

July 30, 2010

MEMORANDUM TO: Timothy R. Lupold, Chief
Piping and NDE Branch
Division of Component Integrity
Office of Nuclear Reactor Regulation

FROM: Ali Rezai, Materials Engineer */RA/*
Piping and NDE Branch
Division of Component Integrity
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF MEETING HELD ON JUNE 17 AND 18, 2010, WITH
THE ELECTRIC POWER RESEARCH INSTITUTE PERFORMANCE
DEMONSTRATION INITIATIVE REPRESENTATIVES
(TAC NUMBER ME2257)

On June 17 and 18, 2010, the staff of U.S. Nuclear Regulatory Commission (NRC) participated in a public meeting with the representatives from the Electric Power Research Institute (EPRI) Performance Demonstration Initiative (PDI) program at the Hilton Charlotte University Place, 8629 JM Keynes Drive, Charlotte, North Carolina. 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 Boiler and Pressure Vessel Code (ASME Code) and to develop and administer the demonstrations and qualifications of ultrasonic testing (UT) examinations of butt welds that are associated with other inspection 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: a) the proposed ASME Code actions affecting ultrasonic examinations, b) status report on the PDI piping program, c) status update on the PDI reactor pressure vessel (RPV) performance demonstrations program, d) status report on the NRC funded nondestructive examination (NDE) projects at the Pacific Northwest National Laboratory (PNNL), e) PDI program for single-sided ultrasonic examinations, f) PDI program for qualification of mitigated dissimilar metal (DM) welds, and g) status of the PDI DM weld program on flaw depth sizing. These meetings are a continuation of formal dialog between the NRC and the industry on PDI's implementation of Appendix VIII and other NDE 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. Open items are described in Enclosure 3. Handouts and presentations provided at the meeting are listed in Enclosure 4.

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301-415-1328

PDI ACTIVITIES ON ASME CODE ISSUES

PDI presented the activity related to the ASME Code, Section XI, and concerns or issues regarding the currently proposed NRC rulemaking. The NRC proposed to amend its regulation to incorporate by reference the 2005 Addenda through 2008 Addenda of the ASME Code, Section XI, ASME Code Case N-722-1, "Additional Examinations for Pressurized Water Reactor (PWR) Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials Section XI, Division 1," and ASME Code Case N-770, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material with or without Application of Listed Mitigation Activities." In addition, the NRC proposed to redesignate paragraph (b)(2)(xv) of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a as paragraph(b)(2)(xi), and revise it so that existing conditions would not apply to the 2007 Edition through 2008 Addenda of the ASME Code, Section XI.

One of the main issues involves several Appendix VIII supplements whose scope has been substantially changed since the 1996 Addenda of the ASME Code, Section XI, and they had formally been required for implementation of performance demonstration by the NRC. Specifically, Appendix VIII, Supplements 4, 5, 6, and 7 in the later editions and addenda of the ASME Code, Section XI, handle different components and/or coverage than their predecessors. PDI suggests adopting the 2008 Edition of the ASME Code, Section XI, only for the purposes of documentation of qualification.

Further, PDI discussed ASME Code Case N-722-1 which is not currently included in the PDI program. PDI indicated that it has no plans or actions to address the control rod drive mechanism (CRDM) qualifications. The NRC staff raised questions regarding what the industry plans to do to satisfy the Appendix VIII requirements for UT which is referenced in ASME Code Case N-722-1. PDI stated that it will continue to look at this issue. It was also noted that Materials Reliability Program (MRP) may be working on the ASME Code action for Code Case N-722-1. The overall consensus was to have a new action for PDI on the status of changes to ASME Code Case N-722-1 with regards to the note referencing Appendix VIII.

PDI discussed about ASME Code Case N-526, "Alternative Requirements for Successive Inspections of Class 1 and 2 Vessels," for remaining ligament qualification. The remaining ligament is defined as the distance "s" between flaw tip and material surface. The qualification objective is how effectively personnel and procedures can be qualified to measure remaining ligament. The remaining ligament can be very important factor for flaw severity determination if the flaw is surface connected or if the flaw is close to the material surface. The NRC staff commented that although ASME Code Case N-526 was approved for use by the NRC, PDI needs to resolve issues with regard to the remaining ligament qualification. From the discussions, it was evident that all the participants were agreed to start ASME Code action that addresses all items that could be affected by ASME Code Case N-526. PDI took action to discuss this item at the industry PDI planning meeting held during the following week.

PDI presented the current changes to ASME Code Case N-613-1, "Ultrasonic Examination of Full Penetration Nozzles in Vessels, Examination Category B-D, Item Numbers B3.10 and

B3.90, Reactor Nozzle-To-Vessel Welds, Figures IWB-2500-7(a), (b), and (c),” which includes reducing the examination volume for nozzle-to-vessel welds from $\frac{1}{2}$ t to $\frac{1}{2}$ inch. It is expected to be approved by the Working Group In-service Inspection Optimization (WGISIO) at the next ASME Code meeting.

PDI PIPING PERFORMANCE DEMONSTRATION PROGRAM UPDATE

Regarding personnel qualifications activities, PDI presented the pool of candidates that have been qualified for manual and automated UT during the first half of 2010. PDI was asked by the meeting participants whether the current request for PDI qualifications tend to be for conventional UT or phased array UT. PDI responded that the current trend in request for PDI qualifications is predominately for phased array UT while it was predominantly for conventional UT in the past. PDI also was asked by the meeting participants about the pass/fail results of the PDI personnel qualifications and if any statistical analyses were performed to provide insights into the qualifications process. PDI stated that there was no such analysis because there were too many variables such as types of preparation that individual candidates might have performed prior to qualification.

Regarding procedure qualifications activities, PDI reported that the procedure expansions for manual and automated phased array UT for Supplement 10 procedure, and the procedure equivalencies for automated UT for Supplements 2 and 3 procedure (i.e. detection, length, and through-wall sizing) were successfully completed during the first half of 2010.

PDI reported that during the first half of 2010, several new large-bore specimens including DM welds and weld overlay designs were fabricated for the PDI piping program and added to the current PDI library of samples. The new DM weld samples were intended to support efforts for evaluation of embedded flaws from the rough and wavy outside diameter (OD) surface. PDI was asked by the meeting participant about the conditions of the inside diameter (ID) surface of these new specimens. PDI stated that the ID surfaces were flat flushed and smooth for now but it could be modified later on an as-needed basis. PDI also discussed the PDI generic piping procedures, PDI-UT-1, PDI-UT-2, and PDI-UT-3, that are currently being reviewed and revised as necessary. The NRC staff asked PDI what constitutes the need to revise the generic procedures. PDI responded that PDI infrequently revises the generic piping procedures, unless there are technology changes such as a search unit. Vendors initially use the PDI generic procedures, but often develop their own later. In the event that PDI revises the previously issued PDI generic procedures, the vendor should incorporate the latest revision.

PDI REACTOR PRESSURE VESSEL DEMONSTRATION PROGRAM UPDATE

Regarding PDI activities related to the RPV performance demonstration testing, PDI reported that the number of candidates for the RPV shell and nozzle weld examinations for 2010 were below the projected numbers for 2010. This reduction in the RPV program utilization may be due to the heavy RPV upper head penetration qualifications activities taking precedence during the first half of 2010. There was no other new information or activities presented for the PDI RPV program.

PNNL UPDATE ON NRC FUNDED PROJECTS

PNNL presented an overview of activities related to the NDE projects at PNNL funded by the NRC. One of the ongoing PNNL projects that generated discussions between the meeting participants is related to the NDE examinations of cast austenitic stainless steel (CASS) piping welds. PNNL stated that a draft NUREG/CR was completed for this project and it is being reviewed by the NRC. The PNNL results showed that all the implanted flaws in the CASS piping welds with less than 2.0 inches in thickness were easily detectable with the current transmit-receive longitudinal probes. PNNL stated that the CASS mock-up specimens were then provided to EPRI for independent and confirmatory tests. The EPRI test results were not encouraging. EPRI and industry are not convinced of the PNNL findings. To identify the causes of discrepancies, PNNL has invited EPRI to the PNNL laboratory to conduct the same test collaboratively using the same CASS specimens and testing procedures with the EPRI's probes. It is expected that the collaborative work would determine the sources of discrepancies between the PNNL and EPRI results. No arrangement has yet been agreed upon for this collaborative work between PNNL and EPRI.

SINGLE-SIDED AUSTENITIC STAINLESS STEEL PIPING UPDATE

PDI presented a short overview of the PDI activities related to the UT examinations of single-sided austenitic stainless steel piping welds. The PDI objective is to determine how the UT techniques or the examination parameters can be improved to increase the reliability of the examinations. PDI reported that mock-up specimens for this project are currently being fabricated, but did not elaborate on their design. The specimens will contain both fabrication and in-service defects. It will be interesting to see the results of this effort as compared to the PNNL work on this area.

DISCUSSION ON UT EXAMINATIONS OF PAINTED WELDS

PDI briefly discussed the UT examinations of welds over coated or painted surface. PDI noted that all the PDI qualifications on the RPV specimens at EPRI are being performed over coated surface. EPRI coats the surfaces of these specimens to control corrosion. PDI noted that the coated surfaces where UT is to be performed should be free of loosely adhered paint, disbonded coating, peeling, or heavy polymer coatings. PDI stated that the ASME Code, Section V, Article 4, T-471.1.2, has general requirements for surface preparation for in-service inspection using UT. T-471.1.2 states that "The examination surfaces shall be free of irregularities, loose foreign matter, or coatings which interfere with ultrasonic wave transmission." The consensus between the meeting participants was that it is a judgment call, and if necessary, the surface of components would need to be conditioned to allow UT to be performed.

DISCUSSION ON EQUIPMENT UPGRADE OR SUBSTITUTION

PDI briefly discussed ASME Code Case N-780, "Alternative Requirements for Upgrade, Substitution, or Reconfiguration of Examination Equipment when using Appendix VIII Qualified Ultrasonic Examination Systems." for replacement of qualified equipment. There were no significant issues identified by the meeting participants, however, PDI stated that it would continue to develop protocols and internal procedures to address equipment substitution.

DISCUSSION ON GUIDED WAVE UT AND QUALIFICATION

PDI presented brief highlights of the recent activities of the PDI guided wave project for buried piping. PDI stated that EPRI was just beginning to study this application, considerable funds were allocated for this project, and several experts in this field have been hired. Two full scale mock-up piping specimens were fabricated that contain fittings and elbows. The mock-ups are above ground (not buried) with one coated and the other uncoated. The main points PDI stated were that the guided wave UT technique may work as a screening tool for detecting and locating flaws, but the technique may have difficulties to accurately size flaws. Other limitations of application of this technique may include the length of the buried piping, piping geometry changes including pipe branching, fittings, valves, or other geometrical changes in the pipe length, the soil in contact with the piping, and the effect of coatings on the pipe for corrosion protection. PDI stated that EPRI will continue to research the guided wave technique for use on buried piping, and more information will be provided in the PDI upcoming meetings.

DISCUSSION ON CORROSION RESISTANT CLADDING WELDS

PDI briefly discussed corrosion resistant cladding (CRC) pipe welds and the submittal of a new proposal to the industry group (PDI, MRP, and Boiling Water Reactor Vessel Internal Program (BWRVIP)) to address these welds. Apparently, the CRC piping welds exist not only in the boiling water reactors (BWR), but also in the pressurized water reactors (PWR), (e.g. Diablo Canyon DM welds). With this broader and more diverse population of CRC welds, EPRI now thinks it may be time to bring CRC under the PDI program. PDI stated that the 2003 guideline, PDI-GL-002, "Guideline for Ultrasonic Examination of Corrosion Resistant Cladding (CRC)," was created by PDI because the examination requirements for piping welds containing CRC were not specifically addressed by the ASME Code, Section XI, due to the relatively small number of welds involving CRC mitigation. Since CRC now impacts both the BWRs and PWRs, EPRI is bringing this issue up at both the BWRVIP and MRP meetings to solicit funding for a new CRC project. PDI suggested that this could be another item that could potentially be included under the proposed NRC and EPRI NDE collaborative agreement.

STATUS OF WELD OVERLAY, INLAY, AND ONLAY

PDI presented the status of NDE development and qualification associated with the structural mitigation technologies including the mechanical stress improvement process (MSIP), the weld overlay, inlay, and onlay technologies as well as the excavate and weld repair (EWR) concept. All these different mitigations for Alloy 600 locations came to light due to the primary water stress corrosion cracking (PWSCC). PDI reported that EPRI has no plan on fabricating any new specimens for the post MSIP welds. The main point PDI stated about the MSIP technology was, the MSIP is a very large tool, when the MSIP tooling is placed over, or next to, the safe end-to-pipe weld, OD surface indentation occurs. This surface indentation may affect the UT examinations of the welds from the OD surface after the MSIP application.

On the weld overlay technology, PDI is expanding its overlay specimen sets to include more full structural and optimized design overlays. The current procedures and personnel qualifications have also been expanded to cover the optimized design overlay applications. A revision to Supplement 11 is being worked on by PDI and it is expected a draft to be ready for the next ASME Code meeting. As far as the inlay or onlay qualification is concerned, PDI referred to the EPRI reports, TR-1016543 and TR-1016655, which contain information to show that the current

UT techniques qualified for examination from the ID surface are also acceptable for the inlay or onlay applications. PDI stated that there are no further works planned by either PDI or the licensees at this time. The NRC staff asked PDI to provide a copy of the above EPRI reports, TR-1016543 and TR-1016655, to the NRC.

In addition, PDI discussed a new mitigation approach known as excavate and weld repair, or EWR. EWR is currently considered a conceptual approach where the old materials (e.g. weld and base metal) are removed from a portion of or 360 degrees around the OD surface of weld to some depth, then the cavity is filled with the weld materials (e.g. Alloy 52/152). PDI stated that this could be considered as a repair weld which would be allowed by the ASME Code without a relief request. PDI stated that the EWR welds may require RT examination per the ASME Code, Section III, and that the UT examinations in lieu of RT would be preferable. It is noted that EPRI and the industry continue to develop this concept. However, there are many questions left to be answered. More information will be available at the next PDI meetings.

DEPTH SIZING ERROR UPDATE AND DISCUSSION

PDI presented the industry flaw depth sizing capabilities for DM welds. Currently the automated UT and the automated and manual phased array UT procedures are qualified for the OD depth sizing (i.e. depth sizing for inspection from the OD surface). The current industry accepted OD depth sizing is based on the 0.125 root mean square error (RMSE) criteria.

Historically, the earlier editions through 1992 Addenda of the ASME Code, Section XI, Appendix VIII, had requirements for performing a statistical regression fit of the data (performance demonstration results reported by the candidate) for flaw sizing. Then the candidate needed to satisfy a requirement for the statistical parameters (slope, mean deviation, and correlation coefficient) and could not undersize by more than 25% the larger flaws. The 1993 Addenda to the ASME Code, Section XI, changed this requirement and adapted RMSE criteria for achieving the same objective.

Currently for inspection from the ID surface, the rough and wavy ID surface conditions create significant challenges to ID depth sizing. So far, several procedures have shown flaw sizing capability for inspection from the ID surface is unable to meet the acceptance criteria. PDI used only thick wall specimens with wall thicknesses ranging from 2.5 - 2.9 inches for qualification for ID depth sizing. PDI stated that the inaccuracy in depth sizing increases with wall thickness. Therefore, the PDI implications are that the ID surface geometry and the thicker wall test specimens account for the inability of the ID depth sizing techniques to achieve a 0.125 RMSE.

For the ID depth sizing, PDI has proposed the new industry evaluation criteria of root mean square percentage (RMSP). The proposed RMSP is defined by the following equation where m_i is the measured size of a flaw, t_i is the true size of a flaw, n is the number of flaws measured, and $t_{wall\ i}$ is the thickness of the sample containing each flaw.

$$RMSP = \left[\frac{\sum_{i=1}^n \left(\frac{m_i - t_i}{t_{wall\ i}} \right)^2}{n} \right]^{1/2} * 100$$

The PDI proposed evaluation criteria for the PDI qualification to ID depth sizing is to calculate the candidate RMSE. Three cases will be encountered as follows:

- i. **RMSE \leq 0.125** meets the ASME Code, Section XI, Appendix VIII, depth sizing criteria and indicates the candidate passed the PDI qualification.
- ii. **0.125 < RMSE \leq 0.187** does not meet the ASME Code, Section XI, Appendix VIII, depth sizing criteria. Therefore, the depth sizing error (i.e. difference between 0.125 and the candidate RMSE) will be added to the flaw found in the field.
- iii. **RMSE > 0.187** does not meet the ASME Code, Section XI, Appendix VIII, depth sizing criteria. Therefore, PDI proposed the RSMP to be calculated according to the above equation. Two cases will be encountered as follows:
 - a. If **RMSP \leq 10%**, then the depth sizing error (i.e. difference between 0.125 and the candidate RMSE) will be added to the flaw found in the field.
 - b. If **RMSP > 10%**, then the candidate will be considered failed the PDI qualification to ID depth sizing.

PDI stated that the draft ASME Code Case for adding the difference between sizing capability and 0.125 RMSE to any flaw found in the field is conservative and should be considered for this limited application (i.e. for inspection from ID surface only).

The NRC staff has raised questions regarding the PDI proposed RMSP technique which lacks both technical basis and conservatism. The meeting participants extensively engaged in discussion about a) continuing to use the current industry ID depth sizing (i.e. subtract 0.125 from the candidate RMSE and add the difference to the detected flaw), b) including thin wall specimens to the test set, and c) including smooth ID surface specimens to the test set.

The NRC staff suggested PDI to consider other options such as:

1. Remove, decouple, or reinterpret the requirement that systems must be qualified for depth sizing of flaws along with flaw detection for successful qualification. If a flaw is detected, then a licensee could propose how they would handle the flaw sizing and ultimate disposition.
2. For depth sizing a flaw, personnel must be qualified to do this through appropriate screening criteria.
3. Ideas for qualifying include:
 - a. Change the screening limit for inspection of DM welds from the ID surface, which would require a reasoned technical argument supported by data analysis that can be reviewed by the NRC,
 - b. Abandon the screening limit and return to the regression analysis,

- c. Add smooth ID surface and thinner wall specimens to the sample set currently being applied for inspection from the ID surface, similar to the OD qualification sample set,
 - d. Fabricate a test set with smooth ID weld surfaces.
4. Provide the NRC an opportunity to statistically evaluate performance demonstration ID depth sizing data.

PDI and EPRI agreed to bring the above items on the ID depth sizing up for discussion during the following week at their industry planning meetings. In addition, a separate meeting between the NRC, EPRI, and the industry participants to further discuss the depth sizing issue was suggested by the meeting participants. A date for this meeting was not set, but PDI will organize and coordinate the meeting.

OPEN ITEMS FROM THE DECEMBER 2009 MEETING

PDI presented the status of open items from the December 2009 meeting. The NRC action items 3 and 4 were complete. The PDI action items 1, 2, 4, 5, 6, and 9 were complete.

NEXT MEETING

The next semi-annual NRC/PDI meeting is tentatively scheduled for the first week of December 2010. The exact date and the location for the meeting will be announced.

Enclosures:

1. Attendance List
2. Meeting Agenda
3. Open Items
4. List of Handouts and Presentations

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DATE	07/30/2010	07/30/2010

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ATTENDANCE FOR PUBLIC EPRI-PDI/NRC MEETING, JUNE 17 AND 18, 2010

NAME	ORGANIZATION
Richard Fuller	First Energy
David Anthony	Exelon
Michael Canny	CENG
John Hayden	Structural Integrity
Randy Linden	PPL Susquehanna
Don Welch	Energy Northwest
Paul Johnson	GE Hitachi
Steve Mortenson	GE Hitachi
Troy Steinbauer	AREVA
Terry McAlister	SCANA
Rick Rishel	Wesdyne
Carl Latiolais	EPRI
Ronnie Swain	EPRI
Sherrie Whiddon	EPRI
Kevin Hacker	Dominion
James McArdle	Duke Energy
Damon Priestly	Progress Energy
Danny Cordes	Southern Nuclear
Michael Anderson	PNNL
Grady Lagleder	IHI SWTech
Tim Lupold	USNRC
Carol Nove	USNRC
Don Naujock	USNRC
Bob Hardies	USNRC
Ali Rezai	USNRC

AGENDA FOR PUBLIC MEETING WITH THE
ELECTRIC POWER RESEARCH INSTITUTE – PERFORMANCE
DEMONSTRATION INITIATIVE
HILTON CHARLOTTE UNIVERSITY PLACE
8629 JM KEYNES DRIVE
CHARLOTTE, NORTH CAROLINA
JUNE 17 AND 18, 2010

June 17, 2010

1. Introductions
2. Status of ASME Code Nondestructive Examination Activities
3. Status of the PDI Piping Program Austenitic & Ferritic
4. Status of the PDI DM Weld Program
5. Status of the PDI Reactor Pressure Vessel Program
6. Status of Work PNNL & PDI on Single Sided Austenitic Piping
7. Status of PNNL Work on Cast Stainless
8. Summary of Approved Work Plans EPRI/PNNL and any Collaboration
9. Status of Weld Overlay, Inlay, Onlay
10. Operating Experience from Spring 2010
11. NRC Comments/Open Discussion
12. Adjourn

June 18, 2010

1. Continuation of June 17 Open Discussion
 2. Discussion of UT Examination on Painted Welds
 3. Discussion of Industry Usage of Guided Wave UT and any Efforts to Develop Qualification Guidance
 4. Review of Old Action Items
 5. Summary of New Action Items
 6. Subjects of Mutual Interest
 7. Location/Date of Next NRC/PDI Meeting
 8. Public Comment
- Adjourn

ENCLOSURE 2

OPEN ITEMS

Actions:

1. NRC will consider requesting access to information in a letter to the NDE Integration Committee (IC) Chairman pertaining to RMSE as it relates to inside surface UT examinations
2. PNNL will request from EPRI a mock WOL test, in order to obtain information on aspects of a standard test set with regards to how much information is provided to a candidate on the nature of flaws in the test

PDI will provide status on the following items in the next semi-annual NRC/PDI meeting which is tentatively scheduled for the December 2010:

1. Technical basis for the UT examination of optimized WOL.
2. Presentation to the EPRI NDE IC on its request for funding and action to review the current implementation of onlays, overlays and inlays for similarities with corrosion resistant cladded (CRC) configurations and champion appropriate changes at the ASME Code.
3. Project to analyze the DM weld and austenitic-to-austenitic piping PDI database for RMSE performed from the inside diameter as a function of the flaw size and metal path, and will coordinate the project with NRC/PNNL participation.
4. PDI will provide the status of changes to ASME Code Case N-722 with regard to the note referencing Appendix VIII.
5. PDI to bring forward the RMS ID depth sizing issue to the PDI steering committee and the NDE integration committee (IC). Recommend focused meeting with all relative parties to discuss this issue.
6. PDI will discuss ASME Code Case N-526 with the steering committee to determine owner. PDI will provide to NRC the results of discussion. (Completed on June 28, 2010)

LIST OF HANDOUTS AND PRESENTATIONS
ADAMS Accession No.: ML102030150

ASME Code Update

PDI Piping Program Update

PDI Reactor Pressure Vessel (RPV) Qualification Program Update

Validation of Single-Sided Ultrasonic Examinations for Stainless Steel - Project Update

Codification of UT Examinations on Welds Containing Corrosion Resistant Cladding (CRC)

Update of Nondestructive Examination (NDE) Projects Funded by NRC at PNNL

Current Industry Depth Sizing Capability for Dissimilar Metal Welds

Alloy 600 Mitigation Methods and Status of NDE Development

Code Case N-780, "Alternative Requirements for Upgrade, Substitution, or Reconfiguration of Examination Equipment when using Appendix VIII Qualified Ultrasonic Examination Systems, Section XI, Division 1"

Action Item List