(via email and hardcopy)

March 19, 2008

US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001
ATTN: Robert Hardies and Al Csontos

Subject: Non Destructive Examination Summary of Pressurizer Safety Nozzles Removed from Service at Port St Lucie Unit 1

ABSTRACT

A manual ultrasonic examination of the safety nozzles in the pressurizer that was removed from service at Port St Lucie Unit 1 indicated the potential presence of severe primary water stress corrosion cracking. Regulatory staff concluded that the operating basis of eight PWRs must be considered to be compromised unless the nozzles could be shown to include no cracking condition that was inconsistent with a 2007 advanced finite element analysis.

Additional, advanced nondestructive evaluation (NDE) techniques were applied to the nozzles. The methods included ultrasonic, radiographic, dye penetrant, and eddy current examination. The examination techniques and results are described and compared. The examination results support the examiners' conclusion that the safety nozzle dissimilar metal welds contain many common, benign fabrication defects, but no specific indication of stress corrosion cracking.

These examination results are consistent with a review of the advanced finite element analysis, using the configuration of the Port St Lucie safety nozzles. Consequently, the FEA models and results for the eight PWR units are still valid and consistent with current inspection data.

Based upon this more complete and accurate characterization, the eight units have concluded that their operability determinations remain valid. There is no safety concern.

BACKGROUND

This section provides general information on component degradation, inspection requirements and methods, and the Port St Lucie Unit 1 (PSL) pressurizer nozzles.

Dissimilar metal welds

Most of the major components in the nuclear steam supply system (NSSS) of nuclear power plants (NPP) are fabricated of carbon steel. Much of the piping systems attached to the nozzles in these components are fabricated of stainless steel. The method of attachment is welding, usually with a safe end of stainless steel or nickel alloy, and sometimes with no safe end. The attachment weld thus joins the carbon steel nozzle to the stainless steel component, or to a stainless steel or nickel-alloy safe end, and is therefore designated a dissimilar metal weld (DMW).

Service experience shows that the nickel-based Alloy 600, of which some safe ends are fabricated, and nickel-based Alloy 82 and Alloy 182, the weld filler metals used to make most DMWs, are susceptible to stress corrosion cracking (SCC). In pressurized water reactor (PWR) welds the degradation mode is primary water stress corrosion cracking (PWSCC). Cracking initiates in the weld metal at the inside surface of the nozzles where it is exposed to the reactor coolant. A tensile stress field at the inside surface is necessary for the cracking to grow in length as the plant operates. It is generally accepted that a compressive stress field on the inside surface will prevent the initiation of cracking. In the presence of a tensile stress field within the body of the material, the cracking can grow in depth. Cracking may be oriented in either the circumferential or axial direction in the nozzle. Circumferential cracking is of greater structural significance.

Management of dissimilar metal welds

Monitoring for degradation of weld metals is managed through periodic inservice inspection (ISI) using nondestructive evaluation (NDE) techniques. The inspections are governed by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, and also by various augmented inspection programs. The primary NDE method is ultrasonic examination (UT). Ultrasonic probes are applied to the outside surface of the nozzle, sound waves reflect from various features throughout the volume of the nozzle and its DMW, and the received reflections are analyzed by the examiner. Reflections, or "indications," arise from geometric features of the nozzle, from metallurgical interfaces within the DMW, from benign fabrication defects, and from service-induced defects such as PWSCC. Ultrasonic examination procedures, equipment, and personnel for examination of DMW must be qualified according to the requirements of the ASME Code, Section XI, Appendix VIII, Supplement 10. This qualification is provided by the Performance Demonstration Initiative (PDI), an industry group.

Often PWSCC has a complex shape: it can change direction as it propagates through the thickness dimension of the weld, it can branch, and the faces of the primary crack and of the branches are generally rough and faceted. The clearest reflections are obtained from the branches and facets that are oriented perpendicular to the direction of the sound beam, and therefore the ultrasonic response of the crack is a collection of connected "hot spots." Even in the absence of cracking, DMWs may produce many geometric and metallurgical reflections, and if significant numbers of fabrication defects also are present, then the examiner may be presented with a quite a complex analysis problem. If many indications are present, and resemble the known ultrasonic characteristics of PWSCC, then the examiner is obliged to make the conservative interpretation that the indications should be considered to represent the presence of cracking.

Ultrasonic examination can be performed using either a manual or an encoded technique. A manual examination is performed by a single examiner, manually moving the ultrasonic probe over the surface of the nozzle, and observing and interpreting the responses in real time. The manual examination can be performed using either conventional or phased array techniques; phased array technology has the advantage of presenting the examiner with a live, real-time cross-sectional image. An encoded examination – again, using either conventional or phased-array technology – records and stores the probe position and ultrasonic response on a computer as the probe is scanned over the surface of the nozzle. One or more analysts subsequently can evaluate three-dimensional images of the recorded ultrasonic data. This superior data presentation, along with the capability for evaluation by multiple analysts, allows for a more reliable determination of whether the complex responses from a DMW represent the presence of cracking or the presence of multiple fabrication defects.

Utilities perform ISI during regularly scheduled refueling outages that occur usually at intervals of 18 or 24 months. If service-induced degradation such as PWSCC is detected, its size and location are characterized and this information is used in a calculation of the fitness of the weld joint for continued service. The calculation requires many other inputs as well, including the stresses on the joint, the properties of the materials, the growth rate of the cracking, and plant-specific criteria such as seismic loading. Additional examinations and analyses may also be performed. If the joint is deemed unfit to serve until the next scheduled refueling outage then the weld is repaired immediately. Some DMWs cannot be examined because the joint configuration does not permit sufficient access for UT. Many utilities have chosen to pre-emptively mitigate such joints using techniques that both ensure structural integrity (making the conservative assumption that cracking exists in the joint) and leave the joint in a configuration that is accessible for effective UT in the future. In some cases mitigation techniques may be applied that produce a compressive residual stress on the inside surface of the weld joint, rendering it insusceptible to PWSCC.

Nine PWRs deviate from the DMW schedule

The schedule for examination of PWR DMW is determined by the requirements of "Primary System Piping Butt Weld Inspection and Evaluation Guidelines MRP-139" [1], developed by the Materials Reliability Program (MRP). These requirements include a specification that all PWR must have completed the examination, repair or mitigation of all pressurizer DMW before the end of 2007. Each PWR has one pressurizer, a large vessel with several nozzles installed on its upper head. Most utilities completed these pressurizer DMW inspections on time, but nine utilities deviated from the requirement, planning to mitigate and examine these welds during their refueling outages scheduled in the Spring of 2008.

In October 2006 significant circumferential indications were discovered in three of the six pressurizer nozzle Alloy 82/182 butt welds in the Wolf Creek PWR. The indications were reported by the ISI vendor to be cracking. Over the next several months, both industry's Materials Reliability Project (MRP) and the Nuclear Regulatory Commission (NRC) performed finite element analyses (FEA) and other engineering calculations to assess the adequacy of the ISI schedule requirements of MRP-139, and particularly to assess the status of the nine PWR units whose inspections were scheduled in Spring 2008.

An advanced, three-dimensional FEA was performed by MRP and reported in “Advanced FEA Evaluation of Growth of Postulated Circumferential PWSCC Flaws in Pressurizer Nozzle Dissimilar Metal Welds (MRP-216, Rev. 1)” [2]. This work provided the technical basis for NRC agreement with the inspection schedules of the nine PWRs. The analysis provided reasonable assurance that the stress fields driving crack growth will always be sufficiently asymmetric to ensure that a circumferential crack will grow completely through the wall thickness at a single point. This will result in detectable leakage and allow an orderly plant shutdown prior to a rupture. In other words, the analysis showed that a 360° circumferential crack that is very deep at all points, but not leaking, is not credible.

<u>The Port St Lucie pressurizer</u>

Replacement of the pressurizer is a highly complex and expensive evolution, but the cost and complexity vary with plant design. Four PWRs have a pressurizer design for which replacement was judged a more economic alternative to ongoing inspections and repairs. The pressurizer has been replaced in each of these four plants. FPL Energy donated the retired pressurizer top and bottom nozzles from Port St Lucie Unit 1 (PSL) to the NRC Office of Research (NRC RES). The PSL pressurizer nozzles were stored at a facility in Memphis, Tennessee. Research staff of NRC RES planned a program of NDE on the nozzles using many techniques, to be followed by destructive evaluation (DE) in order to assess the accuracy of the NDE techniques. MRP would collaborate in this program.

INITIAL EXAMINATION
OF PORT ST LUCIE UNIT 1 PRESSURIZER SAFETY NOZZLES

The PSL pressurizer nozzles have never been examined using PDI-qualified UT techniques. Therefore, NRC RES and MRP engaged an NDE vendor to examine the nozzles and learn which DMWs would be of greatest interest for the research program. This examination took place February 5-7, 2008 at the Memphis facility. The examination vendor used a PDI-qualified manual phased array UT procedure. An EPRI staff member participated in an oversight role.

The examiner’s preliminary conclusions were that all three safety nozzle DMWs contained indications consistent with circumferential cracking around the entire circumference. The reported cracking was most severe in nozzle A. The examiner noted that the indications also could be consistent with stacked fabrication defects instead of cracking, and recommended that encoded ultrasonic examination should be performed to make a more precise interpretation. A dye penetrant examination (PT) of the inside surface of the nozzles resulted in a few, short linear indications, but nothing approaching the extent of the UT indications. These results were communicated by MRP to NRC RES in the form of letter reports MRP 2008-012 [3] and MRP 2008-014 [4], included in this report as Attachments 1 and 2. Attachment 1, the trip report of the EPRI staff member present at the examination, indicates that the 360° indications were interpreted to be consistent with cracking. At a later date, stored data from the manual examination (“movies” of scans at each of 19 circumferential positions) was used to create an approximate envelope, or profile, of the circumferential indication in nozzle A.

Upon receipt of this information, EPRI staff associated with MRP realized that if the indications were indeed from cracking, then the reported profile was not consistent with the predictions of the FEA. Because the FEA was a key element of the technical basis for the nine PWRs' continued operation until their Spring 2008 scheduled outages, EPRI communicated the data to NRC RES immediately. NRC NRR was briefed on the profile information the following day by NRC RES. The NRC NRR staff quickly concluded that the operating basis of the nine PWRs must be considered to be compromised unless the UT analyst's conclusion could be shown to be conservative, and the PSL safety nozzles could be shown to include no cracking condition that was inconsistent with the FEA. Only eight of the plants were affected by this concern, because one of them had already shut down for its Spring 2008 refueling outage.

TECHNIQUES DEPLOYED FOR FOLLOW-UP EXAMINATIONS OF THE PORT ST LUCIE UNIT 1 PRESSURIZER SAFETY NOZZLES

This section describes the NDE techniques that were applied to the PSL safety nozzles at the Memphis facility during March 8-12, 2008, in response to industry concerns over the preliminary UT examination results.

Four NDE vendors were mobilized to the Memphis facility in order to examine the safety nozzles. (One of the four vendor activities was discontinued before examinations could be performed.) Nozzle "A" was accorded the highest priority because its UT indications were the most extensive. The primary purpose of the examinations was to determine definitively whether any of the nozzle DMWs contained a degree of PWSCC that could challenge the results of the FEA. A secondary purpose, to be addressed if the examinations showed that the nozzles did indeed contain significant PWSCC, was to demonstrate radiographic examination (RT) techniques on the nozzles and confirm their effectiveness by comparison with destructive examination (DE) results; this would enable utilities to employ the RT techniques to quickly screen their DMWs and confirm their operability until the scheduled Spring 2008 outages.

Staff of the NRC and Pacific Northwest National Laboratory were in attendance during the examinations.

<u>Encoded ultrasonic examination</u>

The NDE vendor company LMT was engaged to perform an encoded UT examination. LMT used the PDI-qualified procedure "Procedure for Encoded, Manually Driven, Phased Array Ultrasonic Examination of Dissimilar Metal Piping Welds"; Zetec_OmniScanPA_03; Revision D; Addenda: 0. This procedure uses a standard set of wedges contoured for various nozzle diameters. The PSL safety nozzles are of an unusual configuration and none of the available wedge contours were within the qualified range of the procedure. Therefore the nozzles were scanned using the most appropriate of the available wedges, and the procedure's qualification was expanded by demonstrating the effectiveness of the wedge in a blind test using a PDI-approved mockup of the same configuration. This mockup, owned and made available by FPL Energy, was designed and fabricated under EPRI's quality assurance program requirements for PDI mockups.

The procedure employs a phased array probe with dual 2x16-element arrays mounted on a wedge with a 6° roof angle. The probe uses an 8-element virtual aperture to generate longitudinal-wave beam angles of 30°, 45°, 60°, and 70°. At each probe position the virtual aperture is scanned electronically through the 16-element actual aperture. The probe is manipulated manually as its position is tracked and recorded by an encoder system. The acquired data was analyzed off-line using Zetec's UltraVision software, version 1.1Q5. This software allows the analyst to view three-dimensional reconstructions of the ultrasonic data and to view slices and projections in three orthogonal planes.

<u>Radiographic examination using an iridium source</u>

The vendor company IveyCooper Services was engaged to perform radiographic examinations using an iridium source. Two techniques were employed.

A single-wall examination of nozzle A was performed to obtain optimized views of the weld defects. Sensitive, high-speed D5 film was placed inside the nozzle and the source was positioned outside. This technique cannot be applied in the field because the inside surface would normally be inaccessible.

A double-wall technique was applied to all three safety nozzles, using finer-grained, more sensitive D4 film. This technique is applicable in the field. If the nozzles were ultimately found to contain significant PWSCC and the technique imaged them clearly, then this could serve as a benchmark to support the use of this technique to screen the pressurizer DMWs at the nine PWR units in question.

<u>Radiographic examination using a linear accelerator</u>

The vendor company HESCO was engaged to perform double-wall radiographic examinations using a linear accelerator. The linear accelerator produces very high-energy photons that can penetrate both walls of the nozzle more readily than the lower-energy photons emitted by an iridium source. Also, the photons emerge from a spot that is smaller than the iridium source, which has the effect of producing sharper images.

This technique is applicable in the field. If the nozzles were ultimately found to contain significant PWSCC and the technique imaged them clearly, then this could serve as a benchmark to support the use of this technique to screen the pressurizer DMW at the nine PWR units in question.

Because of logistical issues HESCO never reached the site. By the time they could be deployed, other NDE techniques had already provided information that minimized the value of the linear accelerator technique in the present situation. Therefore the activity was discontinued.

Dye penetrant examination of the inside surface

Dye penetrant examination (PT) had been performed during the February activity at the Memphis facility. This technique is sensitive to surface-breaking defects of various types. It provides flaw length information but cannot measure flaw depth.

The accuracy of the PT may have been affected by surface conditioning processes that had been applied to the inside of the nozzles. During the decontamination of the head at the Memphis facility the outside and inside surfaces of the nozzles were shot-blasted with ferritic steel grit, and the inside surfaces of the DMWs were then cleaned up using a metallic sponge grinder mounted on a drill motor. This surface treatment could expose flaws that had been subsurface. These exposed fabrication defects could produce dye penetrant indications that in some cases could be linear and circumferential, resembling PWSCC.

Encoded eddy current examination of the inside surface

WesDyne was engaged to perform an eddy current examination (ET) of the inside surfaces of the three safety nozzles. Eddy current is sensitive to interruptions in a metallic surface, such as cracking, oriented in either the circumferential or axial direction. WesDyne deployed an encoded, robotic scanner that is normally used for examination of the inside surfaces of reactor pressure vessel head (RPVH) nozzles, some of which happen to have almost precisely the same inner diameter dimension as the PSL safety nozzles.

The examination equipment was comprised of the IntraSpect Eddy Current Imaging System and the 7010/Open Housing Scanner, which is the standard equipment for RPVH nozzle inspections when no thermal sleeve is present. The inspection was performed using the procedures "WDI-ET-003 Rev. 12, IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations" and "WDI-ET-004 Rev. 12, IntraSpect Eddy Current Analysis Guidelines." Both procedures have been through the MRP demonstration process for reactor vessel head penetration inspections with results documented in "Demonstration of Vendor Equipment and Procedures for the Inspection of Control Rod Drive Mechanism Head Penetrations (MRP-89)" [5] and have been used extensively in the inspection programs required under NRC Order EAC-03-009. This process was chosen because the material and ID dimensions of the safety nozzles are very close to the head penetration nozzles. The inspection technique uses a 0.25" (6.3mm) diameter X point ET probe (a + point probe rotated 45 degrees) used in a driver/pickup mode. The data was collected using an axial scan on 0.04" (1mm) increments with a 1° index (0.025", or 0.63mm). The system calibration process resulted in having the Lissajous signals from circumferential flaws displayed down to the right and axial flaws displayed up to the left.

RESULTS OF FOLLOW-UP EXAMINATIONS OF THE PORT ST LUCIE UNIT 1 PRESSURIZER SAFETY NOZZLES

This section describes the results of the examinations performed on the PSL safety nozzles at the Memphis facility during March 8-12, 2008.

Encoded ultrasonic examination
The report of the examination vendor, LMT, is included as Attachment 3. The evidence of procedure qualification and qualification of the wedge that was used is included as Attachment 4.

Nine indications were reported in nozzle A, five in nozzle B, and seven in nozzle C. All indications were attributed to subsurface flaws resulting from the fabrication process. All were characterized as embedded flaws that are adequately separated from both the inside and outside surfaces of the nozzle. Many additional responses from embedded reflectors were observed but were below the amplitude threshold for reporting indications, as defined in the examination procedure.

A correlation of the encoded UT results with the manual UT results is presented in another section of this report.

Radiographic examination using an iridium source
The report of the examination vendor, IveyCooper Services, is included as Attachment 5. The Attachment comprises IveyCooper's signed reader sheets with an internal EPRI cover memo detailing the technique and findings.

The vendor concluded that the double-wall examination of all three nozzles revealed no inside surface connected indications indicative of stress corrosion cracking. Embedded flaws indicative of fabrication defects were detected in all three welds.

The vendor concluded that the single-wall examination of nozzle A detected no cracking but also detected fabrication defects. Linear indications were detected and verified to be from an ID machining process performed during fabrication.

Dye penetrant examination of the inside surface
This examination was performed in February at the same time as the manual ultrasonic examination. Five linear indications were identified in nozzle A, seven indications were identified in nozzle B, and seven indications were identified in nozzle C. One of the indications in nozzle C was 50mm long. All the other 18 indications were less than or equal to 16mm long.

Encoded eddy current examination of the inside surface
The report of the examination vendor, WesDyne, is included as Attachment 6.

Four circumferential linear indications were identified in nozzle A. They range in length from 0.25 to 0.46 inch (6.3mm – 12mm). No indications were recorded in nozzle B. Four indications were identified in nozzle C; they lacked definitive characteristics of either circumferential or axial orientation, and were identified as surface blemishes.

Comparison of the results of all techniques

A comparison of the results of all techniques is presented in Attachment 7.

A graphical summary of the comparison is presented in Figure 1. The results of the two volumetric methods, UT and RT, should be compared to each other for assessment of indications obtained throughout the material. The results of ET and PT should be compared to each other for assessment of inside surface conditions. The vertical positions of the indications in Figure 1 are not indicative of the axial position of the indications; a few of the overlapping indications have been staggered vertically for clarity.

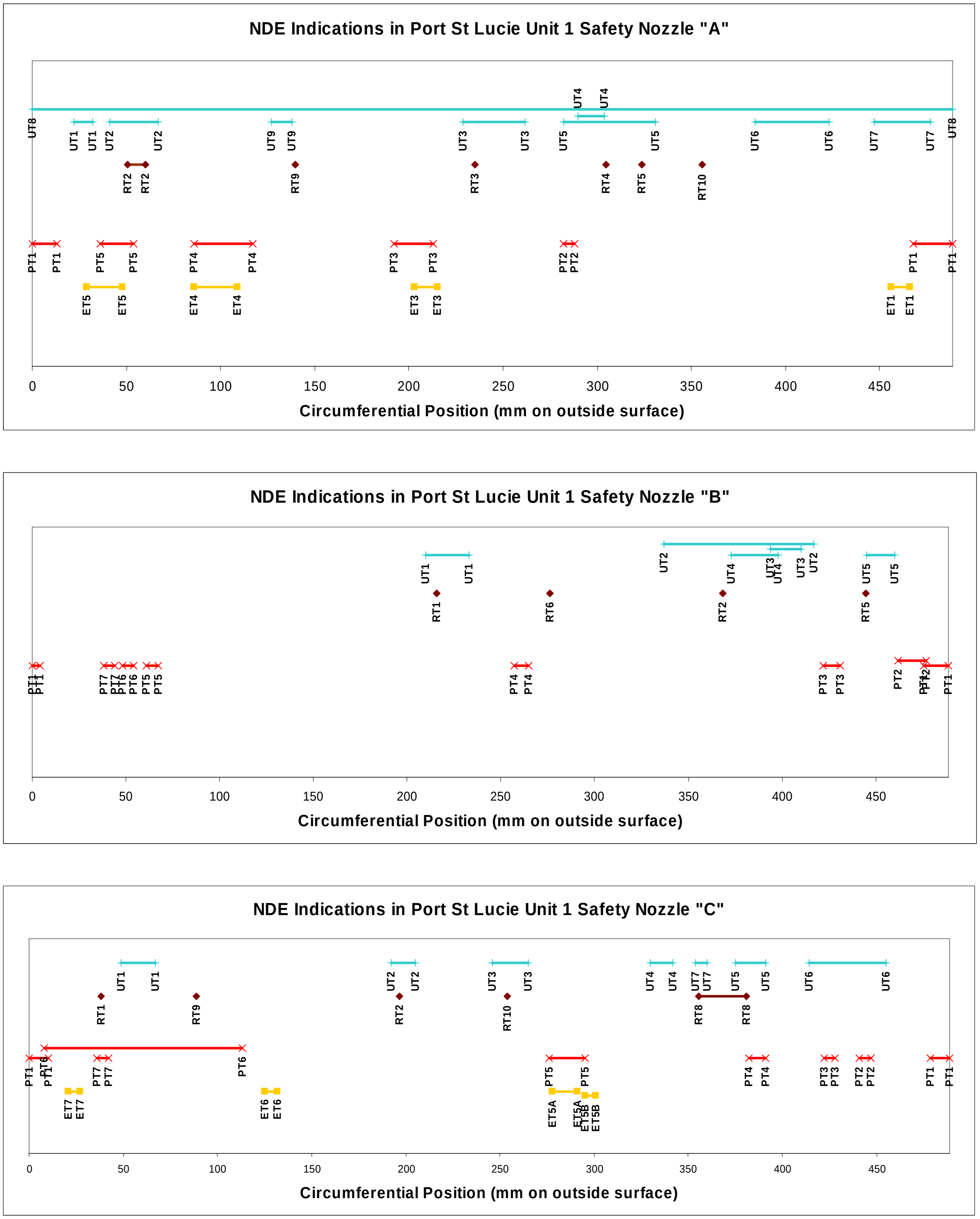

Figure 1. Comparison of all NDE results for PSL safety nozzles A, B, and C.

COMPARISON OF MANUAL ULTRASONIC EXAMINATION RESULTS TO ENCODED ULTRASONIC EXAMINATION RESULTS

The examiner who performed manual UT on the nozzles in February concluded that the indications were consistent with PWSCC, but also that they were consistent with stacked fabrication defects in the weld. He made the conservative decision to report the presence of cracking and also recommended that automated UT be performed to provide additional information.

The examiner who performed encoded UT on the nozzles in March concluded that the indications were related to fabrication flaws only, and reported no evidence of PWSCC.

The two sets of results were compared in order to ensure that the encoded technique had recorded the same reflectors that the manual examiner had evaluated. Normally this would not be possible for a manual UT technique because the ultrasonic information is evaluated in real time, and is not stored. In this case, however, the ultrasonic instrument was capable of recording a live "movie" of the screen presentation as the probe was scanned. A recording was made at each one-inch (25mm) increment on the outside circumference of nozzle A. Each of the 19 recordings comprises the set of sector-scan images that were generated as the examiner moved the phased array probe in the axial direction while maintaining a fixed circumferential position.

To make the comparison, an analyst observed the encoded UT data from each of the 19 circumferential positions at which the manual data had been recorded. At each circumferential position the encoded data was compared side-by-side with a representative screenshot from the manual data. The side-by-side comparison is presented in Attachment 8.

The profile of the indications reported from the manual data is shown in Figure 2 (the same profile that had been reported in Reference [4]). The indications that were reported by the encoded UT vendor were overlaid on the manual UT profile as shown in Figure 3. The two profiles are mutually consistent. Some discrepancies may be due to the difficultly of precisely maintaining a constant circumferential position while scanning manually. There are gaps in the encoded UT profile because the vendor reported only those reflectors whose amplitudes exceeded the procedure's reporting threshold. Many additional reflectors are present in the encoded data and corresponded well with the manual UT measurements, as shown in the side-by-side comparisons in Attachment 8.

The manual UT examiner was provided an opportunity to review the encoded UT data to help develop an understanding of the relative behavior of manual vs encoded examination. After reviewing the encoded data he concurred that the indications represent fabrication defects.

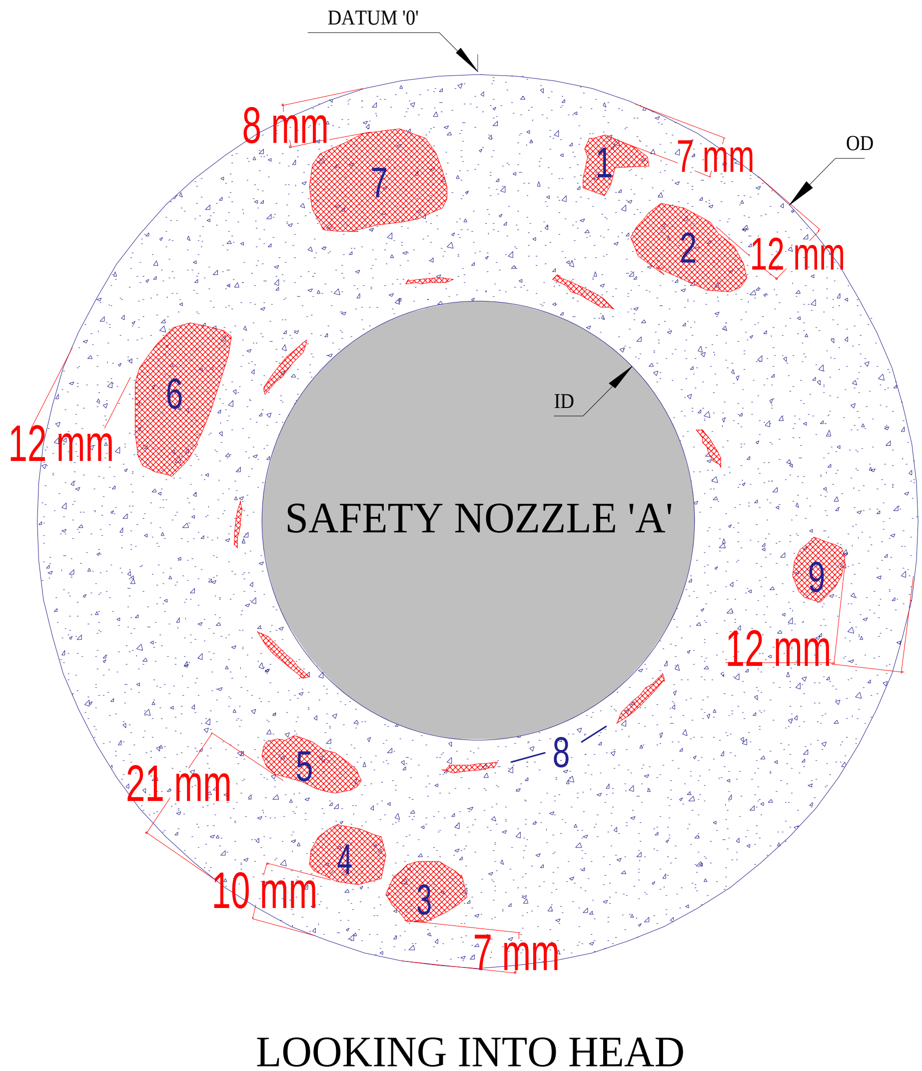

Figure 2. Profile of indications from encoded ultrasonic examination.

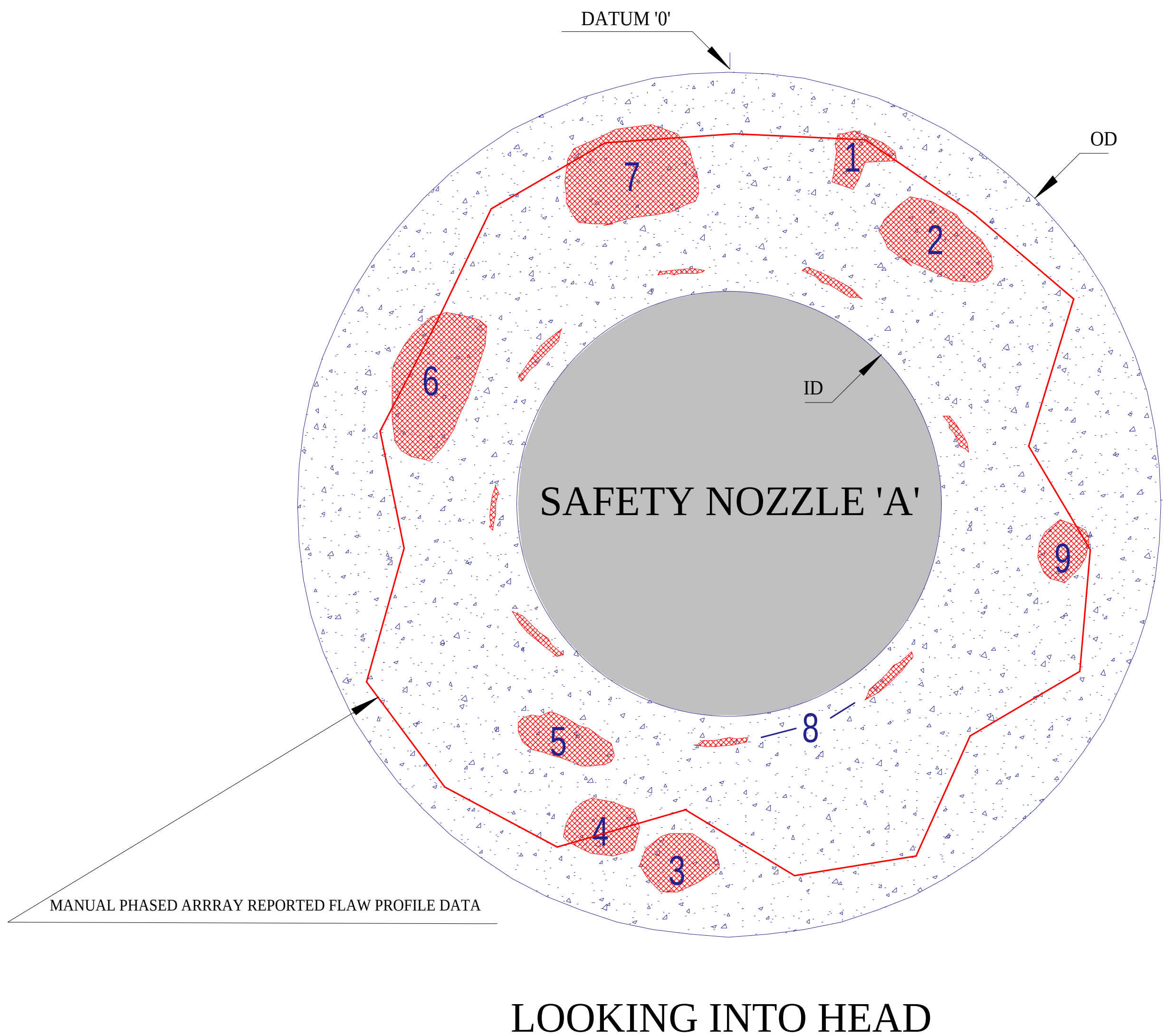

Figure 3. Encoded UT data profile, with manual UT data profile (from MRP 2008-014) overlaid.

INSERVICE EXAMINATIONS OF THE PRESSURIZER SAFETY NOZZLES DURING SERVICE AT PORT ST LUCIE UNIT 1

The safety nozzles were examined during service at Port St Lucie Unit 1. The examinations are described in Table 1. None of the examination techniques were qualified in accordance with ASME Code, Section XI, Appendix VIII, Supplement 10 (this qualification was not available until 2002). None of the examination techniques that were used should be considered to be effective for detection of the reflectors that have been identified during the 2008 examinations.

Table 1. Inservice examinations of pressurizer safety nozzles at Port St Lucie Unit 1.

<table>
<tr><th colspan="4">“A” Safety Nozzle to Flange (6-415A)</th></tr>
<tr><td>Year</td><td>UT Angles</td><td>UT Results</td><td>PT Results</td></tr>
<tr><td rowspan="2">1990</td><td>45RL
0.5” Dia.
2.25mHz Single element</td><td rowspan="2">No Indications</td><td rowspan="2">No Indications</td></tr>
<tr><td>60S
0.5” Dia
2.25 mHz,
Single element</td></tr>
<tr><th colspan="4">“B” Safety Nozzle to Flange (6-415B)</th></tr>
<tr><td>Year</td><td>UT Angles</td><td>UT Results</td><td>PT Results</td></tr>
<tr><td>1994</td><td colspan="2">Not Performed</td><td>No Indications</td></tr>
<tr><td rowspan="2">1996</td><td>45RL
.25” x .5”
2.25 mHz
Dual element</td><td rowspan="2">No Indications</td><td rowspan="2">No Indications</td></tr>
<tr><td>60RL
0.25” x .5”
2.25 mHz
Dual element</td></tr>
<tr><th colspan="4">“C” Safety Nozzle to Flange (6-415C)</th></tr>
<tr><td>Year</td><td>UT Angles</td><td>UT Results</td><td>PT Results</td></tr>
<tr><td>1987</td><td>45RL
0.5” Dia
2.25 mHz
Single element</td><td>No Indications</td><td>No Indications</td></tr>
<tr><td rowspan="2">1996</td><td>45RL
.25” x .5”
2.25 mHz
Dual element</td><td rowspan="2">No Indications</td><td rowspan="2">No Indications</td></tr>
<tr><td>60RL
0.25” x .5”
2.25 mHz
Dual element</td></tr>
</table>

DESTRUCTIVE EVALUATION

The industry and NRC plan to perform DE on nozzle A. Nozzle A has been cut from the PSL pressurizer head and delivered to a hot DE laboratory. The nozzle was cut about 2.5 inches (63mm) below the toe of the DMW. The specific azimuthal locations for DE have not yet been determined.

CONCLUSIONS

Multiple nondestructive evaluation (NDE) techniques were applied to the safety nozzles in the pressurizer that was removed from service at Port St Lucie Unit 1. The methods included ultrasonic, radiographic, dye penetrant, and eddy current examination. The examination results support the conclusion that the safety nozzle dissimilar metal welds contain many common, benign fabrication defects, but no specific indication of stress corrosion cracking.

These examination results are consistent with a review of the advanced finite element analysis [2], using the configuration of the Port St Lucie safety nozzles. Consequently, the FEA models and results for the eight PWR units of interest are still valid and consistent with current inspection data.

Based upon this more complete and accurate characterization, the eight units have concluded their operability determinations remain valid. There is no safety concern.

REFERENCES

1. Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guidelines (MRP-139), EPRI, Palo Alto, CA: 2005. 1010087.

2. Advanced FEA Evaluation of Growth of Postulated Circumferential PWSCC Flaws in Pressurizer Nozzle Dissimilar Metal Welds (MRP-216, Rev. 1), EPRI, Palo Alto, CA: 2007. 1015400.

3. MRP Letter 2008-012 to MRP Technical Advisory Group, "Examination Results on Nozzles from removed St Lucie Pressurizer," with attachment "St. Lucie Pressurizer Nozzle DM Weld Examination Project Internal Office Report", February 21, 2008.

4. MRP Letter 2008-014 to NRC Research, "'A' Pressurizer Safety Nozzle Dissimilar Metal Weld Circumferential Indication Profile," March 4, 2008.

5. Materials Reliability Program: Demonstrations of Vendor Equipment and Procedures for the Inspection of Control Rod Drive Mechanism Head Penetrations (MRP-89). EPRI, Palo Alto, CA: July 2003. 1007831.

ATTACHMENTS

1 – MRP 2008-012
2 – MRP 2008-014
3 – UT report
4 – Documentation of UT qualification
5 – RT report
6 – ET report
7 – Comparison of all NDE techniques for nozzles A, B, and C
8 – Comparison of manual vs encoded UT
9 – Personnel certifications
10 – Pictures of the Memphis activity

The attachments can be downloaded from EPRI's ftp site until March 25, 2008. Instructions have been sent via email for download. You will receive this letter report and the attachments on DVD through the mail as well.

Best Regards,

Christine King
Program Manager
EPRI Materials Reliability Program

ACKNOWLEDGEMENTS

This report represents the results of an intense five-day data acquisition effort. The response of the industry and NRC has been magnificent. The following are acknowledged for their dedicated support without regard to clock or calendar:

AREVA
- Ben Grambau

EPRI
- Bob Barnes
- Craig Harrington
- Christine King
- Doug Kull
- Carl Latiolais
- Greg Selby
- Jack Spanner
- David Steininger
- Ronnie Swain

HESCO
- Mike DePinna

IveyCooper Services
- Jason Glasco
- Matthew Heaps
- David Ivey
- Grady Pickett

LMT
- Todd Blechinger
- Jeff Devers

NRC
- Jay Collins
- Al Csontos
- Tim O'Hara
- Robert Hardies
- Ted Sullivan
- Rob Tregoning

PNNL
- Mike Anderson

Studsvik Memphis facility
- Kevin Butler

Utilities
- Guy DeBoo, Exelon
- Rudy Gil, FPL Energy
- Gary Lofthus, Southern Nuclear
- Terry McAlister, SCE&G
- Dan Nowakowski, FPL Energy
- William Sims, Entergy

WesDyne
- Jack Lareau
- Timothy Majoros
- Eric Overly