April 27, 2001

MEMORANDUM TO: William D. Beckner, Acting Chief
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Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

FROM: Peter C. Wen, Project Manager**/RA/**
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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
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