RIII

From: Melvin Holmberg RIII
To: Harold Chernoff NRR
Date: Mon, May 17, 2004 1:52 PM
Subject: Fwd: RE: Talking Points Regarding PBNP U1R28 Reactor Vessel Head Inspection

Latest licensee extent of condition evaluation for nozzle 26.

CC: Hills, David

Release

A-12

R111

From: R. Michael Morris
To: Chernoff, Harold
Date: Mon, May 17, 2004 12:28 PM
Subject: Fwd: RE: Talking Points Regarding PBNP U1R28 Reactor Vessel Head Inspection

From: "Tomes, Charles A." <Charles.Tomes@nmcco.com>
To: "Tomes, Charles A." <Charles.Tomes@nmcco.com>, "Morris, Mike" <Mike.Morris@nmcco.com>, <RMM3@nrc.gov>, <DEH@nrc.gov>, <MSH@nrc.gov>
Date: Fri, May 14, 2004 6:04 PM
Subject: RE: Talking Points Regarding PBNP U1R28 Reactor Vessel Head Inspection

All
A copy of the extent of condition evaluation is attached to this email.
Thank you,
CATomes
<<PBNP Extent of Condition Evaluation of Pene 26 May 13 2004 final.doc>>

> -----Original Message-----
> From: Tomes, Charles A.
> Sent: Friday, May 14, 2004 4:00 PM
> To: Morris, Mike; 'RMM3@nrc.gov'; 'DEH@nrc.gov'; 'MSH@nrc.gov'
> Cc: Huting, Mark ; Schweitzer, Jim
> Subject: Talking Points Regarding PBNP U1R28 Reactor Vessel Head Inspection
>
> Please find attached talking points for two issues identified by Mel:
> 1) Extent of Condition
> 2) Repair Weld PQR
> Thank you,
> CATomes
> << File: 051404 huting.doc >> << File: PBNP Unit 1 Conference Call 5 14 04 Rev 0.ppt >>

CC: "Huting, Mark " <Mark.Huting@nmcco.com>, "Schweitzer, Jim" <Jim.Schweitzer@nmcco.com>

NMC
Committed to Nuclear Excellence

INTERNAL CORRESPONDENCE

To: Mark Huting
From: Charles Tomes
Date: May 13, 2004
Subject: U1R28 Extent of Condition Evaluation for Penetration # 26 at PBNP
Copy To: John Paul Cowen, Lyle Bohn, Doug Cooper, Gary Van Middlesworth, James Schweitzer, Craig Lambert, Brian Kemp, Bill Jensen, Kim Bezzant, Gary Sherwood, Jim McCarthy

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Purpose
The primary objective of this evaluation is to document the results of the extent of condition review of indications disclosed in penetration #26 at PBNP-1.

Summary

1. PBNP conservatively elected to repair penetration #26 due to:
    a. Presence of a large crack like ultrasonic reflector,
    b. Verification through review of construction records that this area may have been repaired during construction, and
    c. Detection through confirmatory dye penetrant examination of small linear indications.
2. Dye penetrant examination was performed "for cause" as a second NDE method to provide confirmation whether the nature of an ultrasonic reflector disclosed in penetration #26 was relevant. NRC Order EA-03-009 or ASME B&PVC Section XI does not require such dye penetrant examination.
3. PBNP conservatively elected to apply the acceptance criteria in EA-03-009 to repair penetration #26 as opposed to the acceptance criteria in ASME B&PVC Section XI because of problems encountered in industry at other utilities such as leakage.
4. Examinations have been performed to verify the structural integrity and leak integrity of all remaining penetrations for two (2) consecutive operating cycles at PBNP (U1R27 and U1R28). Ultrasonic examinations of the nozzles detected no recordable indications, ultrasonic examinations of the counter bore regions showed no evidence of corrosion products, and bare metal visual examination of the top head region demonstrated no evidence of leakage.
5. Additional dye penetrant or eddy current examinations of the J-groove welds prior to returning the reactor vessel head to service are not required or recommended since structural integrity and leakage integrity has been verified and there are no UT indications that suggest the need for confirmatory PT.
6. NMC has evaluated the need for performing additional dye penetrant or eddy current examinations of the J-groove welds as an extent of condition evaluation consistent with

the corrective action process and general design criteria 16.

7. The existence of a small-undisclosed flaw in a J-groove weld does not reduce safety margins defined in ASME B&PVC Section III and XI over an operating cycle.
8. Engineering assessments[2] by Westinghouse Electric Company (WEC), Structural Integrity Associates (SIA), and Electrical Power Research Institute (EPRI) Materials Reliability Program (MRP) Alloy 600 Working Group demonstrate that the J-groove welds may be safely returned to service even if they contain an undisclosed flaw.
9. NMC should continue to execute plans for replacement of the reactor vessel head in Fall 2005 as its primary method of managing PWSCC of the alloy 600 tubing and J-groove welds.

History

The PBNP U1 reactor vessel was designed by Westinghouse Electric Company (WEC) and fabricated by Babcock and Wilcox (B&W) in accordance with ASME B&PVC Section III. Design of the reactor vessel utilizes margins of safety to protect the health and safety of the public. The Nuclear Regulatory Commission (NRC) has mandated various criteria for acceptance of inspections for PWR reactor vessel heads in the Code and Federal Regulations, Plant Technical Specifications, and Executive Orders. EPRI MRP has developed a safety evaluation report for management of primary water stress corrosion cracking (PWSCC) of alloy 600 CRDM tubing and associated J-groove welds including the potential for boric acid corrosion to the reactor vessel head. The safety assessment has been submitted to and endorsed by NRC.

NRC EA-03-009 mandates that utilities examine the alloy 600 CRDM tubing and J-groove welds either by:

1. Ultrasonic examination (UT) of the tubing, UT of the leak path, and above head visual examination, or
2. EC of wetted boundary and above head visual examination.

Inspection services are available from two (2) vendors: Framatome ANP and WEC. To satisfy these requirements, NMC has awarded a contract to Framatome ANP to perform inspection services. The Framatome ANP inspection program is based upon UT of tubing, UT of the counter bore region for corrosion products, and above head visual examination. NMC personnel perform above head visual examinations. At time of contract award, the WEC inspection program was based upon examination of the wetted boundary of the alloy 600 tubing/J-groove weld and above head visual examination. Under both the Framatome ANP and WEC inspection program, utilities have elected to perform follow-up PT "for cause" to confirm the presence of NDE indications disclosed using automated equipment. Both of these inspection programs ensure margins of safety are maintained and that reactor coolant leakage has not occurred. Industry practice is to perform 100% examination using the combination of methods described above. There is no need to perform a scope expansion to use other NDE methods as 100% examination is conducted each operating cycle and any detected areas of concern are repaired prior to returning the unit to service.

To date, NMC is unaware of any utility that has implemented an expansion criteria to perform inspections over and above 100% ultrasonic (or eddy current) inspection and above head visual examination. NMC and the industry have elected to use various combinations of automated UT or ECT and above head visual examination to confirm margins of safety and verify that leakage of the reactor coolant pressure boundary has not occurred. These NDE techniques preclude the need to implement a scope expansion to conduct additional dye penetrant or ECT of J-groove welds (except for confirmation of a suspected flaw disclosed by either UT or ECT). The use of PT as a primary mode of inspection is discouraged for managing the issue of PWSCC since:

1. The surface condition of the J-groove welds is such that manual grinding may be necessary,
2. Access restrictions exist which preclude examination of the inside diameter of the alloy 600 CRDM tubing thereby requiring the use of UT or ECT as the prior method of examination,
3. Existing surface configuration may result in false calls.
4. PT does not give quantitative information regarding flaw depth.

These potential complications are thought to significantly out weigh any benefit of using PT as a primary mode of inspection because:

1. Leakage integrity and structural integrity is confirmed through automated UT in combination with the above head visual examination,
2. Radiation exposure would be adversely affected due to the need for numerous personnel entries into a high radiation/high contamination area in order to support PT and grinding, and
3. Application of PT may result in some unnecessary repairs since some prior existing fabrication flaws may exist.
4. It is highly likely that grinding operations would be required to clean numerous fabrication indications. Grinding is a know contributor to initiation of PWSCC and could have a negative impact on plant safety far exceeding any benefit that might be gained from removal of minor fabrication indications.

Due to these potential complications, both NMC and the industry have reserved the application of dye penetrant inspection for confirmation of a defect originally disclosed by either UT or eddy current inspection using automated equipment.

Discussion

Framatome ANP completed examinations of the reactor vessel head at PBNP U1 in U1R27 and U1R28. The results of a comprehensive examination program revealed the possibility of cracking in penetration #26 at PBNP during U1R28. NMC has mobilized Framatome ANP to repair this penetration by performing a machining operation to move the affected pressure retaining partial penetration weld, commonly referred to a the J-groove weld, to another region in the bore of the reactor vessel head using temper bead welding techniques. Following repair of the penetration #26, NMC will have satisfied all aspects of NRC Order EA-03-009.

Completion of these examinations and repair of penetration #26 ensures that the reactor vessel head at PBNP U1 is safe to operate and may be returned to service because:

1. The UT examination of the tubing ensures that no circumferential flaws (and axial flaws) exist that could compromise plant safety,
2. The UT examination of the counter bore region ensures that incipient leakage is not occurring through the J-groove welds,
3. The above head visual examination ensures that leakage of the J-groove welds is not occurring, and
4. Engineering assessments by Structural Integrity Associates (SIA) and Electrical Power Research Institute (EPRI) Materials Reliability Program (MRP) Alloy 600 Working Group demonstrate that the J-groove welds may be safely returned to service for an operating cycle even if they contain an undisclosed flaw. Details pertaining to these assessments include:
    a. NMC contracted SIA to evaluate the probability of reactor coolant leakage and/or nozzle failure over the next operating cycle and found that the probabilities are extremely low and acceptable. The model developed by SIA is bench marked based on thirty (30) plants that have performed NDE of tip head nozzles, of which 14 plants experienced either cracking the J-groove welds, the alloy 600 tubing, or leakage. The analysis for PBNP U1 considers actual plant head geometry and materials, operating time, and temperature of the reactor vessel head.
    b. EPRI MRP issued MRP-110 (Reactor Vessel Closure Head Penetration Safety Assessment for U.S. PWRs, April, 2004) which addresses root cause of degradation experienced at Davis Besse. This document summarizes the magnitude of structural damaged seen on carbon steel components due to boric acid leakage and documents that unidentified leakage over an operating cycle will not lead to significant wastage or compromise the structural limits of the reactor vessel head.

Completion of these inspection activities satisfies the criteria outlined in the safety evaluation submitted by EPRI MRP and accepted by NRC. Because PBNP U1 performed examination of essentially 100% of the penetrations, additional scope expansion is not required or recommended in that structural integrity and leak integrity has already been verified. Structural integrity is verified by the absence of axial and circumferential flaws in the alloy 600 CRDM tubing at or above the J-groove weld. Leak integrity is verified by the absence of axial and circumferential flaws in the alloy 600 tubing, absence of corrosion products in the counter bore region adjacent to the alloy 600 tubing above the J-groove weld, and absence of boric acid crystals on the reactor vessel head. Completion of these activities validates margins of safety included in ASME B&PVC Section III and XI.

It should be noted that alloy 600 materials are limited to the reactor vessel head J-groove welds and CRDM tubing and BMIs at PBNP U1. The integrity of the BMI's are demonstrated through visual examinations performed each refueling outage and are inaccessible to other NDE from the exterior of the reactor vessel. Other NDE techniques are not needed on the BMIs at this time, as the operating temperature in the lower head is lower than at the top of the reactor reducing the risk of PWSCC.

Examination Details
During U1R28, Framatome ANP, initially recorded a UT indication on Penetration #26. Following initial recording of the UT reflector as a valid UT indication, the UT signature was re-evaluated by the Framatome Corporate UT Level III, additional examinations were performed to ascertain the nature of the reflector, and the initial fabrication records were reviewed.

The UT reflector is located on the downhill side of the penetration. A comparison of UT data from U1R28 and U1R27 confirms that the reflector was recorded during U1R27. It should however be noted that scanning was only performed using an axial blade probe during U1R27. During U1R28 scanning has been performed using both axial and circumferential blade probes.

Coincident to analysis of the UT indication by the Framatome Corporate UT Level III, PBNP proactively performed a PT to confirm the significance of the ultrasonic signature observed on the downhill side of the penetration. During this PT, light indications were observed on two (2) opposite sides of the penetration approximately 90 degrees from the down hill side. Due to the high radiation fields under the reactor vessel head, the site did not fully characterize the PT indications since it was likely that the penetration would be repaired and NRC had already granted relief to PBNP from characterizing indications observed during PT subject to the Framatome ANP temper bead repair process.

The detection of PT indications in concert with a large ultrasonic reflector with crack like characteristics on the same penetration was cause for further investigation. The site conducted several activities in parallel including mobilizing Framatome ANP for the possibility of making a repair, consultation with the Framatome Corporate UT Level III, and review of construction records.

Regarding the UT reflector, the Framatome Corporate UT Level III determined that the reflector is related to fabrication-related geometry and does not possess characteristics indicative of primary water stress corrosion cracking (PWSCC). A review of the fabrication records provided by WEC reveals that this region of penetration #26 may have been repaired during fabrication. The fabrication records indicate that a UT was performed during construction and that an indication described as "weld repair root pass" is documented. Thus, evidence has been independently verified to confirm the Framatome determination that the UT reflector is fabrication related. Furthermore, the in-service examinations performed during U1R27 and U1R28 confirm that the nature and size of the UT reflector and show that it has remained unchanged over the operating cycle.

Regarding the PT indications on opposite sides of the penetration approximately 90 degrees from the down hill side, the site performed four (4) separate PT examinations, two (2) of which involved removal of weld metal in an attempt to clear the indications. Observations during this process are as follows:

1. The initial dye penetrant indications were extremely faint. The surface conditions of J-groove weld at the time of the initial PT examination was partially ground from original

construction but the site did not perform any additional mechanical surface conditioning (hand cleaning with a Scotch Brite™ pad was performed).

2. The second PT was performed after minor mechanical cleaning (i.e., flapper wheel) and showed a slight increase in coloration.
3. The third PT was performed after grinding/flapping of approximately 1/16 inch and produced results consistent with that from the second PT.
4. A fourth PT was performed after more grinding, e.g., additional 1/8 inch of metal, and produced results similar the previous PTs.

The exact origin of the indications in the J-groove weld for penetration #26 is not known with certainty as a boat sample has not been removed nor has a failure analysis been performed. NMC has reviewed information gathered to date (which includes PT results, UT results, and historical fabrication records) in an attempt to better understand the cause of minor cracking observed in penetration #26. The following list provides a summary of information:

1. The PT bleed out is faint compared to PWSCC observed at other sites.
2. The location of surface cracking is adjacent to the large ultrasonic signature and repair region.
3. The orientation of the short cracks is transverse to the weld beads.
4. The extent of cracking is judged to be minor in nature.

Fabrication of the J-groove welds involved PT of the root weld, PT at various depths throughout the welding process, and PT of the final weld. Construction practice did not include PT between each weld pass. The construction code allowed different size indications to remain in the weld without repair. As noted above, the fabrication records indicate that the weld was repaired during original fabrication. It is well known that the welding of alloy 82 and 182 metal is difficult and can result in various metallurgical defects such as crater cracks, hot cracks, carbides, and slag inclusions. It is speculated from review of available information that:

1. A repair of the J-groove weld was made to penetration #26 during fabrication,
2. The repair resulted in a geometry that displays a large ultrasonic signal,
3. Stresses associated with repair of the J-groove weld aggravated prior existing fabrication related metallurgical defects commonly observed in alloy 82 and 182 welds creating minor surface cracking observed during confirmatory PTs.

The other nondestructive examinations performed on penetrations #26 indicate that the tubing, counter bore region, and reactor vessel head is free of defects, wastage, and boric acid deposits. Additionally, UT and above head visual examinations for the other penetrations indicate that the tubing, counter bore region, and other areas on the reactor vessel head is free of defects, wastage, and boric acid deposits. Thus, the margins of safety for structural integrity and leakage have been maintained for penetration #26 and for the balance of other penetrations in the reactor vessel head.

Considerations to Extent of Condition

NMC has conservatively concluded that a repair to penetration #26 should be performed prior to returning the reactor vessel head to service due the:

a. Presence of a large crack like ultrasonic reflector,
b. Verification through review of construction records that this area may have been repaired during construction, and
c. Detection through confirmatory dye penetrant examination of small surface indications in the J-groove weld.

Structural integrity and leak integrity for the remaining penetrations on the reactor vessel head is verified through a series of activities including:

1. Review of ultrasonic signatures obtained during under heads performed during U1R27 and U1R28.
2. Review of available fabrication records to ascertain what other penetration may have been repaired during original fabrication.
3. Essentially 100% inspection of the alloy 600 CRDM tubing, counter bore region, and reactor vessel head in accordance with EA-03-009.
4. Deterministic crack growth calculations to demonstrate the structural integrity of the nozzles performed by WEC.
5. Probabilistic fracture mechanics analysis performed by SIA of the probability reactor coolant leakage and nozzle failure over the next operating cycle.
6. Verification that any undisclosed reactor coolant leakage that could occur over an operating cycle will not compromise structural limits to the reactor vessel head by wastage.

As part of the review and disposition process for penetration #26, NMC and Framatome NDE Level III's reviewed the scan profiles obtained during U1R28 to identify penetrations that contain ultrasonic features characteristic of fabrication. Furthermore, the site has reviewed RE-RV-445 dated September 1969, entitled "Field Repair of Unit 1 Reactor Vessel Closure Head" to determine penetrations that have been previously repaired. These activities have identified a population of seventeen (17) penetrations that have minor ultrasonic features characteristic of fabrication. Table 1 identifies the population of penetrations classified as having fabrication related ultrasonic signatures. It must be noted that only one (1) of these penetrations, i.e., penetration #26, possess UT signals that are large in size and characteristic of cracking. And only one (1) other penetration, i.e., penetration #27, is noted as having been repaired during construction. However, the in-service ultrasonic examinations on penetration #27 performed during U1R27 and U1R28 did not result in a fabrication or crack like indication. Thus, none of the other penetrations noted as being repaired during construction show ultrasonic signals characteristic of fabrication or cracking.

A review of information collected under this investigation provides the follow insights:

1. Following completion of essentially100% ultrasonic examination and above head visual examination for two (2) consecutive outages, NDE indications have only been confirmed on penetration #26.

2. The ultrasonic signal observed on penetration #26 is large in size and crack like in nature.
3. The size of the repair cavity is judged to have resulted in higher residual stress to the surfaces adjacent to the repair area and aggravated prior existing metallurgical anomalies characteristic of alloy 82 and 182 weld metal such as hot cracking, crater cracking, and micro fissuring.
4. A review of the fabrication records and ultrasonic signatures from U1R27 and U1R28 did not reveal any other nozzle with large fabrication signals and evidence of a repair during construction.
5. One other penetration, #27, is noted as having been repaired during construction however the ultrasonic signatures from U1R27 and UIR28 are clean.

Three other pieces of information are known about the condition of the reactor vessel head alloy 600 tubing and J-groove welds.

1. During U1R27, a PT examination of penetration #1 was performed as a confirmatory second NDE method to help understand and disposition an observed ultrasonic reflector. The PT examination on penetration #1 confirmed that the j-groove weld was free of cracking.
2. In preparation for the underhead inspection during U1R28, NMC contracted SIA to assess the probability of leakage at PBNP U1 as a precaution in case the site was not able to obtain 100% examination coverage. The model used by SIA has been submitted to NRC, (MRP-105, Probabilistic Fracture Mechanics Analysis of PWR Reactor Pressure Vessel Top Head Nozzle Cracking, March, 2004) and is benchmarked on real data at thirty- (30) plants that have performed nozzle NDE, of which fourteen (14) have experienced leaks or cracks. The results of this work indicate that the probability of leakage over the next operating cycle at PBNP U1 is < 1.5%. This information is illustrated in Figure 1. The NRC has stated that a probability of leakage of <5% would seam appropriate and consistent with other regulatory positions (Letter, Richard Barrett to Alex Marion, "Initial Comments and Questions on MRP-75, PWR Reactor Pressure Vessel Upper Head Penetrations Inspection Plan, Rev. 1", December 9, 2003).
3. MRP 110 (Reactor Vessel Closure Head Penetration Safety Assessment for U.S. PWRs, April, 2004) demonstrates that unacceptable wastage of the reactor vessel head will not occur should undetectable reactor coolant leakage occur at a J-groove weld over an operating cycle.

As noted above, the site has confirmed structural integrity by verifying that the absence of axial and circumferential flaws in the alloy 600 CRDM tubing at or above the J-groove weld. Leak integrity is verified by the absence of axial and circumferential flaws in the alloy 600 tubing, absence of corrosion products in the counter bore region adjacent to the alloy 600 tubing above the j-groove weld, and absence of boric acid crystals on the reactor vessel head. Thus, it is known with certainty that leakage through the J-groove welds has not occurred at any time at PBNP U1. While PBNP U1 is not managing PWSCC by leakage (since no leakage has occurred or is allowed by the Technical Specifications) the site has taken steps to quantify and manage the probability of leakage over the next operating cycle when the reactor vessel head will be replaced. The probabilistic analysis by SIA demonstrates that the site is effectively managing the probability of leakage. MRP 110 demonstrates that unacceptable wastage of the reactor vessel head will not occur should undetectable reactor coolant leakage occur at a J-groove weld over an operating cycle.

Completion of the inspection activities and various engineering evaluations discussed herein validates margins of safety included in ASME B&PVC Section III and XI. Based upon this information scope expansion to perform additional NDE such as PT or ECT of J-groove welds is not recommended or warranted.

NMC has made a decision to replace the reactor vessel head as the preferred approach to managing the potential for primary water stress corrosion cracking at PBNP. NMC has made arrangements to replace PBNP U1 in fall 2005 and PBNP U2 in spring 2005.

As a precaution and in strict compliance with EA-03-009 the site is pursuing repair of the J-groove weld for penetration #26 which involves partial removal of the alloy 600 J-groove weld and re-establishment of the pressure retaining boundary with a seal weld to the carbon steel counter bore region of the reactor vessel head using temper bead welding techniques.

[As part of the review process, details pertaining to the scope and results of the examinations during U1R28 including the issue of scope expansion have been discussed with various members of EPRI MRP and Structural Integrity Associates. These individuals concurred with NMC's conclusion that scope expansion to examine additional J-groove welds (by dye penetrant or eddy current testing) is not warranted as discussed above.] [2]

Conclusions

1. The repair of penetration #26 was made as a conservative measure due to a crack like UT indication and the presence of linear indications found during confirmatory PT inspections.
2. It is believed that a large documented repair performed during construction is responsible for the UT indications. The PT indications are likely fabrication flaws that were aggravated by the repair and service conditions.
3. Extent of condition was reviewed and it is determined that the conditions exhibited in penetration #26 are isolated. This is due to it being the only penetration with a repair that causes significant crack like UT indications. Although the indications were evaluated to be fabrication related and not PWSCC they are significant and repair is a conservative measure. No other penetration has this type of UT indication to this extent.
4. PT examination was performed on this penetration only to be used as a confirmatory PT to help characterize the nature and significance of the UT signature. Such a PT examination is not required by NRC Order EA-03-009 or ASME Section XI. It showed that the repair detected by UT had likely aggravated existing fabrication surface indications. There is no reason to expand PT inspections as it was simply used as a confirmatory technique. The PT was not performed as an ASME Section XI examination and such does not fall under the requirements for inspection sample expansion.
5. NMC has verified structural integrity and leakage integrity of all penetrations through 100% inspection and structural analysis. A thorough bare metal visual examination of the

head was performed, and no evidence of leakage exists on any of the CRDM penetrations. Furthermore, it is known that if unidentified leakage were to occur over an operating cycle it would not compromise the integrity of the reactor vessel head.

6. Operation of the reactor vessel head following repair of penetration #26 will not compromise nuclear safety or structural limits whether or not additional PT examinations are performed of j-groove welds. The probability of leakage over the next operating cycle is demonstrated to be acceptably small, < 1.5%, without performing additional PT examinations of the J-groove welds.
7. Based upon this information, the reactor vessel head may be returned to service following repair of penetrations #26.
8. Replacement of the reactor vessel heads should be pursued in accordance with the current schedule.

Footnotes

(1) Reference WCAP-14000 Rev 1, Probabilistic Risk Assessment of Leakage at PBNP U1 (SIA), MRP-55, and MRP-110.

(2) External participants in various telephone calls included Pete Riccardella (SIA), Hal Gustin (SIA), Tom Alley (Chairmen EPRI MRP Alloy 600 Inspection Committee), Kim Kietzman (EPRI Project EPRI MRP Alloy 600).

Table 1
Extent of Condition Evaluation Regarding Examination of Alloy 600 Tubing & J-Groove Welds at PBNP U1R28
(Penetrations With Fabrication Related UT Signals)

Penetration #	1969 WEC Report	U1R28 Data	Ring Location	Comment/Extent of UT Reflector	Priority By Qualitative Ranking
37		X	9	350-359° @ interface Geometrical Reflector	2
36		X	9	14-22°, 11% TW tube Geometrical Reflector	2
9		X	2	143° spot @interface Geometrical Reflector	2
49		X	4	6-55° @ interface Geometrical Reflector	2
6		X	2	214-228°, 11% TW tube Geometrical Reflector	2
43		X	4	3-20°, 3% TW 83-91°, 20% TW Geometrical Reflector	2
29		X	8	17-50°, 10% TW Geometrical Reflector	2
26		X	8	88-96°, 7% TW 134-181°, 19% TW Crack like Morphology	1
25		X	7	117-137°, @ interface 151-175°, @ interface Geometrical Reflector	2
1		X	0	58° spot, 12 % TW Geometrical Reflector	2
4		X	3	82° spot, 7% TW Geometrical Reflector	2
11		X	5	355° spot, 8% TW Geometrical Reflector	2
4	x		3	UT @ DH 12-14 inches, UT @ UH 22-24 inches	2
3	x		3	UT@ UH 16-18 inches	2
40	x		1	UT@ DH 10-14 inches	2
39	x		1	UT@ DH 4-12 inches	2
26	x		8	UT@ DH 14-17 inches	3
27	x		8	UT@ UP 3-5 inches Noted as a weld repair during construction	3

Note 1 – UT reflector for penetration #26 possessed crack-like morphology. Follow-up dye penetrant inspection (using a separate method to confirm presents of flaw)
Note 2 – UT reflector characteristic of geometry but not crack-like in morphology
Note 3 – Construction records provide evidence that a repair may have been performed during fabrication

Figure 1
Probability of Leakage at PBNP U1