March 22, 2001

MEMORANDUM TO: Terence Chan, Acting Chief
Materials Inspection Section
Materials and Chemical Engineering Branch
Division of Engineering

FROM: Donald G. Naujock, Metallurgist ***/ra/***
Materials Inspection Section
Materials and Chemical Engineering Branch
Division of Engineering

SUBJECT: SUMMARY OF PUBLIC MEETING HELD JANUARY 31 - FEBRUARY 2, 2001, WITH PDI REPRESENTATIVES

From January 31 through February 2, 2001, the staff participated in a public meeting with representatives from the Electric Power Research Institute (EPRI) - Performance Demonstration Initiative (PDI) program at the EPRI NDE Center, Charlotte, North Carolina. The purpose of the meeting was to discuss PDI's approach for implementing Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," Section XI of the American Society of Mechanical Engineers, Boiler and Pressure Vessel Code (Code); Supplements 2, "Qualification Requirements for Wrought Austenitic Piping Welds;" Supplement 10, "Qualification Requirements for Dissimilar Metal Piping Welds;" and Supplement 11, "Qualification Requirements for Full Structural Overlaid Wrought Austenitic Piping Welds." Other subjects discussed at the meeting were: corrosion resistant cladding, an alternative flaw production process, and the detection of a small flaw in thick material. The NRC participants are E. Sullivan, T. Chan, D. Naujock, M. Modes, and S. Doctor (under contract with the NRC). The EPRI and industry participants are listed in Attachment 1.

A PDI representative began the meeting with an overview of the agenda that was followed by topical presentations. The presentations outlined PDI's approach for implementing selected supplements to Appendix VIII with associated modifications required by 10 CFR 50.55a(g)(6)(ii)(C) and 50.55a(b)(2)(xv) and (xvi). The meeting agenda is Attachment 2. Handouts provided by PDI for selected items in the agenda are provided in Attachments 3 through 11.

During the meeting, several issues were brought up concerning problems that the EPRI NDE Center was facing. They raised a point about H.B. Robinson regarding a Supplement 4 exam that is to be conducted this spring. The plant is a BWR with a reactor vessel closure head thicker than the current PDI qualified generic manual examination procedure. The problem is that small flaws can be detected with good signal-to-noise ratio (SNR) in blocks 6.8" thick and 11" thick, but one of the small flaws in a block that is 7.89" thick can not be detected with an adequate SNR of 2:1. EPRI is trying to understand the cause. Currently, PDI is unable to develop a qualification process that will meet H.B. Robinson's need for its spring outage.

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Supplement 11 - Weld Overlays

The original Tri-party agreement between EPRI, Boiling Water Reactor Owner's Group (BWROG), and NRC dated July 3, 1984 has been replaced with Appendix VIII, Supplement 11. Attachment 3, "PDI Overlay Development Program," described the PDI Overlay Development Program for addressing Supplement 11. The PDI program expands the test specimen population from 12" nominal diameter pipe specimens to pipe specimens ranging from 4" to 28" diameter and overlay thicknesses ranging from 0.2" to 0.85".

One issue that was raised concerned the use of the Tri-party agreement specimens. These specimens do not meet the requirements of Supplement 11. Specifically, the flaws are located too close to one another which is in conflict with Supplement 11. The EPRI NDE Center staff proposed a code change addressing flaw location. Attachment 4, "Proposed Code Case change to ASME Section XI, Appendix VIII, Supplement 11," is currently being processed through ASME Code committees. The proposed code case contained a requirement that the width of a notch tip not exceed 0.006" diameter. The staff questioned the ability for a notch with a 0.006" diameter to represent a crack tip. The question was based on the results from the "Programme for the Inspection of Steel Components Phase 2 (PISC-II)" which showed that a notch with a radius less than 0.0012" was necessary to simulate a crack. From preliminary data shown by EPRI staff, the hot isostatic pressing (HIP) process applied to electrical discharge machined (EDM) notches produce very tight notches that appear to meet a 0.0012" requirement. The NRC concluded that (1) more samples were needed to demonstrate that there is adequate control for producing acceptable flaw tips, (2) further work on notch branching should be done to ensure that flaws replicate real intergranular stress corrosion cracking (IGSCC), and (3) proposals should be formulated to include other alternates to HIP EDM notches in the event that the HIP process cannot be adequately control.

Documentation of the EPRI notch tip radius data is being reviewed by PDI in order to determine if a tip radius of 0.0012" is easily achievable for the HIP process. EPRI will bring this data to the ASME Code meeting in San Francisco, CA. If the 0.0012" tip radius is achievable, the 0.006" value in the proposed code case will be changed to a smaller tip radius.

The NRC requested PDI to perform a comparison between the number of flaws in test sets under the Tri-party agreement and the number of flaws in test sets for Supplement 11 performance demonstrations. EPRI NDE Center staff provided a table for comparison of the tests. Based on the table, the NRC concluded that the comparison provided assurance that the Tri-party agreement performance demonstration was being represented in the PDI program for Appendix VIII, Supplement 11. The NRC staff suggested that a letter may be necessary to dissolve the overlay portion of the Tri-party agreement. The NRC will review previous letters to determine if this letter is needed[1].

[1]The review did not locate a letter from the NRC that recognized the transfer of the weld overlay performance demonstration criteria recommended by Generic Letter 88-01 to the PDI program. The NRC will write a letter to this effect.

Corrosion Resistant Cladding (CRC) for Piping

CRC is a stainless steel weld applied on the inside machined surface of stainless steel piping to mitigate IGSCC in Boiling Water Reactors (BWRs). These cladded pipes are usually butt welded to uncladded, ICSCC resistant, stainless steel pipes. However, other configurations such as joining two CRC pipes or a joint with a large crown on the outside surface may also be in use. CRC welds are in limited use. They were not included in the PDI program for Appendix VIII, Supplement 2 performance demonstrations. From discussions on examinations of CRC, it was determined that Appendix VIII supplements do not specifically address CRC for piping. However, when welded joints are used to connect CRC pipe sections, the weld is subject to the inspection criteria of IWB-2500-1, Examination Category B-J (B-J), "Pressure Retaining Weld." The NRC staff expressed concerns on the ability to inspect the welded B-J joint.

The users of CRC welds have organized a users group to resolve examination concerns associated with CRC welds. The CRC users group is pulling together a matrix of designs and information on what mock-ups exist for CRC. From the data being gathered the CRC users group will develop a recommendation for conducting CRC examinations. One solution under consideration is an Appendix VIII, Supplement 2, IGSCC qualification coupled with a guideline that would contain the essential elements necessary for an effective examination of CRC. The thinking was that licensee examiners would use mock-ups to demonstrate procedure, equipment, and personnel performance. The guideline would include both programmatic and technical guidance.

There was discussion on the merits of examinations of CRC based on risk-informed data. It was agreed that if the probability of core damage from pipe failure is low, then the use of the guideline document would be acceptable. On the other hand, if the probability of core damage from pipe failure is high, then CRC must be addressed at a higher level, i.e. through an Appendix VIII supplement. It is not clear at this time as to where these requirements would go. Examination of these welds have similarities with IGSCC Supplement 2 demonstration and Supplement 11 weld overlay. The examination of CRC is an open item for future meetings between the NRC and industry, and industry needs to provide data that supports whatever position they propose.

Dissimilar Metal Welds (DMWs)

PDI surveyed the industry for field data on dissimilar metal flaws for the purpose of simulating these flaw characteristics in test specimens. Attachment 5, “BWR Dissimilar Metal Welds Failure Data Review” describes the flaws and UT data. PDI described the complexities of these flaws in Attachment 6, “Dissimilar Metal Weld Program Development.” PDI’s approach is to identify the essential variable covering the greatest number of nozzles in order to create a generic procedure.

The EPRI-PDI staff is procuring 19 samples ranging from 4" to 28" diameter with wall thicknesses from 0.5" to 2.25". These samples are being studied to develop a data base to provide insights to the essential DMW variables and inspection techniques for detecting and sizing flaws. For examinations performed from the outside diameter, PDI determined that the majority of DMWs were accessible for UT examinations from only one side. The accessibility

limited scanning to one axial direction and two circumferential directions. PDI determined that flaws on the far side of the weld that are less than 20% through-wall are difficult to detect.

In order to simulate field examinations from the outside diameter, PDI proposed that performance demonstration be administered from one side of the weld. A one sided examination would be considered a best effort because of the difficulties with flaw detection from the far side of the weld. If access is available, field examinations would be conducted from both sides of the weld and receive the appropriate coverage credit. Otherwise, the examinations would be conducted from the accessible side with coverage for only the side examined.

However, if new conditions are uncovered during an inspection that lie outside the range of the variables qualified in the procedure or the examiner's qualification, a performance demonstration would be necessary. A similar situation would be site-specific DMW configurations. Discussion centered on using a mock-up containing the condition or configuration for expanding qualifications. PDI will develop a proposal that defines what a licensee must do when confronted with a configuration outside the qualifications of DMW procedures or personnel.

The NRC staff expressed concern that single sided examinations could not detect the unacceptable (reportable) flaw size according to IWB-3500 for flaws located on the far side of the weld (weld side opposite of the scanning transducer). The NRC staff asked that PDI explain how licensees will resolve the limited ability of UT to detect flaws on the far side of the weld. PDI will investigate this concern.

Currently, PDI's plan is to cover pipe diameters from 4" to 36"; but there also appears to be some 2" diameter piping which have DMWs, and PDI is trying to decide if it should expand coverage to this smaller size.

DMW Examinations from the Inside Diameter

Examination from the inside surface of the pipe was overlooked when Appendix VIII, Supplement 10 was developed. There are some benefits for conducting inspections from the inside surface of piping: (1) most degradation initiates from the inside, (2) the inspection is easier to perform and more reliable, and (3) the flaws are closer to the transducer which means less energy (sound wave) distortion from material characteristics. However, the inside surface conditions can interfere with the sound wave because of surface roughness, weld repairs, location and dimension of the counterbore, and weld root protrusion.

The PDI is gathering information on the weld configurations, weld repairs, fabrication designs, and surface conditions in order to simulate them in performance demonstrations conducted from the inside surface. Preliminary data is compiled and summarized in Attachment 7, "Meeting Notes from the PDI Informational Meeting on Inside Surface Examination" and Attachment 8, "Supplement 2, 3, and 10 Qualifications from the Inside Surface." Industry proposed that for all diameters that are greater than 24", only one diameter needs to be part of the performance demonstration. The basis for this is that from the inside surface, the larger diameters will appear flat to a small transducer (about 1.5" square). An applicant may be qualified for 24" diameter and greater by qualifying on a 24" diameter test set. The minimum

diameter size is not determined at this point. Core flood systems, which are common to Babcock and Wilcox plants, are around 12" nominal pipe diameter, and safety injection nozzles, which are common to Westinghouse 2 loop plants, may be down to 4" nominal pipe diameter. Further testing is needed in order to determine if small diameter pipes can be effectively inspected from the inside surface.

PDI concluded that there is no difference between the acoustic response of stainless steel and inconel buttering, and proposed that all DMW test specimens be built with inconel welds because inconel has a tendency to form larger grains than stainless steel. The NRC staff asked PDI if there was information to support their conclusion. PDI stated that they would develop a paper for this comparison.

When possible, most vendors are using the UT method for examinations conducted from the inside surface of piping. However, in the recent leaking flaw at VC Summer, multiple examinations methods were necessary to find the flaws that were detected. The methods were UT and eddy current (ET). What VC Summer showed is that DMWs may need a combination of examination methods to ensure weld integrity. Thus, any specimens that are fabricated must consider examinations using multiple nondestructive examination methods.

PDI presented a draft version of a proposed code case for revising Supplement 10 to include performance demonstrations from the inside surface of piping, Attachment 8, “Code Case to Section XI, Division 1, Appendix VIII, Supplement 10, to Include I.D. Examinations and Allow Use of Alternative Flaw Mechanisms.” The draft needs more work before it is put forward to the Code committees. PDI will rework the draft proposed code case for discussion at a future meeting.

General Remarks

On Friday February 2, there were several presentations made on technology that is being developed at the EPRI NDE Center. One of these is a virtual UT training system. This is being developed as one approach to assist in providing annual training to UT examiners. The software program simulates an examination where the computer mouse acts as the transducer and, as it is moved, the UT signals are updated and displayed on the computer screen. One advantage of this kind of technology is that the recorded signal data from a real flaw can be made available for training other examiners. EPRI plans on pursuing a code case to get this technology accepted as a viable training method.

The second item that was covered was the use of phased array technology. The NDE Center is pursuing this technology because it offers some significant advantages for selected applications. Phased array technology may also improve scanning around weld restrictions. EPRI is also pursuing the use of phased array technology for performance demonstration of Appendix VIII supplements in order to reduce the failure rates for personnel qualifications. The effectiveness of phase array technology has potential that is being investigated by EPRI, see Attachment 11 (untitled).

In discussions on the proposed Supplement 2 code case, the NRC staff identified a need to include a minimum number of IGSCC flaws for depth sizing qualification requirements, Attachment 10, Proposed Code Case Change to ASME Section XI, Appendix VIII, Supplement

2." PDI has been using a minimum of four IGSCC flaws in the detection test sets. However, for the proposed code case, those present agreed that the minimum number of IGSCC flaws for depth sizing qualification should be three. The minimum number of IGSCC flaws for depth sizing was included as a resolution to comment for a letter ballot submission to the ASME Main Committee at San Francisco, CA.

FUTURE NRC /PDI INTERACTIONS

A PDI representative initiated a discussion on their desire for NRC to periodically assess the development of the performance demonstration program for piping examined from the inside surface, weld overlays, and dissimilar metal welds. PDI believes that these items will be sufficiently developed for staff review in early 2001. The NRC staff expressed a willingness to conduct an assessment of these items at mutually agreeable times. It was agreed that the next meeting would be tentatively scheduled for the week of June 12th through June 14th at the EPRI-NDE Center.

Attachments: As stated:

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PUBLIC MEETING WITH EPRI-PDI, JANUARY 31, 2001 AND FEBRUARY 1, 2001*

NAME	TITLE	ORGANIZATION
Donald Naujock	Metallurgist	NRC
Michael Modes	Senior Inspector	NRC
Steve Doctor	Senior Staff Engineer	PNNL
Carl Latiolais	Project Manager	EPRI
Mike Gothard	RPV Project Manager	EPRI
Randy Linden	PDI Vice Chairman	PPC
Mike Bratton	PDI Chairman	NDE/Entergy

* Plus random visitors.

CONTINUATION OF PUBLIC MEETING WITH EPRI-PDI, FEBRUARY 2, 2001

NAME	TITLE	ORGANIZATION
Donald Naujock	Metallurgist	NRC
Michael Modes	Senior Inspector	NRC
Steve Doctor	Senior Staff Engineer	PNNL
Fred Bulgin	PDI Str. Com.	Duke Power Co.
James Mc Ardle	NDE Level III	Duke Power Co.
Doug MacDonald	Principal Engineer	EPRI
Mike Gothard	RPV Project Manager	EPRI
Jack Spanner	Project Manager	EPRI
Greg Selby	Project Manager	EPRI
Edmund Sullivan	Section Chief	NRC
Terence Chan	Mechanical Engineer	NRC

Attachment 1

NRC Information Exchange Meeting
1/31/01 –2/2/01
EPRI NDE Center
Charlotte, NC

Wednesday 1/31/01

8:30-9:00 Chairman's Introduction (Mike Bratton)

8:45-9:00 Review of NRC Activities (Staff)

9:00-11:00 Program Description Document (Mike Gothard)

11:00 11:15 Break

11:15 11:45 Facility Tour (Carl Latiolais)

11:45 Lunch

1:00-2:00 Review of PDI Overlay Program (Carl Latiolais)

2:00-3:00 Update of ongoing Overlay Fabrication Activities (Carl Latiolais/R. Smilie)

3:00-3:15 Break

3:15-5:00 Review of Alternative Flaw Making Processes (Carl Latiolais)

Thursday 2/1/01

8:30-9:15 Overview of PDI Dissimilar Metal Weld Program (Carl Latiolais)

9:15-9:30 Break

9:30-11:30 Review of Sample Selection (Outside Surface Examinations) (Carl Latiolais/ Mark Dennis)

- Review of Plant Failures
- Comparison to Samples Selected in EPRI R&D Project

11:30-1:00 Lunch

Attachment 2

1:00-3:00 Review of Collected Data and Procedure Development Activities (Carl Latiolais)

3:00-3:15 Break

3:15-5:00 Review Inside Surface Examination Work (Carl Latiolais)

- Development Work
- Sample Selection

Friday 2/2/01

8:30-9:30 Review of Phased Array Development Work on DM Welds (Greg Selby)

9:30-12:00 Open Discussion and Review of Action Items