

August 26, 2008

MEMORANDUM TO: Terence L. Chan, Chief  
Piping and NDE Branch  
Division of Component Integrity  
Office of Nuclear Reactor Regulation

FROM: Donald G. Naujock, Materials Engineer */RA/*  
Piping and NDE Branch  
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Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MEETING HELD MAY 12 THROUGH 14, 2008 WITH  
THE ELECTRIC POWER RESEARCH INSTITUTE PERFORMANCE  
DEMONSTRATION INITIATIVE REPRESENTATIVES  
(TAC NO.: MD8475)

On May 12 through 14, 2008, the staff participated in a public meeting with representatives from the Electric Power Research Institute (EPRI) - Performance Demonstration Initiative (PDI) program at the EPRI Non-Destructive Examination Center, 1300 W. T. Harris Boulevard, Charlotte, NC. EPRI provides PDI's business operations and technical support. PDI is a nuclear power industry initiative established to develop and administer the qualification requirements of Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," to Section XI of the American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code (Code) and to develop and administer the demonstrations and qualifications of ultrasonic testing (UT) examinations of butt welds that are associated with other EPRI programs.

The purpose of the meeting was to discuss PDI's approach for implementing selected aspects of Appendix VIII and associated items. The subjects discussed were the status of reactor pressure vessel (RPV) and piping performance demonstrations, the retrieval of performance demonstration data from databases, the proposed ASME Code actions affecting ultrasonic examinations, and the inspectibility of cast austenitic piping, dissimilar metal welds, weld overlays/inlays/onlays, and far-side austenitic welds. These meetings are a continuation of formal dialog between the Nuclear Regulatory Commission (NRC) and the industry on PDI's implementation of Appendix VIII and other nondestructive testing issues of mutual interest. The dialog provides opportunities to discuss testing difficulties, review PDI's program methodology for the selected supplements, and address issues regarding the ASME Code. The meeting participants and agenda are listed in Enclosures 1 and 2 respectively. Handouts and presentations provided at the meeting are included as Enclosures 3 through 20.

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## OPEN ITEMS FROM THE DECEMBER 4 AND 5, 2007

PDI presented the status of open items from the December 4 and 5, 2007 meeting in Enclosure 3, "Open Items." Most of the open items are covered in detail in the following presentations. An open item on providing a white paper to the NRC on changing/eliminating the re-qualification requirement for weld overlays did not occur. No further action is contemplated on weld overlay re-qualification requirements. An open item on providing a list of the 11 specific projects under the Materials Research Project (MRP) did not occur. The Pacific Northwest National Laboratory (PNNL) representative is communicating with the MRP representative on the 11 specific projects. No further action is contemplated on the 11 specific projects.

### PDI, REACTOR PRESSURE VESSEL DEMONSTRATION PROGRAM

PDI presented the reactor pressure vessel (RPV) program status in Enclosure 4, "PDI RPV Update." Most of the RPV requests are from international participants for personnel and equipment qualifications, from manufacturers qualifying equipment upgrades, and from personnel expanding existing qualifications. All of the scheduled RPV performance demonstrations are using phased array UT techniques.

### PDI, PIPING PERFORMANCE DEMONSTRATION PROGRAM

PDI presented the status of their piping program in Enclosure 5, "PDI Piping Program Update." Most of the requests for piping qualifications are from international participants, vendors upgrading their equipment, and qualification expansions. The numbers of qualified personnel for different piping examinations seem large but many of these individuals are not performing field inspections. The meeting consensus was that the qualified individuals are employed in management roles, overseeing vendor inspections, writing and qualifying procedures, and conducting training. The pool of UT personnel performing field examinations is believed by the meeting participants to be small. The industry is concerned about the shrinking pool of qualified individuals available for field inspections and the time it takes to train replacements. The industry is formulating ideas to address this issue. No PDI action.

The scheduled qualification tests are for phased array techniques. Most of the UT innovations are in the development of phased arrays. The phased arrays are being qualified using maximum and minimum angles to determine examination coverage. When these techniques are used for actual examinations, the coverage not scanned by these two angles is reduced by the percent of volume that the angles did not integrated.

For UT examinations performed from the outside surface of non-cast stainless steel dissimilar metal welds (DMW), procedures and personnel are qualified for detection and sizing. For UT examination performed from the inside surface, procedures and personnel are qualified for detection and length sizing but not depth sizing. The difficulty in depth sizing is attributed to surface geometry. PDI DMW mockups are representative of the challenging surface conditions that exists in the field. At this time, PDI does not have mockups with inside surface conditions that are conducive to qualifying procedures and personnel to UT examination performed from the inside surface.

### PDI, ALLOY 82/182 BUTT WELDS

PDI presented the status of their Alloy 82/182 program in Enclosure 6, "Inspection & Mitigation of Alloy 82/182 Butt Welds." The mitigation of PWSCC in Alloy 82/182 is to apply weld overlays

(WOL). The presentation summarized the status of different projects for detecting and sizing cracks in cast and wrought austenitic (Alloy 600) components. For thin-wall cast austenitic components, PDI is evaluating several low frequency transducers, and have obtained good results with a 500 kHz transducer. PDI procured two thick-wall cast austenitic mockups DMWs that had full and pre-emptive WOLs. The mockup side made with wrought austenitic steel and the welds were successfully examined with a 1.5 kHz transducer, and the same material was less successful examined with a 500kHz transducer. Cracks in the cast stainless steel under the WOL were successfully detected with the 500kHz transducer but not with the 1.5 kHz transducer. In the overlaid cast stainless steel, PDI was detecting the deeper portion of a crack and could not see the corner trap. PDI is using electrical discharge machined notches stuffed with tungsten mesh and compressed with a hot isostatic pressing process to simulate cracks. The development work is to improve UT detection and sizing in the WOLs and below the outer 25% through-wall base metal in wrought and cast stainless steel. Because these mockups will be used for blind testing, PDI proposed that NRC review their data on flaw detection in a closed meeting. Action item, NRC schedule a closed meeting to review the PDI's data collected on thick wall DMWs containing WOLs.

#### PDI, EVALUATION AND DISPOSITION OF WOL

PDI presented an evaluation and disposition of WOLs in Enclosure 7, "Technical Basis of Weld Overlay Indication Evaluation and Disposition Based on Advanced Technology Assessments." The techniques for determining the width of laminar flaws and depth sizing of embedded planar flaws are not part of the qualification process. If the same sizing tolerances for flaws in welds were applied to WOLs, the width tolerance for laminar would be 0.75-inch root mean square (RMS) error and the depth tolerance for planar flaws would be 0.125-inch RMS error. EPRI report, "Proposed Code Case Criteria for Technical Basis of Weld Overlay Indication evaluation and Disposition Based on Advanced Technology Assessments Report 1015148," evaluates the width and depth sizing errors along with the mitigation of Alloy 82/182 butt welds. Based on the UT techniques used by PDI, sizing of embedded planar flaws in WOLs with a thickness less than ½ -inch could not be sized to satisfy ASME IWB-3514-2 acceptance criteria because the rejectable flaw size is greater than the sizing accuracy. Action Items: PDI will continue developing UT techniques for detecting cracks in cast austenitic components and will make EPRI Report 1015148 available to the NRC.

#### PDI, WELD INLAY DEVELOPMENT PROGRAM

PDI presented the status on the weld inlay program in Enclosure 8, "Weld Inlay Examination Capability." Weld inlays are being developed to address surface flaws originating from the inside diameter (ID) of a pipe or weld susceptible to stress corrosion cracking. PDI reported that the qualified Supplement 14 UT techniques worked well in detecting and sizing flaws beneath weld inlays. PDI's work indicated that the effect on UT from an inlay is not much different than from cladding. Round volumetric and small singular laminar flaws were successful sized using a 3dB signal drop. Large singular flaws were successful sized using a 6dB single drop, and Flaw clusters were successful sized using a full drop to background noise level.

PDI concluded that weld inlay sizing results were similar to sizing results achieved using existing procedures. PDI suggested that weld inlays be grandfathered into the existing procedures and the procedure scope be changed to include weld inlays. To support the suggestion, PDI referenced EPRI report titled, "Ultrasonic Equivalency Testing of Weld Inlaid Components," Report No. 1016543. At this time, PDI is not considering mockups with weld inlays to the Supplement 14 performance demonstration program. However, the procedure

scope is expanded to include weld inlays, mockups with weld inlays will have to be included in the performance demonstration test sets. Although not mentioned during the presentation, the depth sizing error appears well within ASME Code requirements. Action item: PDI is continuing development on weld inlays and will make EPRI Report 1016543 available to the NRC.

### PDI, ACTIVITIES ON ASME CODE

PDI presented ASME Code activities associated with nondestructive examinations (NDE) in Enclosure 9, "Nuclear 2008." PDI developed an ASME Section XI, Appendix VIII proposal for a new supplement addressing the administration of performance demonstrations, for expanding new technology applications in Supplement 1, for revising Supplements 10, 11, and 14 to include weld inlays, onlays and design overlays, for addition of uncladded component examination criteria, and for reducing examination volumes on selected vessel and nozzle welds.

### PDI, SUPPLEMENT 2 SINGLE SIDE EXAMINATIONS

PDI presented essentially the same presentation for single side examinations in Enclosure 10' "Single Side Access Capability," that was presented at the December 2007 meeting. PDI explained that the impediments to single side qualifications are component alignment, weld surface condition, design through-wall limits, and counter-bore. PDI provided examples of weld configuration to show the impediments to UT examinations. The industry's solution to the impediments is to limit austenitic-to-austenitic (Supplement 2) weld examination coverage to the same side as the transducer, i.e., 50% coverage per weld side. The industry self imposed 50% maximum coverage limitation per weld side was instituted in the mid 1990's. Although dissimilar metal welds (DMW) have a carbon base metal weld side, the industry does not impose the same 50% coverage limitation. The UT technique being used for DMWs (Supplement 10, austenitic-to-ferritic and austenitic-to-austenitic welds) was developed in early 2003. The NRC used weld configurations (in Enclosure 10) similar to PDI's configurations to show the UT has made progress toward single side qualification of austenitic welds. To assist the industry in designing for ISI, EPRI published a proprietary report titled, "Guidelines for Inspectability for New Plant Components," Report No. 1015139. Action item: PDI to make EPRI 1015139 available to the NRC.

The NRC presented a need for single side stainless steel qualification in Enclosure 11, "A Need for ASME Code, Section XI, Appendix VIII, Supplement 2 Single Sided Qualification." Since the mid 1990s, weld surface condition requirements have changed to accommodate risk-informed examinations, UT techniques have evolved, and minimum wall thickness requirements supporting Section XI weld overlay Code cases suggest some latitude with Section III wall thickness criteria. Sufficient UT improvements and surface condition improvements have occurred for achieving single sided Supplement 2 qualifications are achievable. Action item: PDI should develop test sets with conditions conducive to single sided Supplement 2 qualifications.

### DRAFT PERFORMANCE DEMONSTRATION DOCUMENT ISO/TC 135

A representative from the International Standardization Organization (ISO) presented a draft performance demonstration document and requested comments from meeting participants. The draft is an attempt to develop commonality between performance demonstrations required by different countries. Individuals interested in making comments on the draft should provide these comments directly to the representative. The draft is not part of these meeting minutes.

### PDI, DMW INSPECTIONS

PDI presented the DMW inspection results from the recent outage season in Enclosure 12, "Spring Industry Dissimilar Metal Weld Examination Update." PDI provided a detailed review of the UT examination performed on a leaking DMW nozzle-to-elbow weld at Davis Besse Nuclear Power Station which started leaking after the first layer of a WOL repair. PDI also provided a detailed review of a DMW at Crystal River Nuclear Generating Plant where the licensee detected a deep circumferential flaw after conditioning smooth the weld surface. No action items.

PDI made a second presentation on the status of their DMW program in Enclosure 13, "BWR Dissimilar Metal Weld Update." Based on the detection of cracks in the nozzle-to-safe end at the Duane Arnold Energy Center, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) recommended that owners re-analyze all previous inspected DMW data since 1998. This exercise identified cracks in DMWs at other facilities. The BWRVIP is developing an accelerated inspection campaign for welds containing Alloy 182 that is exposed to BWR coolant that have not received a Section XI, Appendix VIII, Supplement 10 examination. No action items.

### EPRI, MATERIAL RELIABILITY PROGRAM UPDATE

The EPRI Material Reliability Program (MRP) program manager presented an update on program activities in Enclosure 14, "MRP Inspection ITG Report." MRP is developing a standard for pressurized water reactor (PWR) internals that is similar to the BWRVIP-03 examination guidelines for visual examinations. MRP is working to grandfather existing control rod drive mechanism (CRDM) mockups, to demonstrate j-groove weld leak paths, to apply technical justification qualification, and to developing guidance for inspection of bottom mounted nozzles using visual testing and UT methods. MRP is striving to have procedures, equipment and personnel qualified for CRDM inspections by September 2009. No action items.

### PDI, DMW NDE GUIDELINE

PDI presented an update on a draft guideline for DMW examinations in Enclosure 15, "NDE Guideline for Examination of Dissimilar Metal Welds." EPRI developed the draft guideline to increase the effectiveness of DMW NDE examinations performed by utilities and vendors. The draft guideline is a compilation of existing lessons learned, of key recommendations for planning, of preparing and executing examinations, and of documenting information. The goal is to communicate "best practices" to the industry. No action items.

### NRC, ADDRESSING LIMITED QUALIFICATIONS

NRC presented an overview on examinations in need of procedure, equipment, and personnel UT qualifications in Enclosure 16, "Performance Demonstration with Limited Qualifications." The overview identified a need for test sets that were capable of meeting the Code depth sizing requirement for performance demonstration from the inside diameter (ID) surface, for UT techniques capable of interrogating cast stainless steel along with the supporting performance demonstrations, for performance demonstrations applicable to inlay, onlay, expanding overlay UT qualifications, and for performance demonstrations of high density polyethylene (HDPE) pipe joints. NRC recommended the following PDI action items: provide a DMW test set to support a limited depth sizing qualification for ID examinations, develop a limited flaw detection

qualification for cast stainless steel welds, develop qualifications for inlay, onlay, and expanding overlay, and develop qualifications for HDPE pipe.

#### PNNL, FLAW SIZING ERROR ON THE PTS RULE

PNNL presented research supporting the Pressure Thermal Shock (PTS) rule, 10 Code of Federal Regulations 50.61, "Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events." The research determined the probability of detection and sizing error of flaws. The PNNL used the flaw distribution data from optimum laboratory evaluations and limited field data (41 demonstrations) from Appendix VIII, Supplement 4 performance demonstration data published in 2001. Today, the PDI database has data from over 100 outside diameter (OD) manual demonstration, over 175 OD automated demonstrations, and over 300 ID automated demonstrations. The research accuracy would be greatly improved by using the larger quantity of data currently in the Supplement 4 database to determine the probability of detection and sizing error of flaws. Action Item: PDI will facilitate efforts within EPRI to make the Supplement 4 data available to PNNL.

#### PNNL, HDPE PIPE EXAMINATION

PNNL presented the status of their research with HDPE pipe in Enclosure 18, "Status of HDPE NDE Studies at PNNL." PNNL received 24 HDPE fused joint mockups made using six different joining conditions. Five of the conditions were intended to create embedded defects. PNNL and Flour personnel used time of flight to examine the mockups. Several mockups were destructively examined to verify the UT results. High speed impact test on adjacent material to the defects were less conclusive. Action Items: PNNL will continue with their efforts.

#### PDI, CAST STAINLESS STEEL INSPECTION

PDI presented the status of their cast stainless steel program in Enclosure 19, "EPRI Projects Addressing Inspection Cast [Stainless Steel] SS." PDI has projects for examination of cast stainless steel in various stages of development. Projects approved are research of guided waves for circumferential inspection of large diameter pipe welds and of grain characterization; projects being proposed are filmless radiography for construction and inservice examination, UT for detecting thermal age embrittlement, induction and UT thermograph for flaw detection, and technique development for implanting crack-like flaws in o mockups. Action items: PDI will continue with their efforts.

#### NRC, KEY NRC NDE ISSUES

The NRC presented the topic on key NDE issues in Enclosure 20, "NRC Staff Perspectives on Key NDE Issues." The MRP committed to NRC proactive management of material degradation. The recent missed flaw detections and inaccuracy in characterization of defects at Hope Creek and Crystal River has raised concerns with the adequacy of the performance demonstration process and application of UT. The major contributor to UT shortcomings has been attributed to rough examination surface conditions. The industry has a plethora of solutions for making surface conditions conducive to NDE. The NRC staff does not view surface conditions as an impediment to qualified inspection, single sided qualifications, or meeting the Code RMS depth sizing error. The NRC recommends more aggressive development of performance demonstration to meet the industry needs, such as cast stainless steel, single side examination of austenitic steels, and HDPE piping. NRC staff recommends accelerated support for the development of performance demonstration approaches to industry's needs.

## NEXT MEETING

The next semi-annual NRC/PDI meeting is tentatively scheduled for December 2 and 3, 2008, at Florida Power and Light Company, Juno Beach, Florida

### Enclosures:

1. Public Meeting with EPRI-PDI Attendance
2. Agenda for Meeting with EPRI-PDI
3. Open Items
4. EPRI, PDI RPV Update
5. EPRI, PDI Piping Program Update
6. EPDI, Inspection & Mitigation of Alloy 82/182 Butt Welds
7. EPRI, Technical Base of Weld Overlay Indication Evaluation and Disposition Based on Advanced Technology Assessments.
8. EPRI, Weld Inlay Examination Capability
9. EPRI, Nuclear 2008
10. EPRI, Single Side Access Capability
11. NRC, A Need for ASME Code, Section XI, Appendix VIII, Supplement 2, Single Sided Qualifications
12. EPRI, Spring Industry Dissimilar Metal Weld Examination Update
13. EPRI, BWR Dissimilar Metal Weld Update
14. EPRI, MRP Inspection ITG Report
15. EPRI, NDE Guide for Examination of Dissimilar Metal Welds
16. NRC, Performance Demonstrations with Limited Qualifications
17. PNNL Work in Support of PTS Rule Associated with Flaw Sizing Error
18. PNNL, Status of HDPE NDE Studies
19. EPRI, Projects Addressing Inspection Cast SS
20. NRC Staff Perspectives on Key NDE Issues

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Attendance for public EPRI-PDI/NRC Meeting, May 12 through 14, 2008

NAME	ORGANIZATION	Attended May 12,13,14
Don Naujock	NRC	All
Terence Chan	NRC	All
Steve Doctor	Pacific Northwest National Laboratory	All
Carl Latiolais	EPRI	All
Brad Thigpen	AREVA	All
Mike Gothard	EPRI	All
Jack Spanner	EPRI	13
Randy Linden	PPL Susquehanna	All
Gary Lofthus	Southern Nuclear	All
John Leonard	IHI Southwest Technologies	All
James McArdle	Duke Energy	12, 13
Adam Conti	Quest NDE Services	12
Kevin White	Southern Nuclear	All
Greg Selby	EPRI	12, 14
Terry McAlister	SCANA	All
Damon Priestley	Progress Energy	All
David Anthony	AmerGenEnergy	All
Ronald Swain	EPRI	All
Sherrie Whiddon	EPRI	All
Teresa Donaldson	GE SSI	13, 14
Michawl Turnbow	TVA	13, 14
Mike Orihuela	Westinghouse	All
David Zimmerman	Duke Energy	12, 13
Dewey Muroson	First Energy	All
David Morg	PSE & G	All
A. Thomas Roberts	PSE & G	All
Rick Rishel	WesDyne International	All
Scott Erickson	GE Hitachi	All
Robert Healey	GE Hitachi	All
Steven Mortenson	GE Hitachi	All
Russel Jones	Constellation Energy	All
Mark Dennis	EPRI	14
Robert Barnes	EPRI	14
Phil Ashwin	EPRI	14
John Lindberg	EPRI	14
Robert Bouck	EPRI	14
Mark Hutig	XCEL	14
Joe Donohue	PGN	14
Michele Evans	NRC	14
Ted Sullivan	NRC	14

**AGENDA FOR PUBLIC MEETING WITH THE  
ELECTRIC POWER RESEARCH INSTITUTE - PERFORMANCE DEMONSTRATION  
INITIATIVE AT  
EPRI NDE Center, 1300 W. T. Harris Blvd, Charlotte, North Carolina**

**Monday MAY 12 , 2008**

1. Open Items from Last Meeting (December 5 & 6, 2008).
2. Status of PDI Reactor Pressure Vessel Demonstration Program.
3. Status of PDI Piping, Bolting, and Dissimilar Metal Weld Program.
4. Status of PDI Weld Overlay Program.
5. Status of PDI Weld Inlay Equivalency Project.

**Tuesday May 13, 2008**

1. Status of PDI Activities at ASME Code.
2. Status of PDI Supplement 2 Single Side Qualifications.
3. NRC Presentation, Need for ASME Single Side Supplement 2 Qualifications.
4. PDI Spring Industry Examinations, Update on Flaws Found.
5. Status of EPRI Boiling Water Reactor Vessel and Internal Project.
6. Status of EPRI Materials Reliability Project.
7. PDI Guideline Document Update.
8. NRC Presentation, Performance Demonstration with Limited Qualification.
9. PNNL Presentation, Support of PTS Rule
10. PNNL Presentation, Status of HDPE NDE Studies.
11. PDI Summary of EPRI Cast Projects.

**Wednesday May 14, 2008**

1. Tour EPRI NDE Center.
2. Discuss Items of Mutual Interest.
3. NRC Staff Perspectives on Key NDE Issues
4. New Action Items and Meeting Summary.
5. Public Comments.
6. Adjourn