

April 09, 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 MARCH 23, 2001, MEETING WITH THE NUCLEAR  
ENERGY INSTITUTE AND THE ELECTRIC POWER RESEARCH  
INSTITUTE REGARDING ALLOY 82/182 WELD CRACKING ISSUES

On March 23, 2001, members of the NRC staff and representatives from the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI) Materials Reliability Project (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 for the MRP to brief the staff regarding the status and the preliminary results of its technical work in progress on the recently identified Alloy 82/182 weld cracking issues. Attachment 1 lists attendees at the meeting.

Following opening remarks by Mr. Jack Strosnider, Director, Division of Engineering in the Office of Nuclear Reactor Regulation, 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. Since the V.C. Summer event, the staff has held two public meetings with the MRP (January 25 and February 16, 2001) at NRC Headquarters to discuss this issue and industry planned activities. Those meeting summaries are available under ADAMS Accession Numbers ML010330076 and ML010650435, respectively. Mr. Mathews' presentation materials are in Attachment 2.

Mr. Warren Bamford of Westinghouse discussed the interim safety assessment results of the Alloy 82/182 weld cracking issue pertaining to Westinghouse design plants. His discussion included Alloy 82/182 weld locations in Westinghouse plants, fracture evaluation, leak-before-break (LBB) and risk evaluations. His presentation materials are in Attachment 3. The major points are as follows:

- In all Westinghouse investigated cases, cracking was attributed to primary water stress corrosion cracking (PWSCC). The crack was initiated by PWSCC from high residual stresses and propagated due to hot cracking and residual stresses

in the weld. All significant flaws found thus far are axial, including six at V.C. Summer, four at Ringhals-4 and two at Ringhals-3.

- The operational hoop stresses significantly exceed axial stresses.
- Westinghouse performed fracture evaluations based on various plant designs, weld geometries and loading conditions. The results from these evaluations indicated that the critical flaw sizes are very large. The calculated critical axial through-wall length ranges from 25 to 38 inches, critical circumferential through-wall length ranges from 24.3 to 43 inches, and continuous circumferential flaw depth ratio ranges from 0.52 to 0.71. These values indicate that there is a considerable margin before pipe failure compared with the crack size found at V.C. Summer.
- The results from the LBB evaluation indicate that, regardless of flaw orientation, a one gallon per minute (gpm) leak rate is generally reached for a 2- to 3-inch long flaw. Because these values are much smaller than the calculated critical flaw size, the LBB assumption is still valid.
- Westinghouse estimated the conditional core damage probability due to Alloy 82/182 PWSCC to be 0.01 to 0.02. They believe that the increase in core damage frequency (CDF) ( $\leq 10^{-6}$  /year) is insignificant. However, because of uncertainties associated with incomplete understanding of PWSCC and variations in material, environment and loading conditions, they believe that further evaluation may be needed.

Mr. David Ayres of Westinghouse discussed the interim safety assessment results of Alloy 82/182 weld cracking issue pertaining to Combustion Engineering (CE) design plants. He stated that CE (now part of Westinghouse) analysis results were based on a bounding analysis approach to cover all CE plants. He indicated that the CE analysis results are similar to the Westinghouse analysis results, in that, there exists significant margin between one gpm leakage and critical crack size. His presentation materials are in Attachment 4.

Mr. Stephen Fyfitch of Framatome ANP presented the interim safety assessment results of Alloy 82/182 weld cracking issue pertaining to Babcock & Wilcox (B&W) design plants. He discussed B&W plant reactor vessel nozzle design, the materials used in the reactor vessel nozzle and Alloy 82/182 weld locations. His major conclusion is that through-wall leakage of primary coolant at the reactor vessel nozzle-to-pipe weld locations, resulting from PWSCC, will not occur at B&W design plants. He indicated that additional evaluations are underway to assess the safety significance of all Alloy 82/182 weld locations at the B&W design plants. His presentation materials are in Attachment 5.

Mr. Vaughn Wagoner of Carolina Power & Light (CP&L) presented interim assessment results from the MRP Alloy 600 ITG Assessment Committee's activities. While the assessment findings for pipe welds have been discussed above, his discussion was focused mainly on the assessment of reactor vessel head penetrations. He indicated that the reassessment found that the safety evaluation remains valid for the conclusion performed previously and the utilities still comply with 10 CFR 50.55a and meet the intent of GDC 14, "Reactor Coolant Pressure Boundary." His presentation materials are in Attachment 6.

Mr. Tom Alley of Duke Energy discussed various inspection topics, including short term inspection guidance provided by the MRP 82/182 weld integrity inspection committee, inservice inspection (ISI) vendor capability demonstrations to support Spring 2001 10-year Reactor Pressure Vessel (RPV) ISI program, and procedure enhancements. He informed the staff that a letter, dated March 1, 2001, from Jack Baily, Chairman of MRP Senior Representatives, to MRP senior representatives, was issued to provide inspection guidance for units with Spring 2001 outages. This letter is attached as Attachment 9. The letter provided additional guidance for those units with 10-year RPV ISI also fall in Spring 2001. He indicated that the demonstration results from the participating ISI vendors performed well and the procedure enhancements made as a result of demonstrations is in progress. Mr. Alley's presentation materials are in Attachment 7.

Finally, Mr. Larry Mathews, Chairman of the MRP's Alloy 600 ITG, provided an overview of MRP activities and schedule, and summarized MRP's presentation. He stated that the MRP believes that cracking of pipe and control rod drive mechanism (CRDM) welds are not a near term safety issue. He indicated that the MRP plans to submit its preliminary assessment report for staff review in April 2001. Mr. Mathews' presentation materials are in Attachment 8.

After a short caucus, the staff provided the following comments on the MRP's presentation:

- The staff requested the MRP to provide additional information in the proposed safety assessment regarding evaluations of the ratio between hoop and axial stresses in the welds and the potential for long part-depth circumferential cracks, such as the type seen at Duane Arnold, including residual stresses due to welding.
- The staff requested the industry to address the differences in the as-described leak-rate calculations, including uncertainties, in the proposed safety assessment, especially as it deals with LBB considerations.
- The staff requested additional clarifications regarding the scope of inspections that are planned for the present outage season. Specifically, the staff requested that the MRP discuss what, if any, Alloy 82/182 welds, other than reactor vessel nozzle welds, will be inspected, and if any of these welds to be inspected will include field-fabricated welds.
- The staff requested that the industry promulgate additional guidance to licensees stressing the importance for plant inspectors to look carefully during the boric acid walkdowns.
- The staff questioned whether interim and final written submittals from the MRP are still planned to be provided to the staff in April and June, 2001 time frames, and will they be proprietary.
- The staff inquired as to industry support for the MRP efforts on this issues; specifically, has funding for the industry assessment and response efforts been approved? An MRP representative replied that the funding is currently being reviewed by the MRP Senior Representatives Committee.

The staff noted its appreciation of the opportunity to continue the dialog on these issues, and suggested another technical meeting to be held when the MRP's short term safety assessment on the Alloy 82/182 weld cracking issue is ready to be issued.

Attachments: As stated  
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**NRC-NEI/EPRI Meeting on RCS Hot Leg Weld Crack Issues**  
**LIST OF ATTENDEES**  
**March 23, 2001**

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Jack Strosnider	NRR/DE
Bill Bateman	NRR/DE/EMCB
Keith Wichman	NRR/DE/EMCB
Gene Carpenter	NRR/DE/EMCB
Simon Sheng	NRR/DE/EMCB
Matthew Mitchell	NRR/DE/EMCB
Andrea Keim	NRR/DE/EMCB
Michael McNeil	RES/DET/MEB
Peter Wen	NRR/DRIP/RGEB
Larry Mathews	SNC
Alex Marion	NEI
Kurt Cozens	NEI
Mike Schoppman	NEI
Warren Bamford	Westinghouse
David Ayres	Westinghouse
Dulal Bhowmick	Westinghouse
Charles Holmes	Westinghouse
Karl Haslinger	Westinghouse
Bruce Bishop	Westinghouse
Stephen Fyfitch	Framatome ANP
Tom Alley	Duke Energy
Avtar Singh	EPRI
Allan McIlree	EPRI
Chuck Welty	EPRI
Frank Ammirato	EPRI
Jeff Landrum	EPRI
Vaughn Wagoner	CP&L
Dick Labott	PSE&G
Steve Hunt	Dominion Engineering
Mark Fleming	Dominion Engineering
Leslie Spain	Dominion Generation
Gary Moffatt	VC Summer
Scott Boggs	Florida P&L Co.
Roger Huston	Licensing Support Services
Deann Raleigh	US Scientech
Charlene Burnett	Structural Integrity
Lorraine Pimentd	Kansai Electric Power