safety concern than axial or radial cracking because if it goes undetected, it can lead to a structural failure of a component rather than to a limited leak. Evidence from the Oconee event suggests that leakage from CRDM penetration cracks was of such minimal magnitude that normal surveillance tests, such as daily water inventory testing and the containment radiation alarms could not detect such leakage.
- While B&W vessel head penetrations can be readily inspected visually, this is not the case for some Westinghouse and Combustion Engineering plants. These plants have insulation installed on the top of the reactor vessel head, thereby rendering visual inspection of the top of the head difficult without removing insulation. The staff is concerned that these vessel head penetrations may not be adequately inspected and leakage may not be detected.
- The staff is concerned about the postulated crack growth rate (CGR) for an exceptionally aggressive operating environment. The staff is particularly concerned about the postulated CGR in the CRDM housing annulus, where potentially highly concentrated borated primary water could become oxygenated.
- The staff said that they would like to visit the EPRI Nondestructive Evaluation (NDE) Center to observe the NDE demonstration test when industry reaches the point where they are qualifying NDE inspection procedures for examining the Alloy 82/182 J-groove weld that connects the CRDM nozzle to the reactor head and any other NDE procedures related to inspection of the CRDM housings in this area of interest.

In response to a senior MRP representative's question on whether the MRP had addressed all of the items listed in the April 5, 2001, NRC letter to NEI, the staff indicated that the MRP had provided sufficient information in the meeting. The staff noted its appreciation of MRP's prompt response in supporting this meeting.

Attachments: As stated  
cc w/atts: See next page

The staff provided the following comments on the MRP's presentation:

- The staff is concerned about the circumferential cracks identified at CRDM nozzles at Oconee Unit 3. Circumferential cracking poses a more serious safety concern than axial or radial cracking because if it goes undetected, it can lead to a structural failure of a component rather than to a limited leak. Evidence from the Oconee event suggests that leakage from CRDM penetration cracks was of such minimal magnitude that normal surveillance tests, such as daily water inventory testing and the containment radiation alarms could not detect such leakage.
- While B&W vessel head penetrations can be readily inspected visually, this is not the case for some Westinghouse and Combustion Engineering plants. These plants have insulation installed on the top of the reactor vessel head, thereby rendering visual inspection of the top of the head difficult without removing insulation. The staff is concerned that these vessel head penetrations may not be adequately inspected and leakage may not be detected.
- The staff is concerned about the postulated crack growth rate (CGR) for an exceptionally aggressive operating environment. The staff is particularly concerned about the postulated CGR in the CRDM housing annulus, where potentially highly concentrated borated primary water could become oxygenated.
- The staff said that they would like to visit the EPRI Nondestructive Evaluation (NDE) Center to observe the NDE demonstration test when industry reaches the point where they are qualifying NDE inspection procedures for examining the Alloy 82/182 J-groove weld that connects the CRDM nozzle to the reactor head and any other NDE procedures related to inspection of the CRDM housings in this area of interest.

In response to a senior MRP representative's question on whether the MRP had addressed all of the items listed in the April 5, 2001, NRC letter to NEI, the staff indicated that the MRP had provided sufficient information in the meeting. The staff noted its appreciation of MRP's prompt response in supporting this meeting.

Attachments: As stated  
cc w/atts: See next page

**Package Accession#ML011200336**  
**Memo Accession#ML011200303**  
**Attachments# ML011100449**  
**Template NRC-001**

cc w/atts: See next page  
DISTRIBUTION: See attached page  
Document Name: g:\rgeb\pcw\msum0412.wpd

OFFICE	PM:RGEB	BC:EMCB	SC:RGEB
NAME	PWen	WBateman	SWest
DATE	04/25/2001	04/25/2001	04/27/2001

OFFICIAL OFFICE COPY

cc: Mr. Ralph Beedle  
Senior Vice President  
and Chief Nuclear Officer  
Nuclear Energy Institute  
Suite 400  
1776 I Street, NW  
Washington, DC 20006-3708

Ms. Lynnette Hendricks, Director  
Plant Support  
Nuclear Energy Institute  
Suite 400  
1776 I Street, NW  
Washington, DC 20006-3708

Mr. Alex Marion, Director  
Licensing & Programs  
Nuclear Energy Institute  
Suite 400  
1776 I Street, NW  
Washington, DC 20006-3708

Mr. Charles B. Brinkman, Director  
Washington Operations  
ABB-Combustion Engineering, Inc.  
12300 Twinbrook Parkway, Suite 330  
Rockville, Maryland 20852

Mr. David Modeen, Director  
Engineering  
Nuclear Energy Institute  
Suite 400  
1776 I Street, NW  
Washington, DC 20006-3708

Mr. H. A. Sepp, Manager  
Regulatory and Licensing Engineering  
Westinghouse Electric Company  
P.O. Box 355  
Pittsburgh, Pennsylvania 15230-0355

Mr. Anthony Pietrangelo, Director  
Risk & Performance Based Regulation  
Nuclear Energy Institute  
Suite 400  
1776 I Street, NW  
Washington, DC 20006-3708

Mr. Jim Davis, Director  
Operations  
Nuclear Energy Institute  
Suite 400  
1776 I Street, NW  
Washington, DC 20006-3708

Dr. Theodore U. Marston  
Vice President and Chief Nuclear Officer  
Electric Power Research Institute  
3412 Hillsview Avenue  
Palo Alto, CA 94304

Mr. Gary L. Vine  
Senior Washington Representative  
Electric Power Research Institute  
2000 L Street, N.W., Suite 805  
Washington, DC 20036

Mr. James F. Lang  
Director  
Electric Power Research Institute  
1300 W.T. Harris Boulevard  
Charlotte, NC 28262

DISTRIBUTION: Mtg. Summary w/NEI &MRP Re CRDM Nozzle Crack Issues Dated

Hard Copy

ADAMS-PUBLIC

RGEB r/f

OGC

ACRS

PWen

EMail

SCollins/JJohnson

BSheron

W Borchardt

D Matthews/ FGillespie

W.Beckner

SWest

JStrosnider/TCollins

WBateman

KWichman

GCarpenter

Simon Sheng

J Shea, OEDO

S Rosenberg, OEDO

M Markley, ACRS

OPA

William Koo

Barry Elliot

Allen Hiser

Bart Fu

Jim Davis

James Medoff

Herb Berkow

Rich Emch

David LaBarge

Ujagar Bhachu

Ramn Subbaratnam

Ramin Assa

J. Chung

Ian Jung

Scott Morris

Michael Mayfield

Debbie Jackson

Ross Telson

Tom Koshy

**NRC-NEI/MRP Meeting on CRDM Nozzle Crack Issues**  
**LIST OF ATTENDEES**  
**April 12, 2001**

<u>NAME</u>	<u>ORGANIZATION</u>
Brian Sheron	NRR
Bill Bateman	NRR/DE/EMCB
Keith Wichman	NRR/DE/EMCB
Gene Carpenter	NRR/DE/EMCB
Simon Sheng	NRR/DE/EMCB
William Koo	NRR/DE/EMCB
Barry Elliot	NRR/DE/EMCB
Allen Hiser	NRR/DE/EMCB
Bart Fu	NRR/DE/EMCB
Jim Davis	NRR/DE/EMCB
James Medoff	NRR/DE/EMCB
Herb Berkow	NRR/DLPM/PD-2
Rich Emch	NRR/DLPM/PD-2
David LaBarge	NRR/DLPM/PD-2
Ujagar Bhachu	NRR/DLPM/PD-2
Ramn Subbaratnam	NRR/DLPM/PD-2
Ramin Assa	NRR/DLPM/PD-2
J. Chung	NRR/DSSA/SPSB
Ian Jung	NRR/DSSA/SPSB
Scott Morris	NRC/OEDO
Michael Mayfield	RES/DET
Debbie Jackson	RES/DET/MEB
Tom Koshy	NRR/DRIP/REXB
Ross Telson	NRR/DRIP/REXB
Peter Wen	NRR/DRIP/RGEB
Mike Tuckman	Duke Energy
Mike Robinson	Duke Energy
Tom Alley	Duke Energy
David Whitaker	Duke Energy
Larry Mathews	SNC
Alex Marion	NEI
Kurt Cozens	NEI
Ray Ganthner	Framatome ANP
John Langdon	Framatome ANP
Al McKim	Framatome ANP
Stephen Fyfitch	Framatome ANP
Gary Mignogna	Framatome ANP
Bill Gray	Framatome ANP
Warren Bamford	Westinghouse
John Hall	Westinghouse
Charles Holmes	Westinghouse
Allan McIlree	EPRI
Vaughn Wagoner	CP&L
Dick Labott	PSE&G

Steve Hunt  
Mark Fleming  
Glenn White  
Jim Bennetch  
Gary Moffatt  
Robert Lemberger  
Greg Gerzen  
Mike Krupa  
Priit Okas  
John Hamilton  
Martin Murphy  
J. C. Poehler  
Al Butcavage  
Prasoon Goyal  
Guy Campbell  
Michael Short  
Eric Schoonover  
Gary Moffatt  
Emmett Camp  
Bruce Newton  
Steve Mondrowski  
T. S. Sharma  
Jim Albert  
Bob Hermann  
Roger Huston  
Altheia Wyche

Dominion Engineering  
Dominion Engineering  
Dominion Engineering  
Dominion Generation  
VC Summer  
Progress Energy-Crystal River 3  
Exelon  
Entergy  
Entergy  
Entergy  
Calvert Cliffs  
Constellation Nuclear Service  
Rochester Gas and Electric- Ginna  
First Energy  
First Energy  
SCE  
SCE  
SCE  
TVA  
Welding Services Inc.  
Welding Services Inc.  
AEP  
B&W-Canada  
Structural Integrity  
Licensing Support Services  
Bechtel/SERCH Licensing