DOCKETED

Docket Number:	15-IEPR-12
Project Title:	Nuclear Power Plants
TN #:	206810
Document Title:	Excerpt from the Diablo Canyon Independent Safety Committee Twenty-fourth Annual Report
Description:	Excerpt describing the DCISC report on the U-2 Pressurizer Structural Weld Overlays
Filer:	Justin Cochran
Organization:	Diablo Canyon Independent Safety Committee
Submitter Role:	Public
Submission Date:	12/1/2015 2:33:57 PM
Docketed Date:	12/1/2015

This is an excerpt from the Diablo Canyon Independent Safety Committee Twenty-fourth Annual Report on the Safety of Diablo Canyon Nuclear Power Plant: Operations July 1, 2013 – June 30, 2014

The pages include page 1 (Title page) and pages 354 – 358 (text of interest) of the report.

The complete report can be found in pdf format at: http://www.dcisc.org/24th-pdf.pdf

Report compiled by the Diablo Canyon Independent Safety Committee (DCISC), http://www.dcisc.org/index.php, and posted in Q4 of 2014.

For more information about DCISC contact:

Diablo Canyon Independent Safety Committee
Office of the Legal Counsel 8
57 Cass Street, Suite D
Monterey, California 93940

Telephone: In California call 800-439-4688 Outside of California call 831-647-1044

Send E-mail to: dcsafety@dcisc.org

Diablo Canyon Independent Safety Committee
Twenty-fourth Annual Report on the Safety of Diablo Canyon Nuclear Power Plant Operations
July 1, 2013 – June 30, 2014

DCISC Team Observing New Fuel Inspection at DCPP

Peter Lam, Chair
Robert K Budnitz, Vice-Chair
Per F. Peterson, Member

technologies or modifications may warrant further study. Dr. Lam acknowledged and complimented Dr. Budnitz for Dr. Budnitz' work in coordinating the Evaluation under an exceptionally strict schedule. **Dr. Peterson confirmed the DCISC will continue to monitor and attend the meetings of the RCNFPP.**

XX Adjourn Morning Meeting

The Chair thanked all the PG&E presenters and then adjourned the morning session at 11:00 A.M.

XX Reconvene For Afternoon Meeting

The afternoon meeting of the DCISC was called to order by Committee Chair, Dr. Peterson, at 1:00 P.M.

XXI Committee Member Comments

There were no comments by any Committee member at this time.

XXII Public Comments and Communications

There were no comments by any members of the public at this time.

XXIII Information Items Before the Committee (Cont'd.)

DCPP Director of Compliance and Risk Mr. Cary Harbor introduced the next informational presenter, Mr. Kenneth Bych, Interim Technical Support Engineering Manager at DCPP and remarked that Mr. Bych has a Master of Science degree in Nuclear Engineering and is a Professional Engineer with more than 30 years experience in the nuclear power industry with service in leadership roles within the Independent Safety Review, Reliability, Probabilistic Risk Assessment, and Instrument and Electrical Engineering organizations. Mr. Harbor stated that members of Mr. Bych's staff including Mr. Dave Gonzales, with more than 25 years of experience in the nuclear industry and with In-service Inspection and Mr. Mike Leger with more than twenty-five years experience with In-service Inspection were also in attendance.

Presentation on U-2 Pressurizer Structural Weld Overlays.

Mr. Bych reported that during 2R17 DCPP identified previously undetected flaws in weld overlays which were installed in U-2 Pressurizer during 2R14. This discovery was made by the use of Phased Array examination, which is an advanced detection technique. A DCPP consultant analyzed the newly found flaws and provided technical justification for safe and continued operation and the NRC approved one cycle of operation (the current cycle for U-2). Mr. Bych stated DCPP has completed a root cause evaluation, informed the NRC and the industry of the results, and is currently performing a more comprehensive flaw analysis to address NRC specifications for safe, longer-term operation which is expected to be submitted to the NRC in early 2014.

Mr. Bych discussed the background of this issue relative to industry operating experience and stated NRC regulations indicated that the weld material used to join the U-2 Pressurizer nozzles to associated piping was susceptible to primary water stress corrosion cracking. U-1 Pressurizer weld material is not similarly susceptible so this is not an issue for U-1. Mr. Bych displayed a cutaway drawing of a pressurizer and described its function as maintaining pressure in the Reactor Coolant System (RCS). He identified the location of a 14" diameter surge line at the bottom of the pressurizer which he stated was the only pipeline for water flowing into and out of the pressurizer to the RCS and he identified five different penetrations located at the top of the pressurizer. He displayed a photo of a structural weld overlay made in the 1970s to one of the five attachments welded to one of the penetrations at the top of the pressurizer and described the overlay as the equivalent of a pipe outside a pipe, welded in a circumferential manner to add approximately 2" to the diameter of the pipe. He stated the technical issues he would be discussing with the DCISC involve the bonding between the weld overlay material and the underlying pipe.

Mr. Bych stated a problem was identified due to the susceptibility of the welds to primary stress corrosion cracking. However, due to the geometric profile of the nozzles, inspection using ultrasonic testing (UT) was not possible. The engineering solution was to install structural weld overlays which shift the stress in the nozzle welds from tensile to compressive and thereby eliminate the susceptibility of pipe to failure as the structural loads are picked up by the weld overlay material which bounds all stress from the inner pipe.

Mr. Bych reported during outage 2R14 in February 2008, the DCPP U-2 Pressurizer had pre-emptive full structural weld overlays applied to all six nozzle-to-pipe welds to resolve primary water stress corrosion cracking concerns with the original welds in accordance with an NRC approved Relief Request and in conformance with a American Society of Mechanical Engineers' (ASME) code case. Many other nuclear power plants around the country also installed pressurizer weld overlays at this time. Weld overlay acceptance exams by the vendor were conducted using conventional manual ultrasonic testing (UT) methods and the industry standard procedure, an Electric Power Research Institute (EPRI) generic procedure. The first in-service inspection (ISI) was performed by the original vendor for all six weld overlays following outage 2R15 in October 2009 using UT technique with minor indications noted. The conventional UT was qualified for the application and the examiners were qualified for its use. All six of the weld overlays passed and were found acceptable.

Mr. Bych stated that in preparation for inspections during 2R17 in 2013, the DCPP Engineering organization enhanced the capabilities of its Level III ISI inspectors by qualifying them on the newest state of the art examination technique called Phased Array. Phased Array attributes include higher resolution and improved user interface. Detailed plans were prepared for the 2R17 inspection and included a formal oversight plan, extensive pre job briefing and Phased Array training and practice on an overlay nozzle mockup prior to the start of the examination. Phased Array exams were performed during 2R17 by PG&E Level III personnel qualified to ASME Section XI, Appendix VIII Supplement 11. Mr. Bych reported in-service inspection during 2R17 selected the safety "B" nozzle weld overlay for examination. He stated there are three safety nozzles, termed A, B, & C. The manual Phased Array technique employed via generic industry procedure found three indications in Safety Nozzle "B." These indications were characterized as lack of bond/interbead

non-fusion (LOB/IBNF). EPRI and the vendor's non destructive examination (NDE) experts reviewed PG&E's unexpected discovery and its characterization of the indications and verified that the length of the indications exceeded the original relief request acceptance criteria. Mr. Bych stated this was in contrast to the original acceptance during 2R14 and subsequent ISI of the "B" nozzle during 2R15 by the vendor which reported no indications. The 2R17 exam scope expanded to Safety "A" nozzle per ASME Section XI rules and Phased Array exams identified indications with length that exceeded original relief request acceptance criteria characterized as LOB/IBNF similar to indications in the "B" nozzle. Original acceptance reported two indications well within the acceptance criteria. Mr. Bych reported the scope was then expanded to include all six pressurizer weld overlay nozzle welds for exceedance indications similar in nature to "A" and "B" nozzles. Safety "C" nozzle was found to have smaller LOB/IBNF indications with lengths meeting the relief request length acceptance criteria. The pressurizer power operated relief valve and surge nozzle weld overlays were examined and no indications were found. Mr. Bych reported three of six pressurizer weld overlays were found to have excessive length indications beyond the stipulated NRC relief request requirements during 2R17 inspections.

Dr. Peterson observed the DCISC reviewed this issue in fact-finding and stated there may be some finite element modeling of these flaws necessary to determine their potential for propagation and Mr. Bych confirmed that DCPP will be addressing that issue for the NRC in order to continue safe operation. **Dr. Peterson remarked the DCISC would be following up on this issue as, while all materials have flaws, the question is whether the flaws are large enough to grow or small enough to stay the same size and the issue is how can this be demonstrated using modern computerized tools**. Dr. Budnitz commented that the technical studies which supported the ASME decision establishing the code criterion should be in the record and Mr. Bych agreed that the basis for the ASME code criterion would need to be reviewed to understand and evaluate what kind of conservative assumptions and calculations were used by ASME and addressed in the report to the NRC on this issue and he stated the burden of proof is on PG&E in this analysis to verify that these flaws are, in fact, capable of being bounded. **He stated DCPP has committed to do Phased Array examinations in 2R18, 2R19 and 2R20 to justify its calculations with empirical evidence. Dr. Budnitz remarked the DCISC will follow the results of PG&E's future examinations**. Dr. Budnitz stated PG&E was fortunate in that the Phased Array technique is recent and the persons on the code committees who participated in establishing the ASME code are likely still available and working in the industry. In response to Mr. Wardell's inquiry, Mr. Bych stated two of the circumferential indications found at DCPP were 18" as compared to 5" allowed by the criterion.

Mr. Bych reported after discovery during 2R17 and following characterization that three of the six weld overlays exceeded the NRC relief request requirements, DCPP immediately entered the issue into its Corrective Action Program and a flaw analysis (fracture mechanics) was immediately performed by the vendor on Safety Valves A, B, C lines and on the spray nozzles. The analyses demonstrated that the weld overlays performed their structural safety function. DCPP revised the weld overlay relief request detailing newly identified conditions and evaluations and submitted it to NRC. The NRC granted approval for one cycle of operation, the current cycle of operation for U-2. Extended approval has not been received pending the root cause and enhanced analysis. EPRI was engaged to support the root cause evaluation. Prior to the end of 2R17, EPRI representatives

acquired data with manual conventional UT technique for comparison to Phased Array. Industry expert peers and the vendor also participated in root cause evaluation.

Mr. Bych displayed a plat showing a generic indication of a weld and associated piping with the location of a weld overlay and he explained the characteristics of the overlay and the nature of the material susceptible to stress corrosion cracking.

Mr. Bych stated the Root Cause Team employed three analytical techniques during the June – July 2013 investigation:

- A comparative time line to capture and contrast contributing factors
- An Events and Causal Factor Chart with Fault Tree Analysis to identify causes (results independently verified by Stream Analysis)
- A human error investigation tool to evaluate the performance of the individuals conducting the UT

The following were findings from that investigation:

- EPRI, PG&E and vendor investigations indicated that the subject flaws are detectable with conventional UT overlay exam procedure, PDI-UT-8 Rev. F.
- PG&E found that scan speeds slower than the maximum allowed by procedure are required to produce easily recognizable indications with zero degree search unit. Mr. Bych described this as a key insight. Fundamentally the procedure allows a maximum scan speed but optimum performance is below the maximum allowed by the existing procedure.
- Under sizing of indications during acceptance exams on Safety Nozzle A contributed to examiner human performance issues.

Mr. Bych stated PG&E concluded there was a combination of process and human performance weaknesses that prevented the conventional UT in the 2R14 and 2R15 time frames from fully identifying these indications. In response to Dr. Budnitz' observation that either there was an error in the measurement or in the way the measuring instrument was deployed, Mr. Bych replied the issue involved a combination of process, speed, and individual performance by the UT examiners. There was, to PG&E's knowledge, no equipment malfunction.

Mr. Bych reviewed the corrective actions taken at DCPP as follows:

- Prohibiting use of PDI-UT-8 Revision F conventional exams at DCPP
- Employing Phased Array for subsequent examinations of pressurizer weld overlays in future outages
- Communicating the root causes to the industry

Actions ongoing to address NRC and code requirements include an updated flaw analysis (fracture

mechanics) being conducted by a consultant to support the relief request. Mr. Bych stated the NRC has requested this analysis use a conservative flaw combination and that all detectable indications be considered. PG&E will submit a relief request pursuant to 10 CFR 50.55a(a)(3)(i) as a proposed alternative in early 2014. Mr. Bych stated that he has no knowledge of relevant operating experience at other plants on this issue and DCPP is the first plant to find such flaws using Phased Array which is a principal reason the NRC remains very interested in this issue.

Mr. Bych reported, in summarizing his presentation, in 2R17 DCPP identified previously undetected flaws in three locations in U-2 Pressurizer weld overlays in 2R14 using Phased Array, an advanced detection technique. DCPP's consultant analyzed these newly found flaws and provided technical justification for safe and continued operation. The NRC approved one cycle of operation (the current cycle for U-2). DCPP has completed a root cause evaluation, informed the NRC and the industry of the results, and is currently performing a more comprehensive flaw analysis to address NRC specifications for safe, longer-term operation. This will be submitted to the NRC in early 2014.

Dr. Lam observed, and Mr. Bych agreed, that the evaluation demonstrating the overlays perform their structural safety function provided the basis for the NRC approval of operation during the current cycle for U-2. In response to Dr. Lam's inquiry, Mr. Bych stated that DCPP was required to demonstrate that the 0.06" thick weld flaws, which were up to 1/4" wide, did not detract from the weld's structural function of creating new pipe capable of handing the most severe accident at that location. Dr. Lam further observed and Mr. Bych agreed that the NRC is apparently not entirely satisfied concerning long term operation and hence the one cycle operational approval. Mr. Bych commented the NRC's immediate concern is with laminar growth in the flaws which is not viewed as a short-term credible accident scenario. In response to Dr. Budnitz' comment, Mr. Bych agreed that if the weld flaws are found to have grown then there is a different set of questions to be addressed.

Dr. Henriette Groote, a member of Mothers for Peace, was recognized. Dr. Groote observed that a plot of the data points, comparing them over time, obtained by the two different types of analysis, UT and Phased Array, might have been useful in this analysis. Dr. Peterson stated during fact-finding the DCISC observed the use of both types of instrumentation and he compared the use of a one-dimensional to a two-dimension sonogram as analogous to the use of UT to Phased Array, and part of the corrective action going forward will be the use of the two-dimensional Phased Array tool. Mr. Harbor stated that, similar to the enhanced pixels provided by newer digital cameras, there is an enhanced ability with newer tools to see elements and details in an enhanced manner not previously available. Dr. Peterson stated that it would be preferable to have the ability to detect incipient locations for stress corrosion cracking but the ability to do so is, at present, rudimentary and is limited to detecting flaws after they've grown to a certain point and to then determining whether growth is likely to occur.

Mr. Harbor requested Mr. Larry Pulley, Fuel Storage Manager at DCPP, and Mr. Mark Mayer, Supervising Engineer for Reactor Engineering, to make the final informational presentation to the Committee. Mr. Harbor reported Mr. Pulley has a Bachelor of Science degree in Mechanical Engineering and more than 30 years experience in the nuclear industry including fuel management.