

Update of Industry Actions Related to Diablo Canyon OE

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Background

- Structural weld overlays were installed in 2006 on six (6) pressurizer nozzles
- Following installation, the same vendor also performed UT acceptance and pre-service (PSI) examinations of all six (6) overlays
 - Two small acceptable indications were recorded during both examinations
- These examinations were performed using PDI generic conventional UT procedure, PDI-UT-8
- During the next refueling outage, inservice examinations were performed by the same vendor on all six (6) weld overlays using the same UT procedure
 - The original acceptance examination of the weld overlay was not repeated during this examination

Background (continued)

- During the 2013 outage, one of the overlays was scheduled for an ISI examination
- During the examination, previously unidentified fabrication flaws were detected using a qualified manual phased array (PA) ultrasonic procedure EPRI-WOL-PA-1
- The examination scope was expanded to the remaining overlays and additional fabrication flaws were identified in a total of 4 of the 6 overlays installed in 2006
- Some of these newly identified flaws exceeded the acceptance criteria specified in the approved relief request used for installation and acceptance

Background (continued)

- Prior to completing the 2013 outage, both the overlay installation vendor and EPRI personnel examined selected indications to establish the detectability of the indications using the conventional ultrasonic procedure PDI-UT-8 used for the original acceptance examination
- Both the vendor and EPRI personnel concluded that the flaws were detectable with this procedure
- Following the outage, the utility formed a Root Cause Team (RCT) to identify the causes that resulted in the flaws not being detected
- EPRI, industry and vendor peers were included as part of the team

Diablo Canyon Root Cause

- A mismatch exists between the conventional UT weld overlay inspection procedure PDI-UT-8 and the Performance Demonstration Initiative (PDI) qualification process.
 - Although the qualification process successfully demonstrated the ability to detect flaws, the procedure instructions do not adequately constrain the zero-degree scan speed to assure that small cross-section, low-angle flaws are consistently detected in the field

Diablo Canyon Contributing Cause

- Inattentive error was made by vendor examiners
 - Data indicate that 45-degree angle beam was able to detect indications in the weld overlays, yet the indications were not recorded
 - Examiners failed to adequately investigate indication responses to determine the actual length of the flaw
 - Examiners failed to recognize zero-degree ergonomic factors necessitated reduced scan speed to maintain optimum search unit coupling

Diablo Canyon

Recommended Corrective Action 1

- Provide the following recommendations to PDI for revision of:
 - The conventional UT weld overlay procedure (PDI-UT-8) training/qualification process:
 - Assure that scan speed, length sizing, and any other essential variables used during qualification testing are conservatively reflected in the examination procedure
 - Expand the sample set to include Westinghouse Nuclear Steam Supply System (NSSS) pressurizer nozzle configuration
 - Include more realistic oriented fabrication-related flaws in the test set
 - The procedure (PDI-UT-8):
 - Add guidance on when to reduce scan speed
 - Evaluate the need to increase sensitivity for zero-degree examinations
 - Include instructions related to detection of low-angle flaws

Diablo Canyon

Recommended Corrective Action 2

- Recommend EPRI publish a communication to all conventional UT overlay qualified examiners to review the causes and contributors of the Diablo Canyon event

Industry Actions

- PDI-UT-8 has been revised to provide enhancements for the areas identified in the RCE report
- New weld overlay demonstration samples have been examined with both the non-encoded conventional and phased array procedures to assure that no additional procedure changes are required to address these configurations
- NDE IC has endorsed a project to develop a training module that can be used to train and prepare examiners prior to qualification and performing examinations at the plant
 - This training will address the OE and contain specific guidance and recommendations highlighted by the utility root cause.
- PDI Program has fabricated practice mockups representative of non-standard weld overlays. The NDE IC focus group recommends the use of these mockups prior to performing ultrasonic examinations of non-standard weld overlays on site to allow the examiner to become familiar with the intricacies of performing examinations of these configurations.

Industry Actions (continued)

- The NDE IC has endorsed a project to modify the non-standard weld overlay practice mockups to implant fabrication flaws similar to those missed at DCCP for the purpose of providing indications representative of known field conditions to assist in preparing the examiners for the examinations
- The NDE IC has endorsed projects to perform additional research in 2014 to evaluate approaches to improve the surface contact for the zero degree examinations of small diameter (< 8" diameter) weld overlays
- The FG has evaluated the DCCP root cause evaluation to determine if this event was the direct cause of inadequate procedure, equipment, personnel qualifications or the qualification process that requires an extent of condition evaluation at other sites (Evaluation details latter)

Industry Actions (continued)

- The NDE IC issued NDE Alert 2014-02 - February 10, 2014
 - Inform utilities and vendors of an inspection issue identified during a recent examination of structural weld overlays (SWOLs),
 - Convey industry actions,
 - Provide NDE Integration Committee (IC) recommendations

NDE IC Recommendations for the Industry

- Perform a detailed review of the DCPP root cause and corrective actions taken, specifically the enhancements made to the examination procedures to address non-standard overlays, which includes scan speed guidance and sensitivity adjustments
- When applying non-encoded conventional UT examinations of weld overlays, implement the latest revision of the qualified examination procedure
- Prior to performing examinations of non-standard overlays, utilize the practice mockups to prepare examiners

Extent of Condition Evaluation

- The NDE IC focus group (FG) performed a detailed review of the root cause and the information obtained from the hands on evaluation by vendor, utility and EPRI using the conventional techniques and the following observations were made:
 - RC stated referenced ergonomics being a factor, but this only applies to the zero degree search unit. The 45 RL longitudinal search unit readily detected the flaw in Safety Nozzle A and the criteria in the procedure provided adequate guidance to determine the correct length - **Human factor**
 - Procedure stated that *“The scan speed shall not exceed 2.0” per second. The scan speed shall be reduced on less than optimum overlay surfaces”*
 - Based on hands on evaluation, the geometry of the overlay, and the physical positioning required to actually perform the examinations would not have allowed the overlays to be examined at the maximum scan speed - **Human factor**

Extent of Condition Evaluation (Continued)

- The root cause indicated that the procedure did not provide sufficient guidance for scan speed, but it also stated that if the examiners had practiced on the available mock-ups prior to the examination they would have been more aware of what the scan speed should be
 - Mock-ups were not provided prior to 2006 or 2008 examinations - **Implementation issue**
- Comparison of the acceptance examination results to the investigatory results in 2013 clearly shows that the two 1 inch-long indications recorded at the acceptance examination on Safety Nozzle "A" were undersized and re-examinations using the same equipment clearly indicate that a significantly longer length when measured using procedurally defined techniques - **Human factor**
- The root cause recommends to evaluate if there is a need to increase sensitivity for zero-degree examinations, but the procedure requires evaluation of all indications with a signal to noise ratio ≥ 2 to 1 and all of the reported flaws clearly had signal to noise greater than 2 to 1 - **Human factor**

Extent of Condition Evaluation (Continued)

- Based on this review, the NDE IC FG concluded:
 - The procedurally defined techniques, if applied correctly, were capable of detecting and sizing the flaws in the Diablo Canyon weld overlays
 - Human performance was a significant contributor to the flaws being missed
 - Site implementation was also a contributing factor
 - The actions taken by the industry are focused directly on these issues and will be sufficient to improve NDE reliability

Summary

- The NDE IC thoroughly evaluate the Diablo Canyon operating experience and took proactive steps to address the lessons learned
 - Communicated to the industry the operating experience
 - Recommended that prior to performing examinations of non-standard overlays, utilize the practice mockups to prepare examiners
 - Optimized the examination procedure
 - Augmented the demonstration sample inventory
 - Increase the number of practice samples
 - Optimized the search unit designs
 - Developing training models that can be used to train examiners
- Based on this evaluation, the NDE IC has concluded:
 - The missed fabrication flaws are related to human performance errors and less than adequate implementation of the examination procedure guidance
 - The non-encoded conventional examination procedure was capable of detecting the flaws
 - An industry extent of condition evaluation is not warranted