Bryce L. Shriver
Senior Vice President and
Chief Nuclear Officer

PPL Susquehanna, LLC
769 Salem Boulevard
Berwick, PA 18603
Tel. 570.542.3120 Fax 570.542.1504
blshriver@pplweb.com

April 7, 2004

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station OP1-17
Washington, DC 20555

SUSQUEHANNA STEAM ELECTRIC STATION
SUPPLEMENTAL INFORMATION FOR
PROPOSED RELIEF REQUESTS NO. 29 AND 30 TO THE
SECOND 10-YEAR INSERVICE INSPECTION PROGRAM
FOR SUSQUEHANNA SES UNIT 1
PLA-5743 **Docket No. 50-387**

Reference: 1) PLA-5740, B. L. Shriver (PPL) to NRC titled "Proposed Relief Request No. 29 to the Second 10-Year Inservice Inspection Program for Susquehanna SES Unit 1," dated March 26, 2004.

2) PLA-5741, B. L. Shriver (PPL) to USNRC, "Proposed Relief Request No. RR-30 to the Second 10-Year Inservice Inspection Program for Susquehanna SES Unit 1," dated March 26, 2004.

This letter provides the supplemental information discussed during the teleconference held April 5, 2004 between PPL Susquehanna and the NRC staff. The information provided in the attachment supplements the proposed Relief Request No. 29 (Reference 1) and Relief Request No. 30 (Reference 2). Both Relief Requests are needed to support the current refueling and inspection outage Inservice Inspection repair plan for the repair of the Reactor Pressure Vessel N1B Nozzle to safe-end weld.

Review and approval of the Relief Request 29 and 30 is requested by April 12, 2004.

There are no new commitments made in this letter. If you have any questions, please contact Mr. Michael H. Crowthers at (610) 774-7766.

Sincerely,

B. L. Shriver

Enclosure – Response to Request for Additional Information

Attachments:
Attachment 1 - Weld Sketches
Attachment 2 - EPRI NDE Center Summary Report
Attachment 3 - Revised Relief Request 29

A047

copy: NRC Region I
Mr. R. V. Guzman, NRC Project Manager
Mr. S. Hansell, NRC Sr. Resident Inspector
Mr. R. Janati, DEP/BRP

ENCLOSURE TO PLA-5743

SUPPLEMENTAL INFORMATION IN SUPPORT OF RELIEF REQUESTS NO. RR-29 AND 30

PPL SUSQUEHANNA, LLC
SUSQUEHANNA SES UNIT 1
SECOND 10-YEAR INTERVAL
SUPPLEMENTAL INFORMATION
IN SUPPORT OF RELIEF REQUEST NO. RR-29 AND 30

NRC Question 1:

American Society of Mechanical Engineers (ASME) Code Case (CC) N-638 limits the size of the repair to 100 sq. in. maximum and a depth not greater than ½ the ferritic base metal thickness. Some of the reasons for these limits are:

a. Distortion of weld and base metal

b. Cracking in weld and base metal

c. Large residual stresses

A final weld surface area of 300 sq. in. is significantly larger than that allowed by ASME. Justify the basis for exceeding these limits and addresses each point above, by analysis, testing and specific experience with these types of weld areas.

PPL Response

Sizing of the defect identified that it is 2.3 inch long in circumference and is 1.1 inches deep. A full structural weld overlay repair (standard weld overlay) has been designed and is being implemented.

This weld overlay repair involves temper bead welding on the low alloy steel nozzle to provide load transfer across the weld. The weld overlay design is based on the requirements of ASME Section XI, IWB-3640 and uses the guidance of Code Case N-504-2, for the weld overlay design and Code Case N-638 for the ambient temperature temper bead welding. One of the requirements of Code Case N-638 is that the weld overlay repair on the low alloy steel surface be limited to 100 in^2. PPL has requested relief from this restriction such that the overlay covers a low alloy steel surface area of about 300 in^2. The reason for the relief is to allow PPL to ultrasonically inspect the area involving the crack region from the nozzle side of the weld as required by Paragraph 4.0(b) of Code Case N-504-2.

The justification for this requested relief is presented in the paragraphs below.

Prior History

There have been a large number of temper bead weld overlay repairs applied to nozzle to safe-end welds in the nuclear industry. For the most part, these have involved smaller diameter components, and have generally been able to be performed while meeting the 100 in^2 requirement of Code Case N-638. However, at least two nozzle to safe end welds have exceeded this limit. These include the nozzle to safe end repair at V. C. Summer, where a nozzle butter was applied to a nominal 30 inch diameter, 3-inch thick nozzle using the temper bead process (this repair involved approximately 300 in^2), and to the Three Mile Island surge nozzle, where a weld overlay repair was extended onto the nozzle to vessel blend radius so as to avoid producing a high stress concentration at the toe of the overlay (this repair involved greater than 200 in^2).

Code Considerations

Code Case N-432 has always allowed temper bead welding on low alloy steel nozzles without limiting the temper bead weld surface area to 100 in^2. The two additional conditions required by N-432 that are not required by Code Case N-638 are that the temper bead repair have preheat when applied and that the procedure qualification be performed on the same specification type, grade and class of material as the component being welded in the field. The first of these requirements would present a severe man-rem radiation burden to PPL when performing this repair. The second condition could readily be met. It is principally for the man-rem exposure reason that Code Case N-638 was selected for performing this repair. Code Case N-638 is more restrictive than N-432 when the size of the repair is considered.

The ASME Code committees have recognized that the 100 in^2 restriction on the overlay surface area size is excessive and a draft code case is currently in progress within ASME Section XI to increase the area limit to 500 in^2. The code case currently has the designation RRM 00-04 and attempts to combine the features of Code Cases N-432 and N-638 into a single code case. The supporting analysis for the draft code Case RRM 00-04 (prepared by EPRI) concluded that residual stresses are not detrimentally changed by increasing the area of the repair for ambient temperature temper bead repairs, and that tempering of the heat affected zone is unaffected by the weld overlay application.

NRC Request for Additional Information Concerns

The NRC has noted that limits for the 100 in^2 repair are based upon the following issues:

a. Distortion of the weld and base metal
b. Cracking in weld and base metal
c. Large residual stresses

The EPRI report that supports the draft code case RRM 00-04 examined the issue of residual stresses and of cracking associated with the weld overlay application. It concluded that the residual stresses were not detrimentally changed and that the tempering effects of the repair were not affected by the size of the overlay.

The issue of cracking and/or distortion of the weld and base metal were not specifically addressed in the code case development work. Since the girth weld and butter, and the weld overlay are fabricated from austenitic materials, with very high inherent toughness, no cracking is expected to occur due to the shrinkage associated with the weld overlay. With respect to the low alloy steel, as was noted above, many temper bead weld overlays have been applied in the BWR industry to these nozzle to safe end locations. In no instance has there been any reported cracking due to the weld overlay application. The stiffness and high toughness inherent in the low alloy steel nozzle is expected to protect against any cracking and severely limit any distortion that might occur in the low alloy steel nozzle. PPL will be measuring and evaluating axial shrinkage for impact on the nozzle and safe end materials and piping system in accordance with Code Case N-504-2.

Summary and Conclusions

Significant laboratory testing and field experience have been documented qualifying the temper bead weld overlay repair for safe end to nozzle welds. These efforts and experience have demonstrated that the remedy provides a very high quality, sound repair to these joints. These repairs have included instances where more than a 100 in^2 surface area repair was applied to low alloy steel nozzles without detrimental effects. The 100 in^2 repair limitation has been examined in detail. It has been concluded that it is acceptable to exceed that limit without detrimental effects. As a result, the draft Code Case RRM 00-04 has been prepared by ASME.

The ASME Code has recognized that the 100 in^2 repair limitation is arbitrary and is progressing with a code case to extend the limit to 500 in^2.

The PPL request for this area limit extension is based upon the desire to perform the best baseline UT possible following the weld overlay application.

NRC Question 2:

What are the thickness of the nozzle, pipe, original ASME II material classification 182 butter, and final weld overlay?

PPL Response

The requested thicknesses are as follows:

Nozzle	2.125 inches
Pipe	1.453 inches
Original 182 butter	See Sketch # 2 in Attachment 1
Final overlay weld	0.74 inch

In addition, the thickness of the safe end is the same as the nozzle. The final weld overlay weld was designed assuming a flaw 360 degrees in circumference 100% though wall. The actual flaw is approximately 2.3 inches long in circumference and 1.1 inches deep.

NRC Question 3:

Provide a sketch of the original weld and base metal configuration and final weld and base metal configuration with the overlay?

PPL Response

The original weld and base metal configuration is shown in the attached Sketch #2. For the final weld and base metal configuration with the overlay, see the attached Sketch #1. These sketches are included in Attachment 1.

NRC Question 4:

How many layers of weld metal will be applied for the overlay?

PPL Response

The current plans are to apply 12 layers of weld material. The final number of layers will be determined based on the number of layers needed to meet the thickness requirement of the overlay.

NRC Question 5:

What is the Code of Record and current Inservice Inspection interval?

PPL Response

The Code of Record is ASME Section XI 1989 Edition. The present interval is the second.

NRC Question 6:

What is the original code of construction?

PPL Response

The original code of construction is ASME Code Section III 1968 Edition up to and including 1970 Summer Addenda.

NRC Question 7:

Provide additional information regarding your ultrasonic examinations of N1B nozzle to safe end weld:

> **NRC Question (a)**
>
> You have determined that the detected flaw is due to intergrannular stress corrosion cracking (IGSCC). Provide the bases for your determination. Also describe in detail the ultrasonic testing (UT) characteristics that are used to support the IGSCC determination. What are the UT characteristics or other considerations that are used to exclude the possibility of thermal fatigue cracks?
>
> **PPL Response:**
>
> The ultrasonic data from the flaw has characteristics indicative of a multifaceted and branching indication propagating in a direction consistent with a stress corrosion crack in weld material, which generally follows the dendritic structure of the weld. This type of response is not consistent with the expected responses from a thermal fatigue flaw, which are typically not faceted. The ultrasonic responses from this flaw are also consistent with other IGSCC flaws detected in the industry.

NRC Question (b)

Describe in detail the inspection results reported in Table 1 of Electric Power Research Institute (EPRI) summary report dated March 26, 2004.

PPL Response:

See answers to specific questions below.

NRC Question i.

Explain and describe the reported features of inside surface geometry, interface, acoustic interface, non-relevant indications, clad roll, non-geometric and slag inclusion. Also explain why different features were reported at different examinations.

PPL Response:

The following is a description of the ultrasonic response reported features from the previous examinations;

Inside Surface Geometry

Inside Surface Geometry generally results from reflections from known geometric feature reflections such as root or counterbore. These indications are usually seen for the entire length of the scan and have consistent echo dynamic patterns with little or no through wall extent. Other conditions that could cause geometric indications are welded lugs or other machining or welding processes (clad) that may have caused a surface condition sufficient to reflect energy back to the instrument.

Interface and Acoustic Interface

Interface and acoustic interface are terms for the same effect, which is caused by the impedance differences between the weld material and base material. This type of indication is usually seen for 360 degrees and is generally more prevalent from the carbon steel to stainless interfaces. These indications can also be seen when there is a change in welding direction such as the butter to structural weld interface, and at the location of weld repairs.

Clad Roll

Clad roll is an ultrasonic indication produced by the acoustic interface between the ferritic base material and the cladding and/or the reflections from as-welded clad beads. This type of indication is only seen when scanning from the nozzle side of a clad nozzle and can be seen for 360 degrees. This type of indication can also be classified as a geometric indication, but usually does not exceed reportable threshold levels.

Non Relevant Indication

Non Relevant indications, such as surface noise, are generally considered indications that are of no concern. Some examiners also considered geometric indications as non-relevant.

Non-Geometric and Slag Inclusion

Indications that cannot be classified as geometric or metallurgical are classified as non-geometric. Examples of non-geometric indications are cracks, slag, and lack of fusion or other welding type defects. Slag inclusions are embedded defects that are contained within the volume of the weld.

Summary

All of the examination data reported examples of each of the above. These indications, however, were not required to be reported to the plant for disposition. These were reported simply as notes on the examination data sheets. The level of detail provided from one examination to the other varied with the particular analyst. The present PDI qualified procedure requires all indications, regardless of amplitude, be evaluated and addressed.

NRC Question ii.

Provide a sketch to show the locations of the slag inclusion or weld repair, if any, and the circumferential flaw.

PPL Response:

The EPRI report (Attachment 2) contains numerous prints that show the location of the previously reported slag inclusion and the newly reported crack. It is believed that the previously reported slag inclusion was actually the crack.

NRC Question iii

Provide the reason that slag inclusion was not reported in 2004 examination?

PPL Response:

The improved and newly qualified techniques used in 2004 allow for improved data collection and analysis such that the previously reported slag inclusion could be more accurately determined to be the reported crack.

NRC Question (c)

In EPRI summary report dated March 26, 2004, the reason that the flaw indication was not detected using a reflective longitudinal (RL) 45-degree probe in earlier examinations was attributed to lack of contact. However, the indication was identified in Figure 7 based on 2004 data using 45 degree RL probe. Please explain.

PPL Response:

It is believe that the 45 degree data from the previous examinations did not have sufficient contact due to loss of couplant or incorrect pressure applied to the search unit to keep it coupled to the surface. This condition was not obvious to examiners when using the older data analysis software. When using the new data analysis software, this type of condition is easy to detect and thus easy to make appropriate adjustments to correct the condition. The data collected in the 2004 examination with the 45 RL search unit has very good contact.

NRC Question (d)

Provide details regarding how the Performance Demonstration Initiative (PDI) qualified techniques were optimized in 2004 examination and compared it with the techniques used in earlier examinations.

PPL Response:

Three major things have changed from the previous techniques and the newly qualified techniques. 1) The data analysis software is much improved from previous examinations performed prior to 1999. This new software allows the viewing of the data in numerous, coordinated views (A, B, C and D scans). These views make it easier for the examiner to assure adequate contact and coverage is obtained. 2) The amplifier was changed from a linear to a logarithmic amplifier with a much larger dynamic range. This allows the examiner to view the data with a much larger range of gain levels and reduces chances of saturating the signals or running at a gain level that is too low. 3) Search units used with the present PDI qualified procedure are larger and focused closer to the inside surface of the component than the search units used for previous examinations. This results in greater sensitivity for inside surface breaking flaws.

NRC Question (e)

Discuss in detail that how the mechanical stress improvement process (MSIP) will impact the transparency of the flaw during ultrasonic examination. Can this be demonstrated by comparing the results between pre-MSIP and post-MSIP examinations?

PPL Response:

MSIP applies high compressive stresses to the region of the pipe near the inside surface, which would compress at least portions of any existing flaw. This compression could, at a minimum, reduce its reflectivity at the inside surface. Studies have shown that the detectability of flaws is not compromised significantly by the use of MSIP. (See EPRI report Title: *"Evaluation of Repair, Replacement, Mitigation and Examination Approaches for Boiling Water Reactor Nozzle/Safe End Configurations" dated September 27, 1993.*) However, in this case the combination of marginal contact, the use of less than optimized search units and decreased reflectivity from the compression of the flaw on the inside surface could have given the appearance of an embedded defect with no connection to the inside surface. The search units used during 2004 examination were larger and focused closer to the inside surface, and thus they clearly showed the connection to the inside surface. This fact supports the findings of the above referenced report. Below is a table of measurements taken on flaws that have been compressed utilizing Hot Isostatic Pressure (HIP). All of the flaws were placed in a single plate and were run through the same HIP cycle. The flaws were located in alloy 182 material welded in a similar fashion to the welds at PPL. While this is not the same compression process and does not produce the same through-wall stress distributions as MSIP, it does show the effect of compression on the ultrasonic response. All flaws were detectable after squeezing. All of the flaws showed reduced amplitude and signal to noise ratio after HIP, but to varying degrees. The reduction indicates that the effects of the compression are not consistent from one flaw to another. Therefore, the effect on the ultrasonic responses from cracks depends on their individual shapes and degree of faceting and tightness.

Plate	Angle	Access	Flaw	Max. Amp Pre-HIP	Max. Amp Post-HIP	Delta	SNR Pre-HIP	SNR Post-HIP
1_2_03	45	DNS	1C	20.1	13.8	-6.3	5.12 to 1	2.29 to 1
1_2_03	45	DNS	2C	22	14	-8	5.12 to 1	2.29 to 1
1_2_03	45	UPS	1C	18.8	11.3	-7.5	4.89 to 1	2.37 to 1
1_2_03	45	UPS	2C	12.2	8.2	-4	2.72 to 1	2 to 1
1_2_03	60	DNS	1C	16	10	-6	3.93 to 1	1.8 to 1
1_2_03	60	DNS	2C	20.1	17.3	-2.8	5.8 to 1	4.4 to 1
1_2_03	60	UPS	1C	17.6	10.7	-6.9	4.89 to 1	2.13 to 1
1_2_03	60	UPS	2C	13.5	6.9	-6.6	4.73 to 1	2 to 1

NRC Question 8:

In RR-30, provide the bases for changes to the following paragraphs in Appendix VIII, supplement 11 examination: Paragraphs 1.1(b), 1.1(e)(2), 1.1(e)(2)(a)(2), 1.1(e)(2)(b)(3), 1.1(f)(1), 1.1(f)(3), 1.1(f)(4), 2.1, 2.2(d), 2.3 and 3.1.

PPL Response

(Note that the bolded text is added for emphasis.)

1.1(b) was changed from:

> "The specimen set must include at least one specimen with overlay thickness within -0.1 in. to +0.25 in. of the maximum nominal overlay thickness for which the procedure is applicable."
>
> To:
>
> "The specimen set **shall include specimens with overlays not thicker than 0.1 in. more than the minimum thickness, nor thinner than 0.25 in. of the maximum nominal overlay thickness for which the examination procedure is applicable.**"

Basis for the change: The revision to paragraph 1.1(b) was made solely to clarify the intent of the original wording.

1.1(c)(2) was changed from:

> "Specimens shall be divided into base and over-lay grading units. Each specimen shall contain one or both types of grading units."

> To:

> "Specimens shall be divided into base **metal** and overlay **fabrication** grading units. Each specimen shall contain one or both types of grading units. **Flaws shall not interfere with ultrasonic detection or characterization of other flaws.**"

Basis for the change: The term base "metal" and overlay "fabrication" was applied for clarity and consistency through out the Supplement. This change was made in several other areas. The proposed sample requirements allow a tighter mix of flaws and the last sentence was intended to prevent the location of flaws from precluding their detection.

1.1(c)(2)(a)(2) was changed from:

> "When base metal cracking penetrates into the overlay material, the base grading unit shall include the overlay metal within 1 in. of the crack location. This portion of the overlay material shall not be used as part of any overlay grading unit."

> To:

> "When base metal **flaws penetrate** into the overlay material, the base **metal** grading unit shall not be used as part of any overlay **fabrication** grading unit."

Basis for the change: The term base "metal" and overlay "fabrication" was applied for clarity and consistency through out the Supplement. This change was made in several other areas. The PDI removed the reference to "cracking" because the sample sets may contain "alternative flaws." The requirement that the base metal grading unit include the overlay metal within 1 inch of the crack location is unnecessarily restrictive. It is PDI's intention to allow a tighter mix of flaws, provided they don't interfere with ultrasonic detection or characterization of other flaws.

1.1(c)(2)(b)(3) was changed from:

"Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base grading units, ten unflawed base grading units, five flawed overlay grading units, and ten unflawed overlay grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units."

To:

"Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base **metal** grading units, ten unflawed base **metal** grading units, five flawed overlay **fabrication** grading units, and ten unflawed overlay **fabrication** grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units. **For initial procedure qualification, detection sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required."**

Basis for the change: The term base "metal" and overlay "fabrication" was applied for clarity and consistency through out the Supplement. This change was made in several other areas. The last two sentences were included to provide additional requirements for qualification of procedures and to make this Supplement consistent with the requirements in the other Supplements for procedure qualification.

1.1(f)(1) was changed from:

"The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be cracks open to the inside surface."

To:

"The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws **shall be open** to the inside surface. **Sizing sets shall contain a distribution of flaw dimensions to assess sizing capabilities. For initial procedure qualification, sizing sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required."**

Basis for the change: The PDI removed the reference to "cracks" in the 2nd sentence because the sample sets may contain "alternative flaws." An additional requirement that the sizing sets contain a distribution of sizes is intended to challenge the procedure over a wide variety of flaw sizes. The last two sentences were again included to provide additional requirements for qualification of procedures and to make this Supplement consistent with the requirements in the other Supplements.

1.1(f)(3) was changed from:

> "Base metal cracking used for length sizing demonstrations shall be oriented circumferentially."
>
> To:
>
> "Base metal **flaws** used for length sizing demonstrations shall be oriented circumferentially."

Basis for the change: The PDI removed the reference to "cracking" because the sample sets may contain "alternative flaws."

1.1(f)(4) was changed from:

> "Depth sizing specimen sets shall include at least two distinct locations where cracking in the base metal extends into the overlay material by at least 0.1 in. in the through-wall direction."
>
> To:
>
> "Depth sizing specimen sets shall include at least two distinct locations **where a base metal flaw** extends into the overlay material by at least 0.1 in. in the through-wall direction."

Basis for the change: The PDI removed the reference to "cracking" because the sample sets may contain "alternative flaws."

2.1 was changed from:

> "Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base or overlay) that are present for each specimen."

To:

> "Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base **metal** or overlay **fabrication**) that are present for each specimen."

Basis for the change: The term base "metal" and overlay "fabrication" was applied for clarity and consistency through out the Supplement. This change was made in several other areas.

2.2(d) was changed from:

> "For flaws in base grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25% of the base wall thickness."

To:

> "For flaws in base **metal** grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25% of the base **metal** wall thickness."

Basis for the change: The term base "metal" was applied for clarity and consistency through out the Supplement. This change was made in several other areas.

2.3 was changed from:

> "For the depth sizing test, 80% of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate. For the remaining flaws, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region."

To:

> "(a) **The depth sizing test may be conducted separately or in conjunction with the detection test.**
> (b) **When the depth sizing test is conducted in conjunction with the detection test and the detected flaws do not satisfy the requirements of 1.1(f), additional specimens shall be provided to the candidate.** The regions containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region.
> (c) **For a separate depth sizing test, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region."**

Basis for the change: Though not precluded in the original requirements, paragraph (a) specifically provides the latitude to conduct the sizing test separately or in conjunction with a detection test and was included for clarity. Though not precluded in the original requirements, paragraph (b) specifically allows providing additional specimens to the candidate who is successful during detection, but detected less than the 10 flaws required for sizing. It was again included for clarity. Rather than identify a specific location the PDI proposal in paragraph (c) is to only identify the region of the flaw. It is then incumbent on the examiner to determine the maximum depth by searching along the flaws length. This is consistent with the way examinations are conducted in the field.

3.1. was changed from:

> "Examination procedures, equipment, and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. The criteria shall be satisfied separately by the demonstration results for base grading units and for overlay grading units."
>
> To:
>
> **"a) Examination procedures are qualified for detection when;**
>
> **1) All flaws within the scope of the procedure are detected and the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for false calls.**
> - **(a) At least one successful personnel demonstration has been performed meeting the acceptance criteria defined in (b).**
> - (b) Examination equipment and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls.
> - (c) The criteria in **(a), (b)** shall be satisfied separately by the demonstration results for base metal grading units and for overlay fabrication grading units."

Basis for the change: The original requirements would allow qualification of procedures equipment and personnel with only a personnel qualification. Paragraph (a)(1) includes the additional requirement that the procedure be capable of detecting all flaws within its scope. Paragraph (a)(1)(b) was included at the request of the NRC and basically states that a procedure cannot be qualified until a person is qualified to use it.

NRC Question 9:

In the latest version of Regulatory Guide 1.147, Revision 13, dated June 2003, CC N-416-2 is accepted with a condition that the provisions of IWA-5213, "Test Condition Holding Times," 1989 Edition, are to be used. Therefore, CC N-416-2 with imposed condition should be used instead of CC N-416-1.

PPL Response

The flaw in the N1B nozzle did not penetrate the pressure boundary either before or during the welding process as evidenced by the lack of leakage. This was confirmed by the acceptable completion of a surface examination on the surface of the nozzle prior to welding and the first layer of the weld overlay, as well as by visual observation during welding operations. Therefore, in accordance with the requirements of Code Case N-504-2, paragraph (h), there is no longer a need to perform a system hydrostatic test, and therefore there is no longer a need to implement Code Case N-416-1. A system leakage test will be performed in accordance with IWA-5000. The revised Relief Request 29 included in Attachment 3 has been revised to remove the requested option to utilize Code Case N416-1.

NRC Question 10:

In CC N-416-1 and CC N-416-2, non-destructive examination is required to be performed on welded repairs in accordance with the methods and acceptance criteria of the applicable Subsection of the 1992 Edition of Section III. Section III generally requires 100% radiography testing (RT) of all Class 1 butt welds. However, only UT and surface examinations are specified in CC N-504-2 and N-638. Provide discussion to demonstrate that UT specified for weld overlay inspection is an acceptable alternative to RT, particularly regarding the detection capability of welding defects such as slag, inclusion, porosity and lack of fusion.

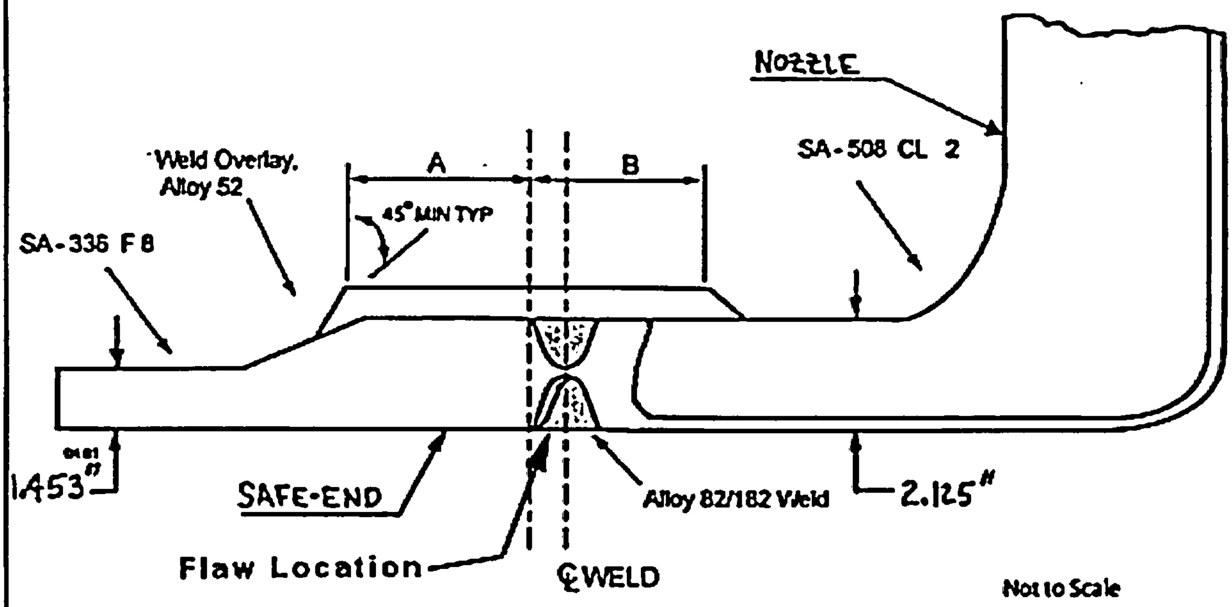
PPL Response

As indicated in the response to question 9, Code Case N-416-1 will not be implemented for this repair, therefore there is no need to take exceptions to the requirements of Code Case N-416-1.

ATTACHMENT 1 TO PLA-5743

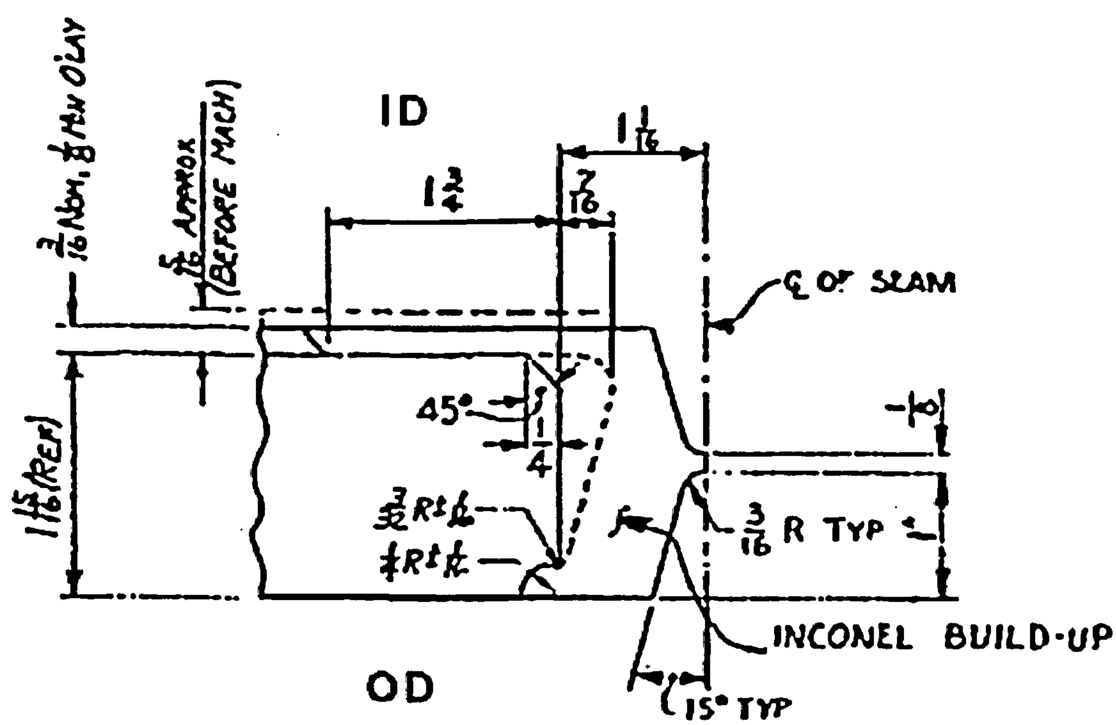
WELD SKETCHES

Sketch #1
N1B Nozzle and Weld Overlay Configurations



WELD NUMBER	FLAW CHARACTERIZATION	Design Dimensions t	A	B	COMMENTS
Recirculation Outlet Nozzle N1	Assumed 360° Circ. 100% throughwall flaw	0.74" min	2.5" min	4.2" min	

Sketch #2
N1B Nozzle Weld Prep
(Original Configuration)



ATTACHMENT 2 TO PLA-5743

EPRI NDE CENTER SUMMARY REPORT

ELECTRIFY THE WORLD

Susquehanna Steam Electric Station – Unit 1
Ultrasonic Examinations of N1B Nozzle to Safe End Weld
EPRI NDE Center
Summary Report
March 26, 2004

Scope

EPRI NDE Center staff provided on-site assistance at Susquehanna Steam Electric Station (SSES) during the Unit 1 13th Refueling & Inspection Outage (U1-13RIO). The primary purpose of the on-site support was to perform an independent review of ultrasonic (UT) examination results for the N1B nozzle to safe end (N1B Noz-SE) weld. On-site support for this activity included the following related tasks:

- Review of previous manual and automated ultrasonic examination data
- Review of available fabrication records including construction radiographs
- Assistance with site preparations for weld overlay UT examinations
- Assistance with review and selection of expanded scope welds

Background

During the U1-13RIO inservice inspections (ISI) at SSES, the N1B Noz-SE weld was examined as part of the population scheduled in Unit 1's second ten-year interval ISI program. The N1B Noz-SE configuration contains a dissimilar metal weld joining the carbon steel nozzle to a stainless safe end (28 inch OD and nominal thickness 2.15 inches). N1B Noz-SE is denoted in SSES's ISI program as a Category "C" weld. This category refers to welds that have undergone a stress improvement (SI) process , but are not made of resistant materials. A mechanical stress improvement process (MSIP) was applied to the N1B Noz-SE weld in 1995 during U1-8RIO. SSES also started Hydrogen Water Chemistry in 2000.
Automated UT examinations of the N1B Noz-SE weld was performed during the U1-13RIO using GE Nuclear Energy Procedure GE-UT-209, *"Procedure for Automated Ultrasonic Examination of Dissimilar Metal Welds, and Nozzle to Safe End Welds."* As documented on the applicable Performance Demonstration Qualification Statement (PDQS No. 468) dated Sept. 11, 2003, GE-UT-209 meets the requirements of The Performance Demonstration Initiative's Implementation of The American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Appendix VIII, Supplement 10.

GENE's initial evaluation of the U1-13RIO automated UT data revealed a planar-type, circumferentially oriented indication located at the approximate top dead center. The planar indication appeared to be contained in the weld material and connected to the inside surface. Evaluation of the qualified UT sizing data showed the flaw to be approximately 2.0 inches long with a through wall dimension of 1.14 inches.

On-site assistance from NDE Center staff was requested by Mr. Randy Linden to support an independent evaluation of the weld and to support expanded scope activities. EPRI's Carl Latiolais and Jeff Landrum traveled to SSES in support of this request. This summary report documents the on-site NDE Center support and provides recommendations for related weld overlay repair NDE activities. Additionally, the report includes related industry experience.

References

1) General Electric Rapid Information Communication Services Information Letter (RICSIL) No: 082 Titled *"Core Spray Nozzle to Safe-end Leak"* Dated October, 17, 1997.

2) GE Nuclear Energy Services Information Letter (SIL) SIL No. 455 Revision 2 Titled "*ISI of additional Alloy 182 Welds*" Dated January 29, 2001.

3) Brookhaven National Laboratory Report Titled *"Metallurgical Evaluation of a Feedwater Nozzle to Safe-End Weld from River Bend Station Unit 1"*. This report was prepared by request of the NRC. (Task Order No; 2, Fin E2089, Subtask No. 5a.) Dated August 1995.

4) NDE Alert Bulletin P-98-009 Titled "*Lessons Learned Regarding Effective Detection and Discrimination of Flaws in Dissimilar Metal Welds.*" Issued early 1998.

5) *Dissimilar Metal Piping Weld Examination – Guidance and Technical Basis for Qualification,* EPRI, Palo Alto, CA: 2003. 1008007.

Service Related Experience

Documentation from dissimilar metal weld failures in BWRs was collected and reviewed for relevance. Related information relevant to this review has been included below.

Hope Creek

In October of 1997, Hope Creek Nuclear Power Station detected a through wall crack in their N6 Core Spray nozzle to safe end weld. Root cause analysis determined that this crack was due to interdendritic stress corrosion cracking (IDSCC) in the alloy 182 weld material located in a weld repair area. The presence of this weld repair was confirmed by a review of the fabrication data, which indicated that the weld was repaired nine times, and in some cases was excavated down to the root (Ref.4). This type of repair process may have caused a crevice condition on the inside surface of the component, which is a known initiation point for IGSCC. Due to problems in the ultrasonic characterization of the defect, GE issued a revision to SIL-455 (Ref. 2) to incorporate lessons learned from this experience. Additionally, EPRI issued an NDE Alert (Ref. 4) that also included additional inspection processes aimed at increasing the reliability of the examinations. These recommendations included the following:

- Expanding the examination volume to cover the entire inconel weld and adjacent heat affected zone.
- Interrogate the upper regions of the weld, outside the code examination volume, to search for reflections from growing face of midwall to deep flaws orientated both axially and circumferentially.
- The use of enhanced automated imaging systems that allow presenting the ultrasonic data in multiple views which aid in the evaluation
- Review of previous examination data utilizing the improved ultrasonic data analysis software.
- Thorough reviews of the fabrication records in an effort to locate fabrication defects or known repair areas, especially on inside surfaces, that could be a potential site of initiation.

Duane Arnold (RF-16, 1999)

While performing scheduled ultrasonic examinations on the recirculation system, two indications were found in the N2B safe-end-to-nozzle inlet weld. As a result, expanded scope examinations were performed on welds of a similar configuration. During these examinations, similar indications were also found in the N2D. The examinations were performed using automated ultrasonic examination procedures approved for application to dissimilar metal weld configurations that were enhanced based on the Hope Creek experiences documented above.

Depth sizing data was collected, but this data was limited due to the presence of weld crowns. However, the flaws could be measured to a depth of at least 65% of the thickness.

Weld overlay repairs were performed on both nozzles. In preparation for overlay, one of the flaw locations started to leak, confirming that the indication was associated with a deep crack found with the enhanced automated techniques. Review of previous automated data with the advanced data analysis software indicated that the indications were present in the 1996 data. A complete review of the fabrication records and digitized radiographs show that there were extensive weld repairs performed in the root area of the welds during fabrication. The final root, while acceptable, contained areas of suck-back and root concavity in the area of the flaws, which appear to have sharp edges creating an inner surface creviced condition. These conditions are believed to act as stress risers that are initiation points for SCC.

Riverbend Unit 1

During a 1989 scheduled inservice inspection, a circumferential indication was found by ultrasonic examination in the N4A-2 inlet feedwater nozzle to safe-end weld during the second refueling outage. The indication, approximately six inches long with a reported maximum depth of 0.20"was located in the Alloy 182 weld butter on the safe-end side of the weld. This indication was reexamined four times in a period of 3 years and crack growth was reported each time. The safe-end was replaced during the 1992 RF-4 refueling outage.

The NRC contracted Brookhaven National Laboratory to conduct a metallurgical examination and failure analysis, including destructive examination of the safe-end weld. The results of this evaluation indicated that the cracking was interdendritic stress corrosion cracking of Inconel 182 weld metal that initiated at a weld defect (lack of root penetration or lack of fusion) located at the original base metal/alloy 182 interface, approximately 84% through wall and 7.0" long.

The cracking mechanism determination in this report was based on tests performed on alloys 82 and 182 in simulated reactor environments. Testing was conducted on creviced and noncreviced slow strain specimens. These experiments showed that in the uncreviced condition all alloys were immune to SCC, while in the creviced conditions, both Alloys 600 and 182 were susceptible to SCC. It also stated that the fractography of the specimens were quite similar to the River Bend crack and that the fabrication flaw noted acted as the crevice condition needed for initiation.

Nine Mile - Unit 2

During RF07 (1999), as a result of industry events and implementation of lessons learned from Hope Creek, Nine Mile Staff reviewed the data on 17 dissimilar metal welds that were previously examined with automated techniques. This review was performed with RD-TECH TomoView data analysis software. While reviewing the feedwater nozzle to safe end weld 2RPV-KB20 (N4D), it was noted that there were several indications present that were not addressed in previous examination reports. The newly identified indications appeared to be located in the same radial plane above a surface connected fabrication flaw originally reported in 1995. A detailed flaw analysis was performed in 1998 and it was considered acceptable for continued operation. Although this analysis was performed conservatively assuming active IGSCC, it was considered to be most likely a fabrication flaw that exhibited no growth based on three UT examinations (1990, 1995 and 1998).

In RF07 (2000) the utility requested EPRI personnel to perform a detailed evaluation and comparison of the 1998 data with the new data collected in 2000. The results of this effort determined that the flaw length remained essentially the same from 1998 to 2000. However, when the 1998 data was re-analyzed and compared to the 2000 data, it indicated that there was some evidence in growth in the through wall height of the flaw.

Based on this evaluation, it was determined that the flaw identified in the Inconel 182 buttering of this weld was representative of an active stress corrosion crack that had initiated from a previously documented area that contained a fabrication defect believed to be lack of fusion that was connected to the inside surface. This condition may have provided a crevice condition that acted as the initiation point for the Stress Corrosion Crack.

Pilgrim Unit 1

While online Entergy personnel noted an increasing trend of unidentified drywell leakage. The plant was shutdown in a planned outage to install a Unit Aux Transformer (UAT). At this time, it was noted that Control Rod Drive nozzle (N10) was leaking in the nozzle to cap weld area. Subsequent investigations by NDE ultrasonic personnel determined that source of the leak appeared to be a 1.75" long circumferential crack located in the butt weld adjacent to what seemed to be a previously repaired area. A manual examination was performed on this weld to better characterize the flaw and provide information to support the overlay repair. This examination was performed in accordance with ASME Section XI, Appendix VIII, Supplement 10 as modified by the Performance Demonstration Initiative (PDI) program. The following was observed during the examination;

- A circumferential flaw was detected within the area adjacent to the through wall leak,

- This flaw could only be evaluated with the higher angle search units (60 and 80-ODCR) degree refracted longitudinal search units due the unusually large weld width caused by the repair.

- The length of flaw was measured to be 1.75" and has a semi-elliptical depth profile that starts out shallow on the ends and propagates radially toward the center of the flaw where it actually leaked through,

- This flaw did not exhibit typical ultrasonic signal characteristics indicative of Intergranular Stress Corrosion Cracking (IGSCC), which is understandable since the flaw is located totally in the weld material unlike IGSCC, which is generally located solely in the fine grain base material,

- It was visually and physically apparent that a weld repair was performed in the same location as the flaw.

Fabrication records for this weld were reviewed and confirmed that a weld repair was made in the area of this flaw. Radiographic reader sheets state that the inside surface in the area of the flaw was also ground in an effort to remove unacceptable conditions noted on the fabrication radiograph. Additionally, the radiographs were digitally enhanced to increase resolution and they also confirmed the presence of the weld repair in the area of the leaking crack.

<u>Review of Weld History for SSES Unit 1 Weld N1B</u>

Available documentation was reviewed to determine the examination history of N1B. Records show that N1B was mechanically stress improved (MSIP) in 1995 during the U1-8th RIO. A review of the UT examination history (see Table 1) for N1B revealed that an automated UT examination performed in 1992 using the GE Smart 2000 system served as the pre-MSIP examination. The examination recorded only inside surface geometry and interface. Post MSIP automated UT examination of N1B in 1995 also was performed using the GE Smart 2000 system. No new indications were recorded during the post-MSIP UT examinations.

Table 1 – N1B Noz-SE Ultrasonic Examination History

Date of Examination	Type of Examination (Automated/Manual)	Results
1978 Note 1	Manual	No Recordable Indications
1989	Manual	No Recordable Indications
1992 Note 2	Automated (GE Smart 2000)	Inside Surface Geometry, Interface
1995 Note 3	Automated (GE Smart 2000)	Acoustic Interface, Inside Surface Geometry, and Non-Relevant Indications
1998	Automated (GE Smart 2000)	Acoustic Interface, Clad Roll, Non Relevant Indications, Non-geometric (Slag Inclusion) Note 4
2004 Note 5	Automated (GE Smart 2000)	Acoustic Interface, Clad Roll, Non Relevant Indications, Non-geometric

(Circ Flaw)___ Note 6

Note 1. Preservice ultrasonic examination.
Note 2. Pre-MSIP ultrasonic examination.
Note 3. Post-MSIP ultrasonic examination.
Note 4. Recorded with 60RL at 0.500" from top dead center. 1998 review of construction radiographs by RT Level III documents presence of original fabrication flaw. Note 5. U1-13RI0 examination using PDI qualified procedures. Note 6. See next session for discussion of U1-13RI0 results

Efforts to locate all fabrication records are on-going.

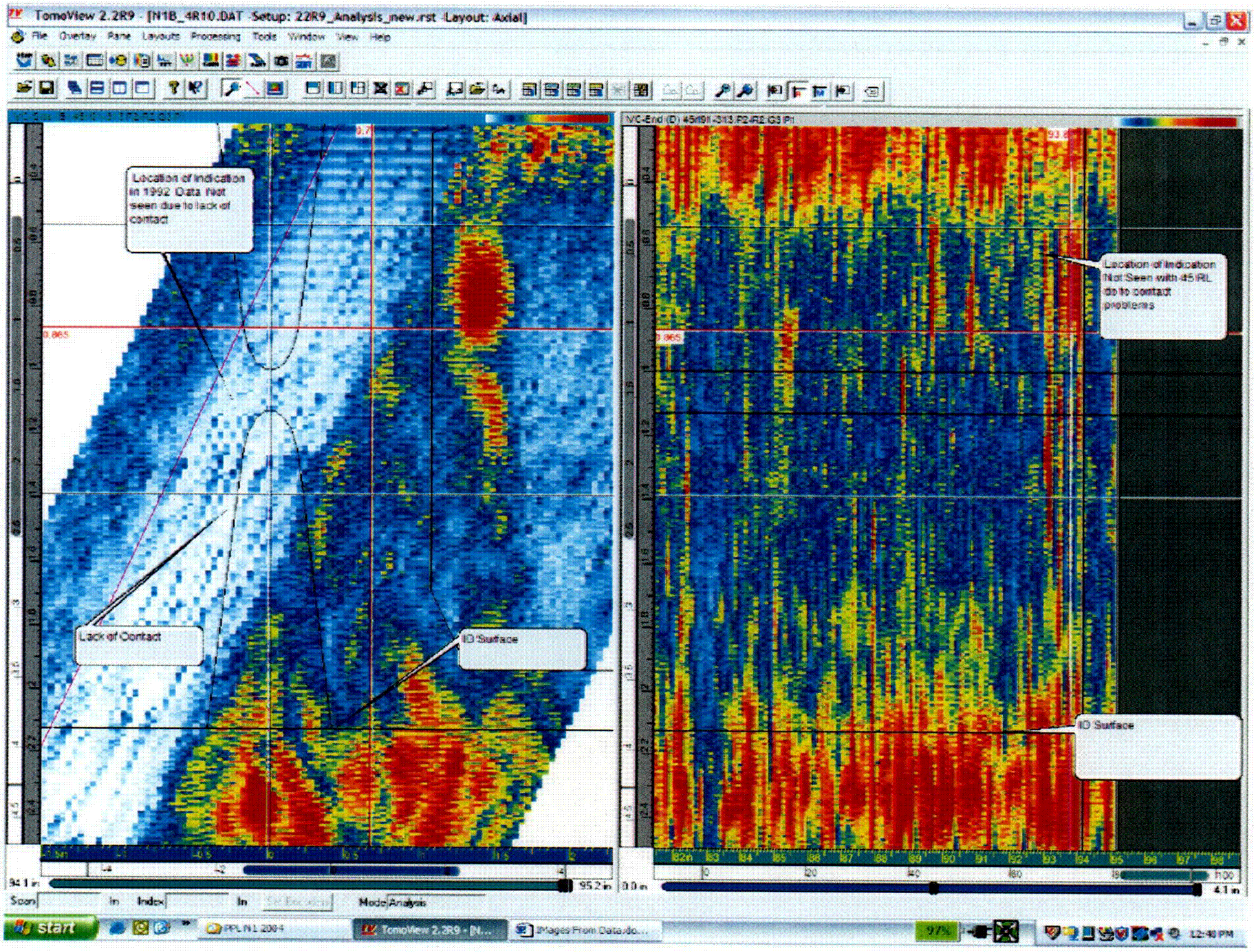
EPRI Review of Examination Results for the N1B Noz-SE Weld

A complete review of all available ultrasonic data was performed and the results are listed in Table 1. TOMOVIEW data analysis software was used to evaluate the data. This software provides the examiners enhanced data analysis capabilities (A, B, C and D Scans) above and beyond what was available to the data analyst during the original analysis. GE incorporated the use of this software based on lessons learned from the Hope Creek failure and recommended its use in the GE SIL-455 Revision 2 (Ref. 2). This software is the same software presently used in GE' PDI qualified procedure.

As a result of this review there is strong evidence that this flaw was actually present in the 1992, (Pre-MISP), 1995 (Post MSIP) and 1998 data in same location and relative depth. Figures 1- 8 illustrate comparisons of ultrasonic responses from each automated inspection. Due to the fact that the data was collected with several different procedures and varying data quality, it was impossible to perform finite depth and length sizing using this data. However, it did appear that the reflectivity of the flaw, at least at the inside surface, was reduced or eliminated after MSIP, probably due to the extreme compressive forces applied to the inside surface of the component. This process may have made the lower portions of the flaw transparent to the ultrasonic techniques applied at the time of examination.

During the U1-13RI0 examination, the PDI qualified techniques were optimized for this configuration (thickness, diameter). The resultant ultrasonic data revealed a very defined indication, which was clearly connected to the inside surface. The responses from the higher angle search units imaged in a very clear profile of the length and through wall extent of the flaw.

Figure 1
45 Degree RL Data from 1992 (Prior to MSIP did not see indication due to lack of contact)



c01

Figure 2
60-Degree RL Data From 1992 (Prior to MSIP)

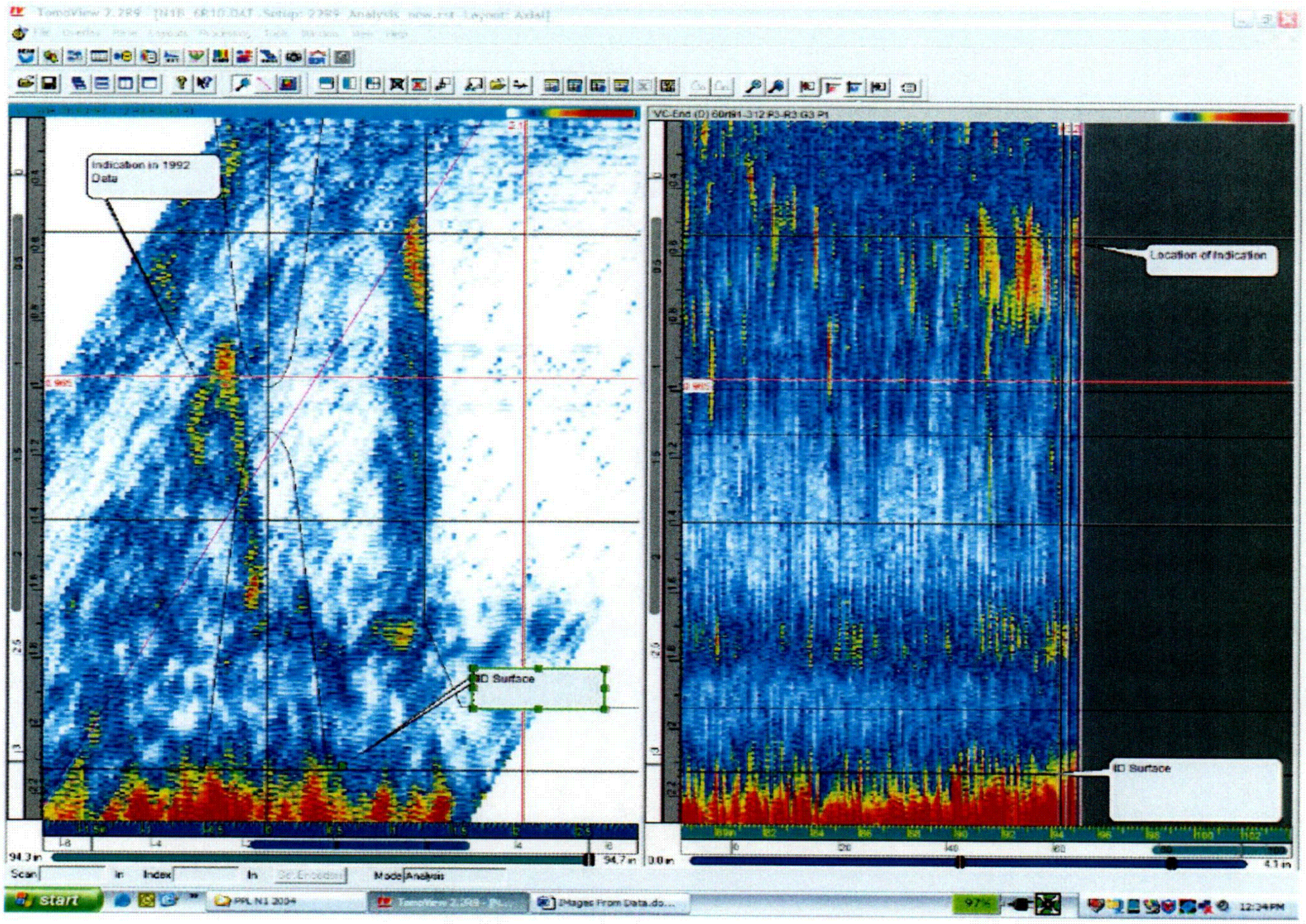


Figure 3
45-Degree RL Data from 1995 (Post MSIP)

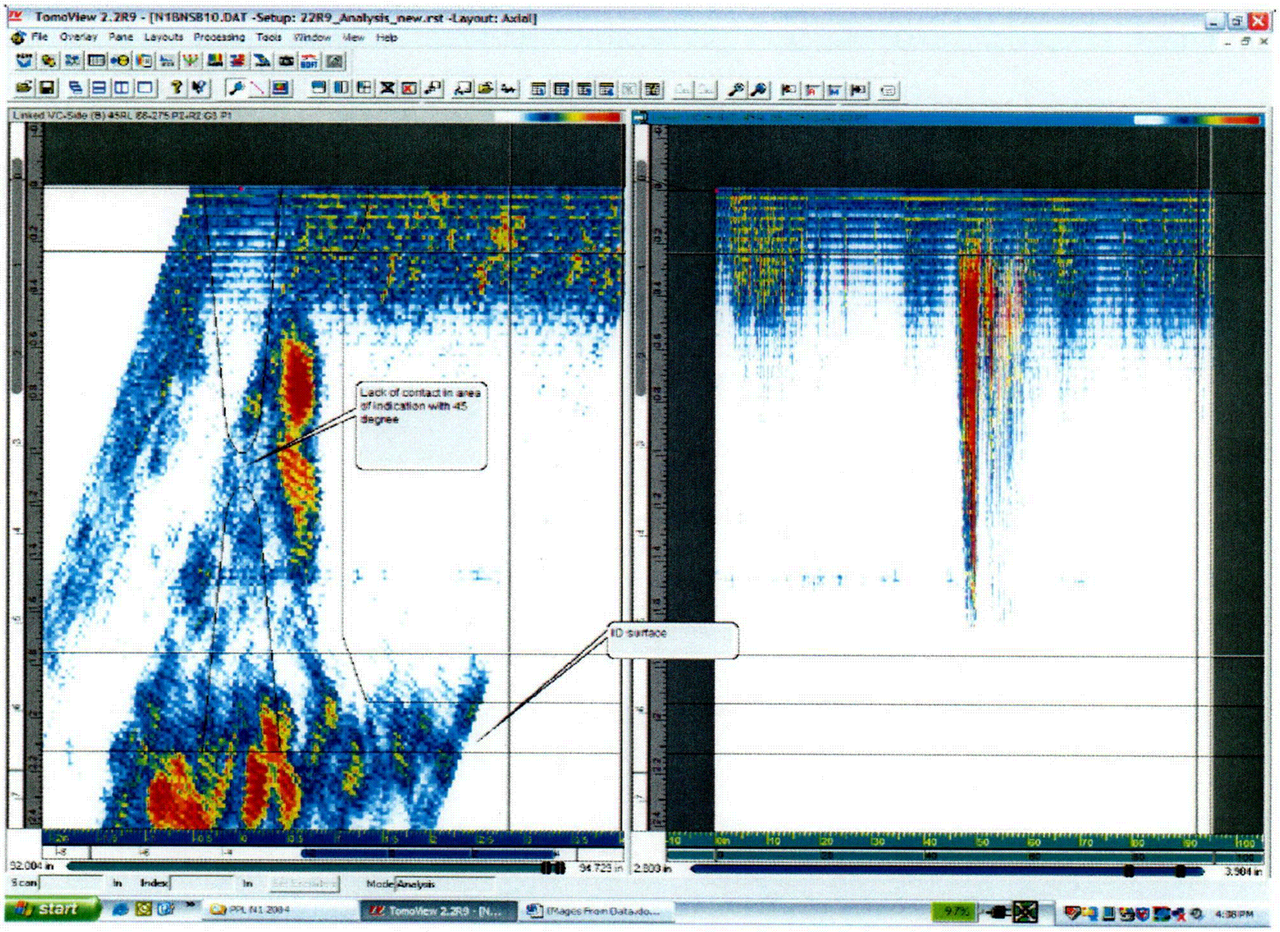


Figure 4
60 RL Data from 1995 (Post MSIP)

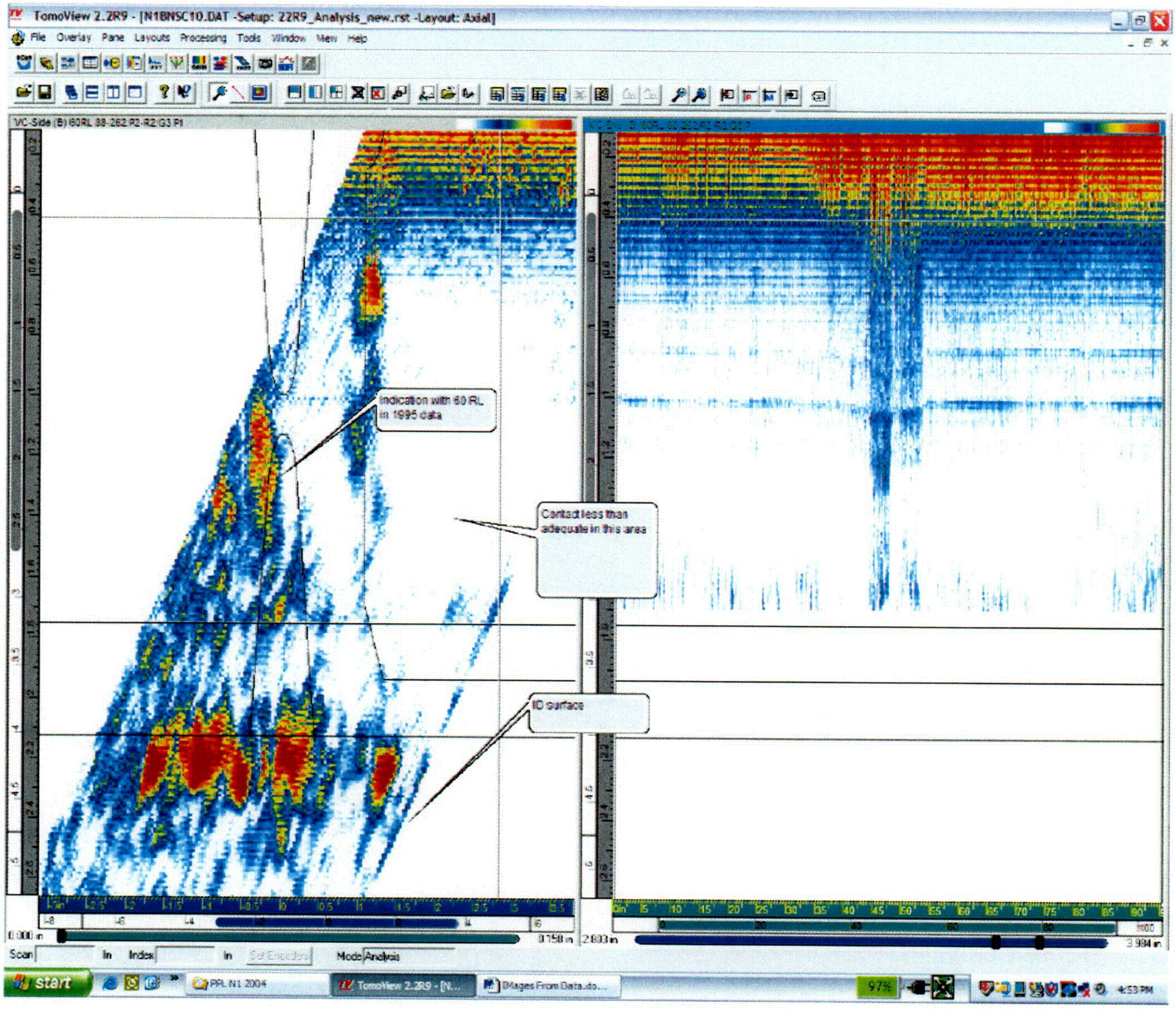


Figure 5
45 degree RL from 1998 data

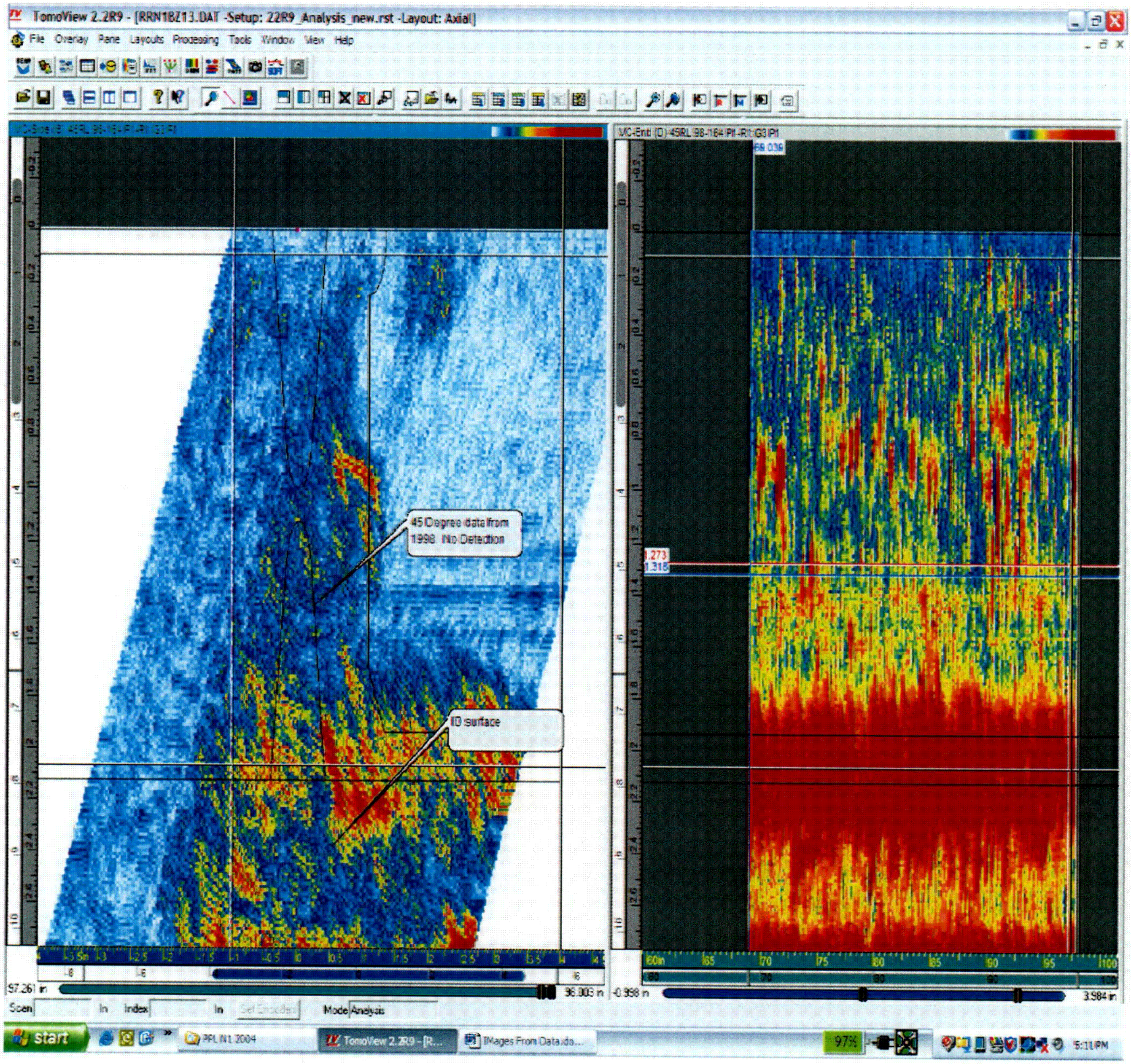
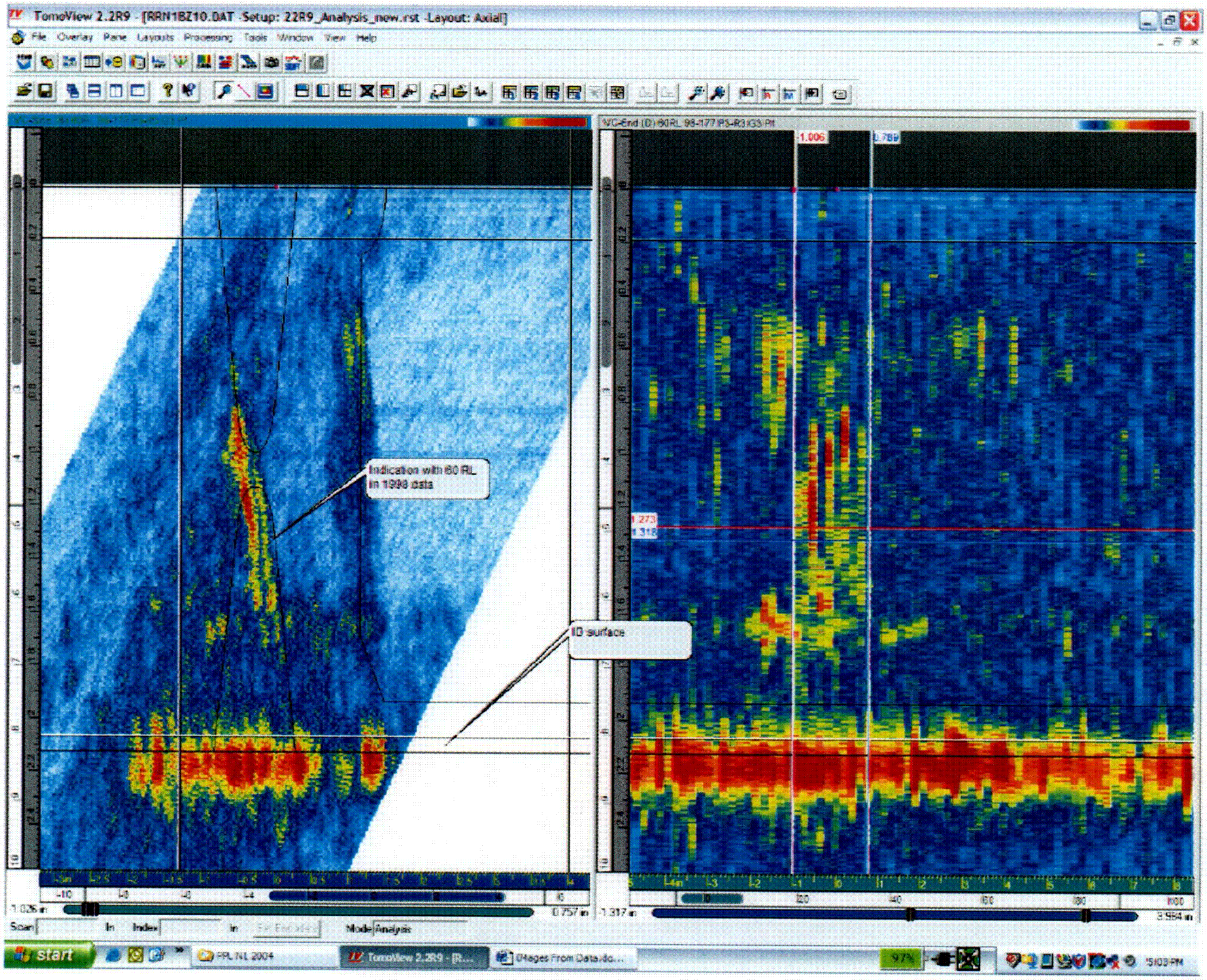
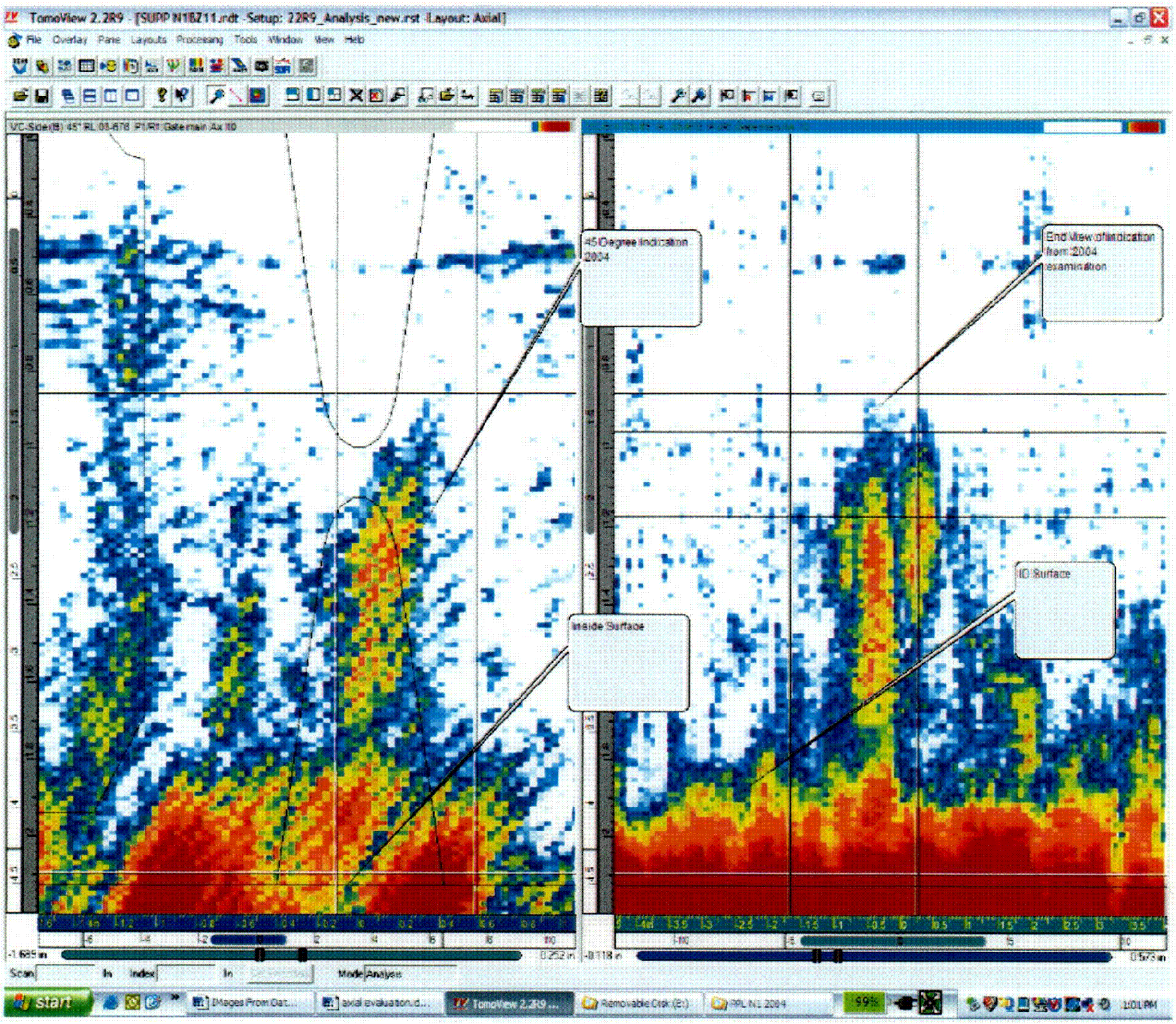


Figure 6
60 RL data from 1998 data



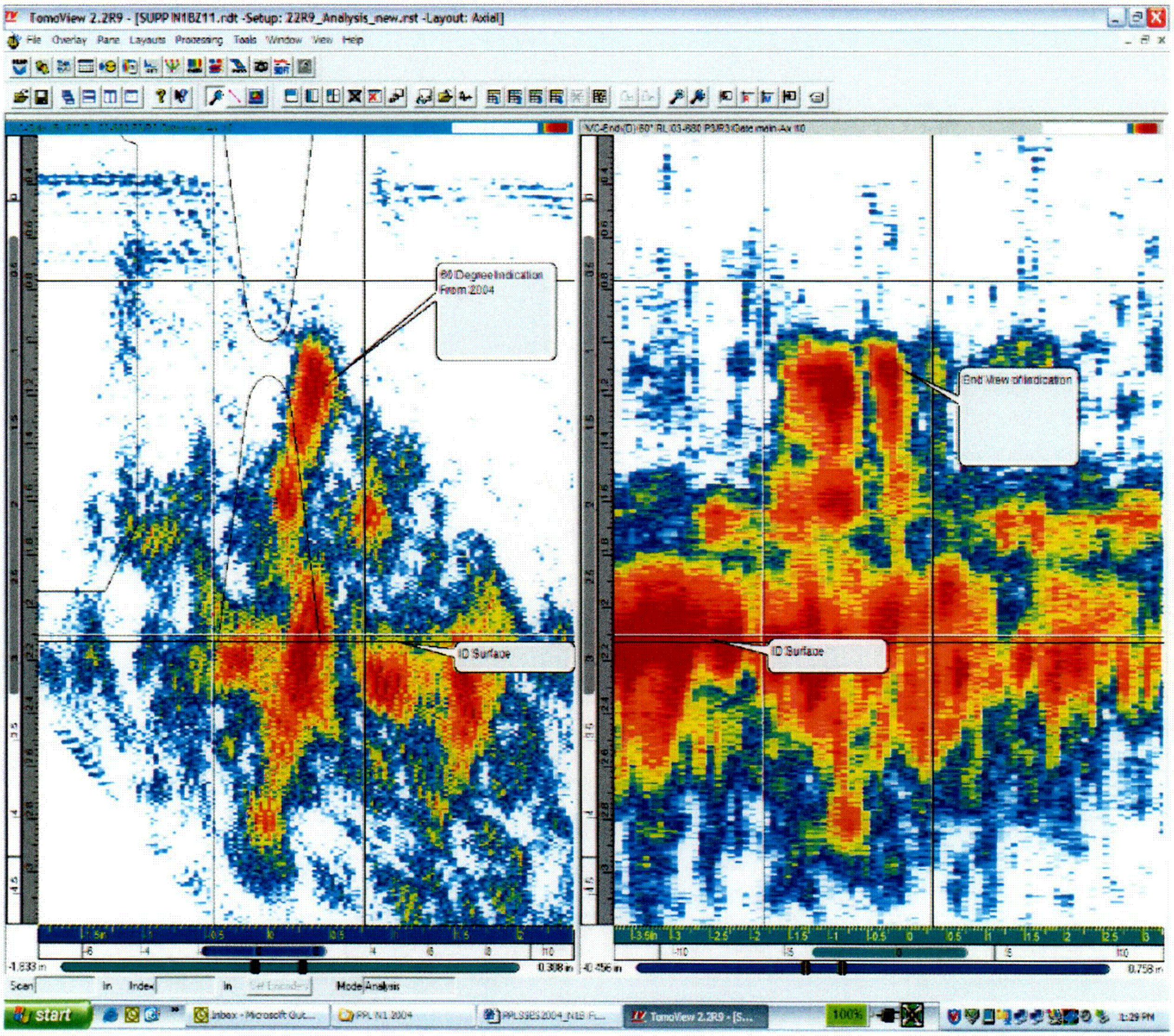
CDG

Figure 7
45 Degree RL from 2004 data



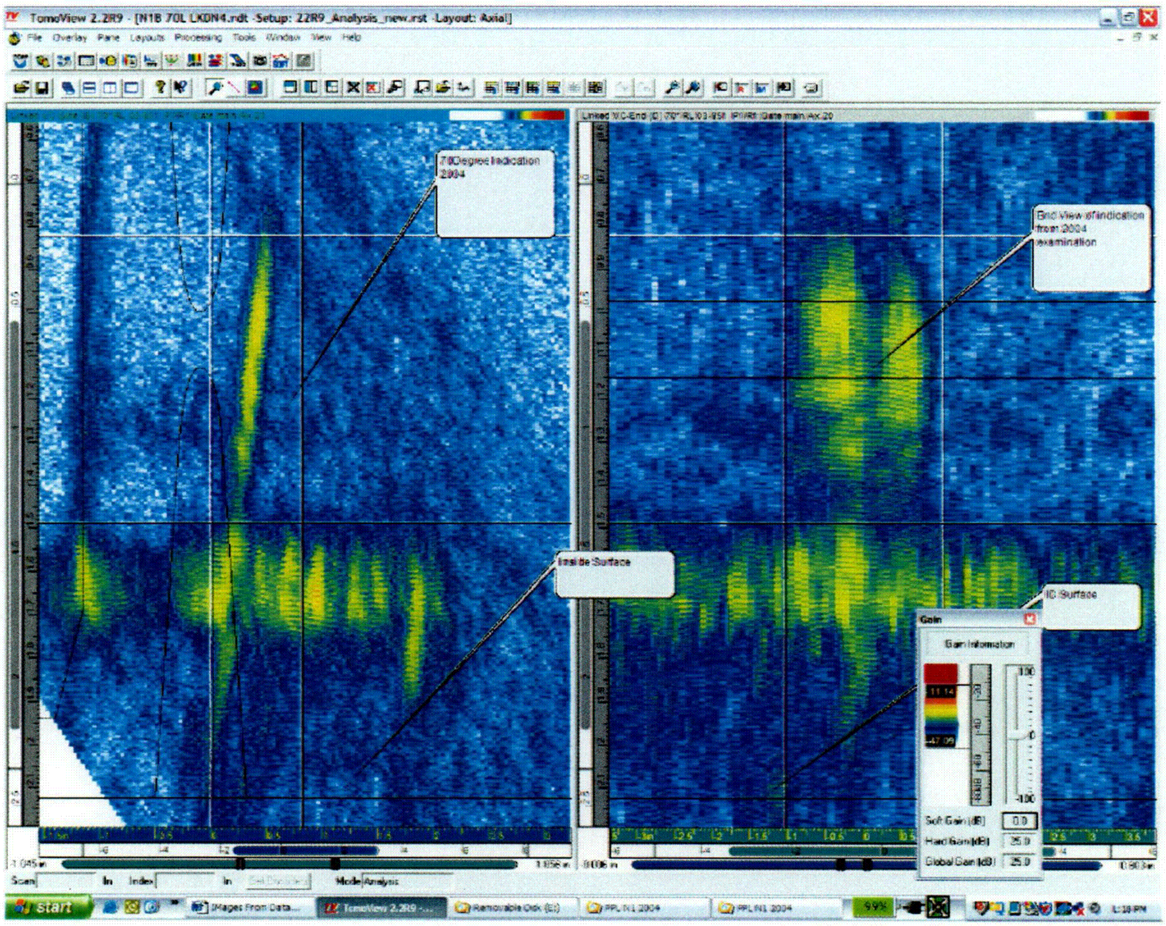
C07

Figure 8
60 Degree RL from 2004 data



C08

Figure 9
70 Degree RL from 2004 data



In addition to the evaluation of the circumferentially oriented flaw, axial reflectors were noted in the safe-end base material with the 30-degree shear wave that is generated from the 60 RL search unit. These indications had little or no echo-dynamic travel, and no measurable depth. The indications were barely detectable with the 45-degree RL and the 45-shear search units and also showed no through wall dimension. The majority of the indications were well outside of the required examination volume, but several of them fell just inside. The images below (Figures 10 –13) illustrate the location and response of the indications. Available fabrication records were reviewed and they required the inside surface to be ground or machined flush after completion of the welding of the butt weld. This grinding process is the likely cause of these indications. Previous automated data from 1998 was reviewed and, while compromised due to contact, this data also shows these indications were present.

Figure 10
Area of Suspected Grinding Marks seen with 30-shear wave component of 60 RL search unit

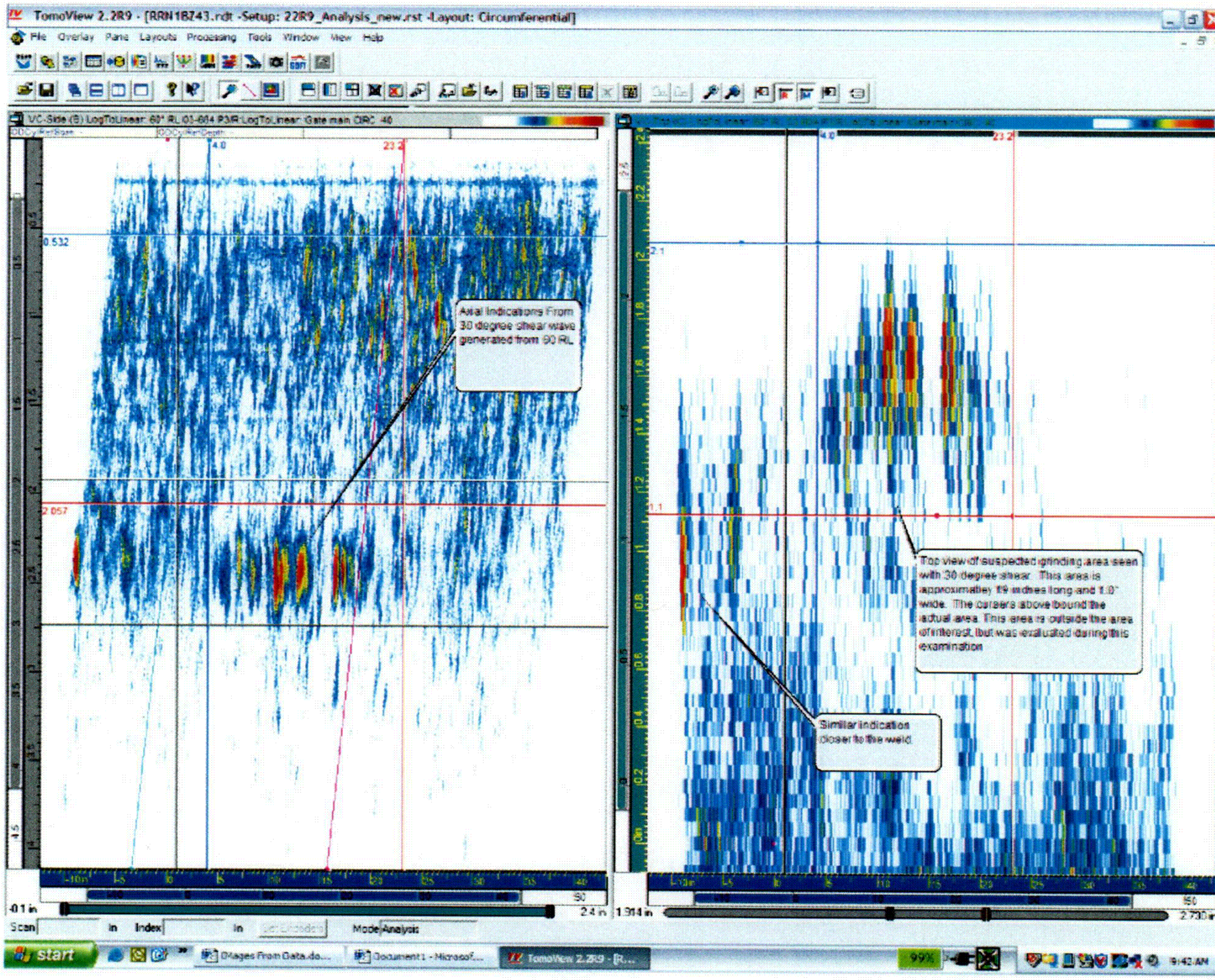
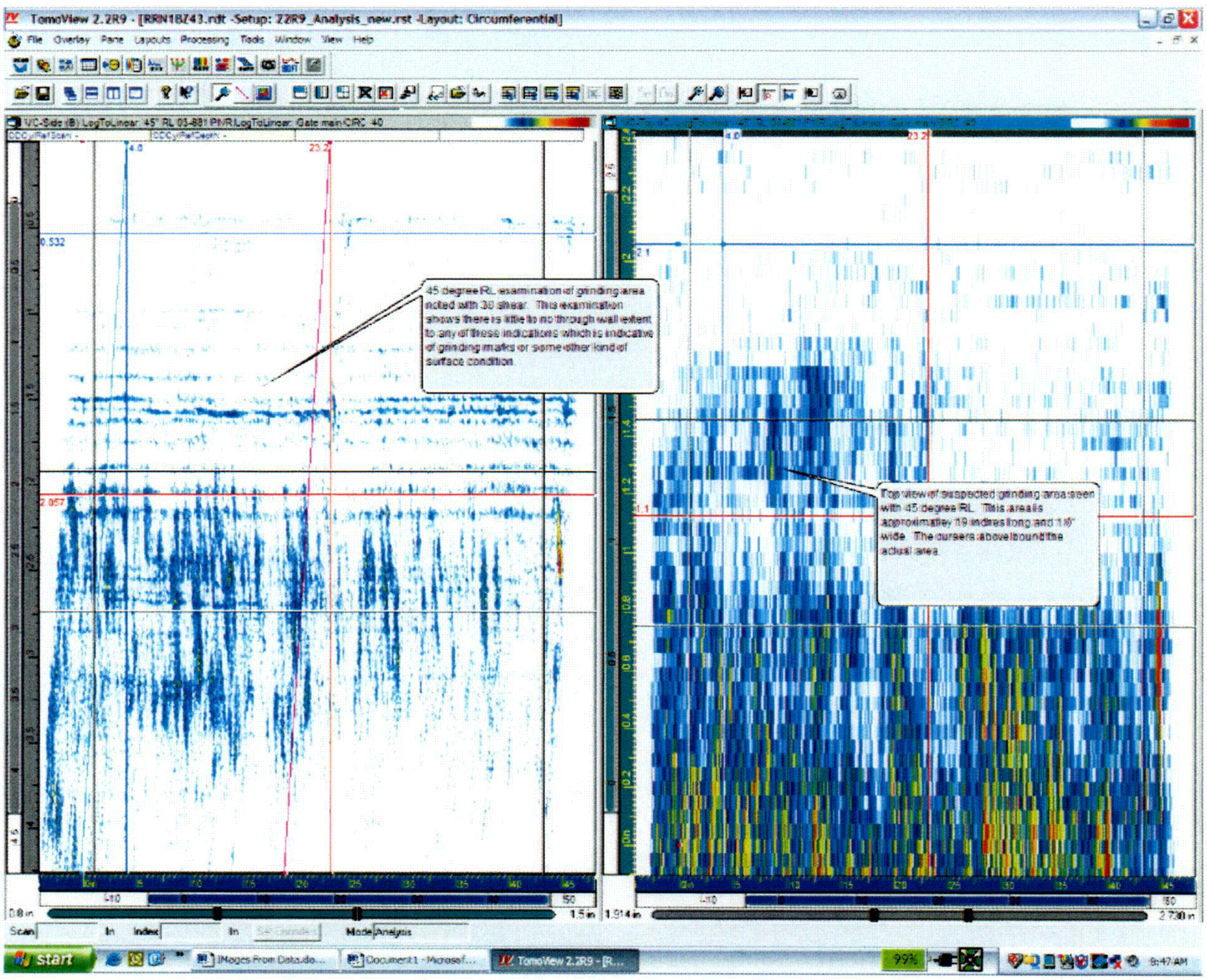


Figure 11
Area of Suspected Grinding Marks seen with 45 degree RL search unit



C11

Figure 12
Area of Suspected Grinding Marks 45-Degree Shear Wave

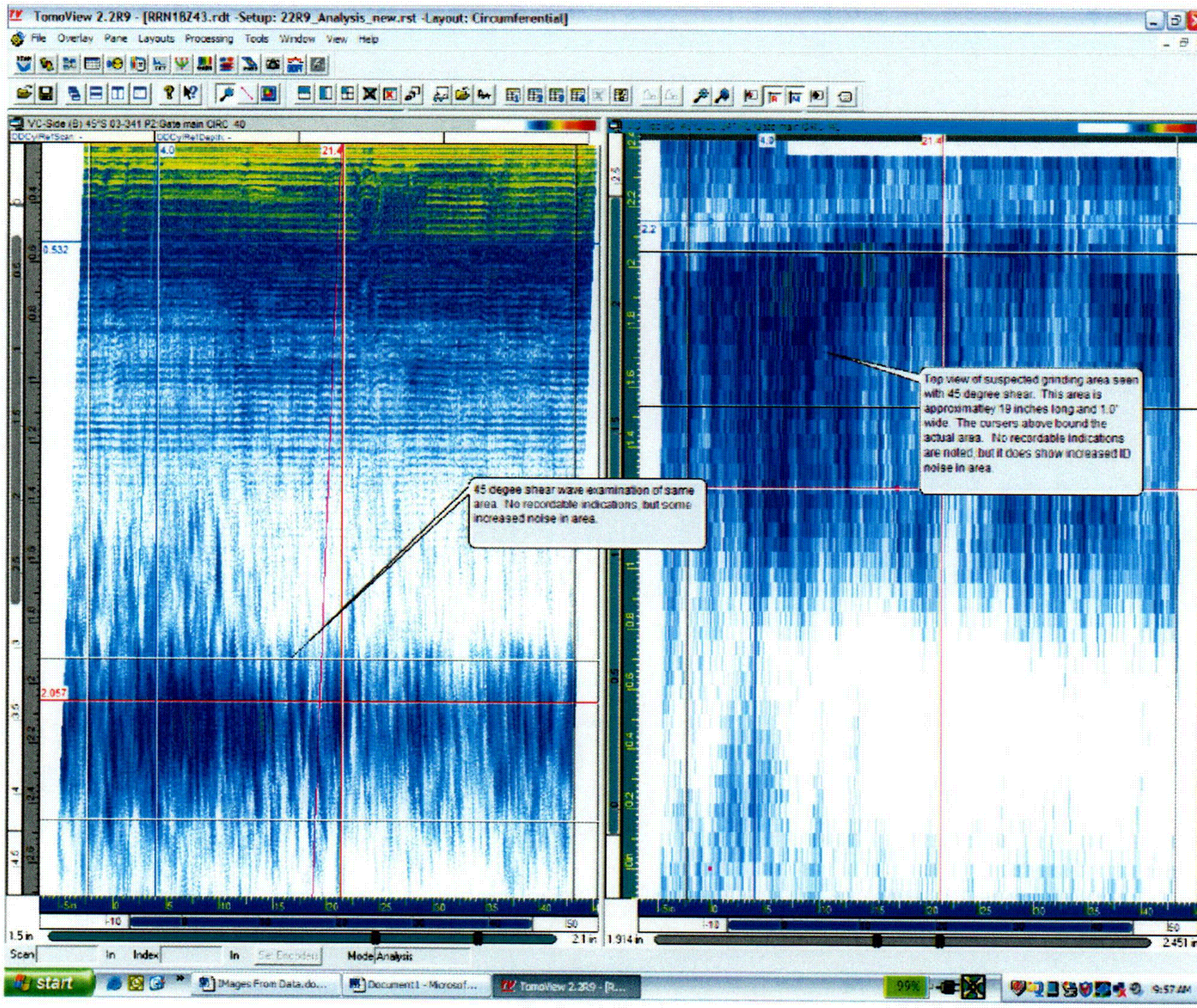
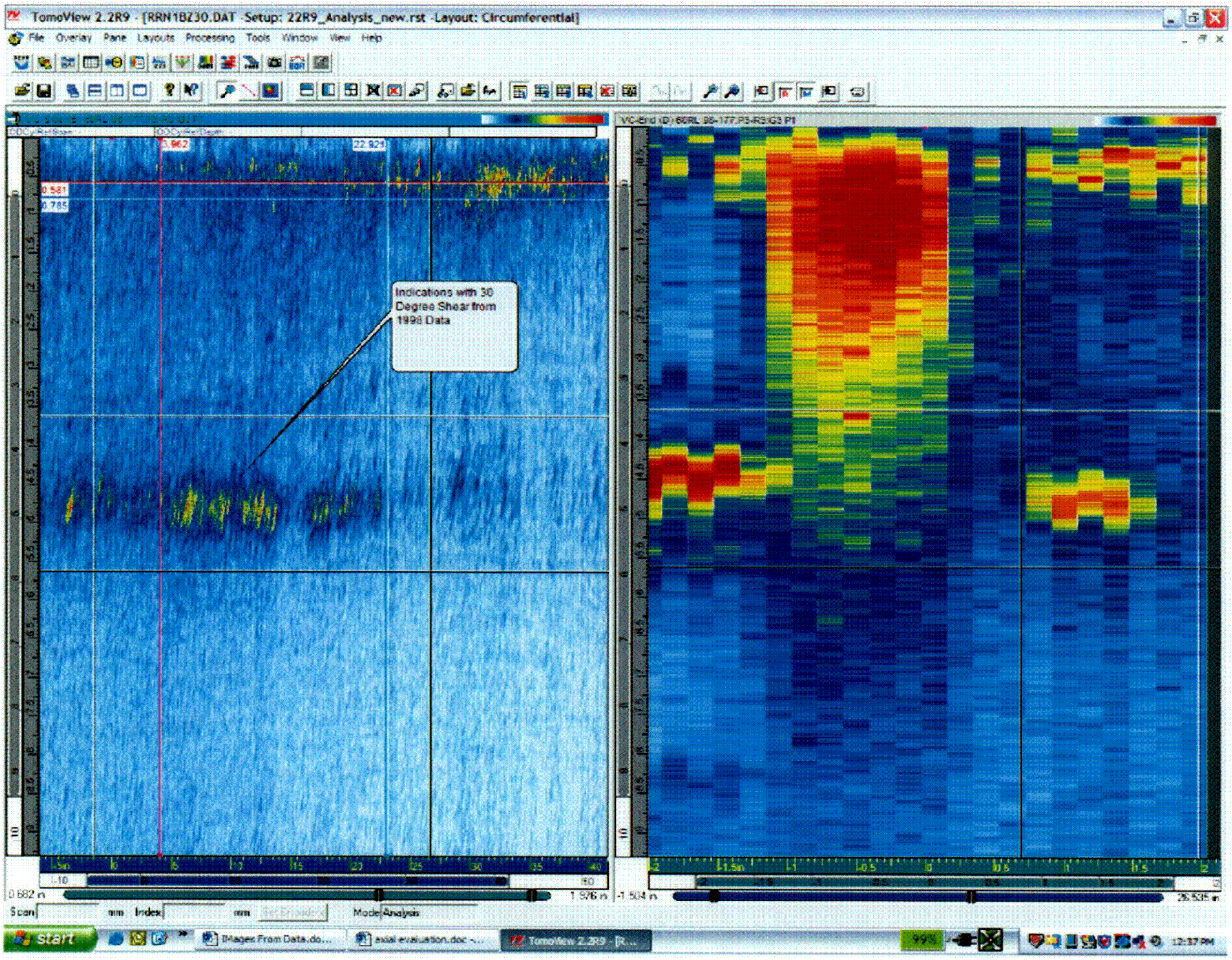


Figure 13
Similar indications from 1998 30-degree Shear Wave data



C13

Conclusions and Recommendations

EPRI personnel were requested to provide on-site assistance at SSES during U1-13RI0 to perform an independent review of examination results for the N1B Noz-SE dissimilar metal weld. Results of this review support GENE's conclusion that N1B Noz-SE weld contains a 2.34 inch long planar-type, circumferential flaw having a 1.14 inch through wall extent. The flaw is ID connected and is contained within the Alloy 82/182 weld material. The characteristics of this flaw are typical of Stress Corrosion Cracking located in Alloy 82/182 weld material.

Based on a review of automated UT data from previous examinations, there is good evidence that this flaw was actually present in the 1992, (Pre-MISP), 1995 (Post MSIP) and 1998 examinations of the N1B Noz-SE weld at the same location and relative depth. Evidence suggests that the reflectivity of the flaw at the inside surface was reduced or eliminated after MSIP, probably due to the extreme compressive forces applied to the inside surface of the component. This process may have made the lower portions of the flaw transparent to the ultrasonic techniques applied at the time of examination. However, during U1-13RI0, PDI qualified techniques identified a very defined indication providing a clear profile of the length and through wall extent of the flaw.

Recommendations

EPRI recommends the following:

- Continue efforts to identify complete fabrication records for N1B Noz-SE.
- To assist in the planned overlay weld repair, EPRI recommends ensuring weld overlay design dimensions adequate for providing coverage of the required examination volumes as depicted in existing PDI qualified overlay procedures.

Prepared by:
Jeff Landrum
EPRI
Project Manager
Piping & Bolting

Jeff Landrum by: Carl Latiolais
3/26/04

Carl Latiolais
EPRI
Project Manager
Piping & Bolting
Performance Demonstration

3/26/04

Cc; F.Ammirato
B.Thigpen
F.L. Becker
S. Hamel
R.Bouck
B.Carter

ATTACHMENT 3 TO PLA-5743

Revised Relief Request 29

PPL SUSQUEHANNA, LLC
SUSQUEHANNA SES UNIT 1
SECOND 10-YEAR INTERVAL
RELIEF REQUEST NO. RR-29

COMPONENT IDENTIFICATION

A full structural weld overlay repair is proposed for the N1B recirculation system outlet nozzle. The current configuration of this nozzle is described below.

The N1B recirculation outlet nozzle to safe-end configuration consists of a SA336 F8 safe-end welded to a SA 508 Cl 2 nozzle. The end of the nozzle was buttered with Alloy 182 weld deposit and subsequently joined with a weld having an Alloy 82 root and hot passes with Alloy 182 fill.

EXAMINATION AND REPAIR REQUIREMENTS

A weld overlay repair has been designed consistent with the requirements of NUREG 0313 Revision 2 (which was implemented by Generic Letter 88-01), ASME Code Case N-504-2, and ASME, Section XI, Paragraph IWB-3640, 1989 Edition with Appendix C (1989 Addenda).

WELDER QUALIFICATION AND WELDING PROCEDURES

All welders and welding procedures will be qualified in accordance with ASME Section IX and any special requirements from Section XI or applicable code cases. A manual shielded metal arc weld (SMAW) procedure will be qualified to facilitate localized repairs and to provide a seal weld, prior to depositing the overlay, should the defect be deep enough to be near through-wall or through-wall and leaking. This procedure will make use of SMAW electrodes ENiCrFe-7, UNS W86152, F No. 43, known commercially as Alloy 152. The weld overlay repair will be performed by qualified personnel from WSI. Welding Procedure Specification (WPS 03-08-T-801, Rev. 0) for welding ERNiCrFe-7, UNS N06052, F No. 43 (commercially known as Alloy 52) will be used.

Welding Wire Filler Material

A consumable welding wire highly resistant to intergranular stress corrosion cracking (IGSCC) and interdendritic stress corrosion cracking (IDSCC) was selected for the overlay material. This material, designated UNS N06052 F No. 43 is a nickel-based weld filler material, commonly referred to as Alloy 52, and will be applied using the GTAW (Gas Tungsten Arc Welding) Machine TIG process. Alloy 52 is identified in ASME Section II, Part C as SFA-5.14, ERNiCrFe-7, classification UNS N06052 F No. 43 Filler Material. Alloy 52 contains a nominal 30% Cr that imparts excellent resistance to IGSCC. Where localized repairs are required, Alloy 152 may be used. Alloy 152 is identified in ASME Section II, Part C as SFA-5.11, ENiCrFe-7, classified as UNS W86152. Alloy 152 also contains a nominal 30% Cr that imparts excellent resistance to IGSCC.

Weld Overlay Design

The weld overlay will extend around the full circumference of the safe end to nozzle location in accordance with NUREG 0313 Rev. 2, Code Case N504-2, and Generic Letter 88-01. The overlay length will extend across the projected indication intersection with the outer pipe surface. The design thickness and length will be computed according to guidance provided in ASME Section XI, Code Case N-504-2 and ASME Section XI Paragraph IWB-3640, 1989 Edition with Appendix C (1989 Addenda). The overlay completely covers the defect location and other Alloy 182 susceptible material areas with the highly corrosion resistant Alloy 52 material. A temper bead welding approach will be used for this repair, because it will be necessary to weld on the P3 Group 3 low alloy steel (LAS) nozzle material. ASME Code Case N-638 will be applied because it provides for machine (GTAW) temper bead weld repairs to P3 Group 3 materials at ambient temperature using dissimilar materials and without need for post weld heat treatment. The temper bead approach was selected because temper bead welding supplants the requirement for post weld heat treatment (PWHT) of heat affected zones in welded low alloy steel (LAS) material. Temper bead techniques produce excellent toughness and ductility in heat affected zones of the LAS. This approach provides a comprehensive weld overlay repair, and increases the volume of material under the overlay that can be inspected. The weld overlay length will conform to the guidance of Code Case N-504-2, which satisfies the stress requirements.

Examination Requirements

The examination requirements for the weld overlay repairs are summarized in the following table. *Note: No post weld inspections may be performed until after a 48 hour waiting period has elapsed after completing the weld. This is required to be able to identify any possible hydrogen delayed cracking that might occur.*

EXAMINATION REQUIREMENTS			
Examination Description	**Method**	**Technique**	**Reference**
Weld and Safe-End Overlay Surface Preparation Exam	PT	Visible Dye	N-504-2
Thickness Measurements	UT	0° Long.	N-504-2
As-Found Exam	Auto UT	45° Ref. Long. 60° Ref. Long. 70° Ref. Long.	IWB-3514
As-Found Sizing	Auto UT	60° Ref. Long. 70° Ref. Long.	IWB-3514
First Weld Overlay Layer Surface Exam	PT	Visible Dye	N-504-2
First Weld Overlay Thickness Checks	UT	0° Long, or Hand Meas.	N-504-2
Surface Exam of Nozzle within 1.5 t of Weld overlay	PT	Visible Dye	NB-5350 N-638
Surface Exam of Completed Overlay	PT	Visible Dye	N-504-2
Exam of Completed Overlay for Lack-of-Bond and Thickness	UT	0° Long.	IWB-3514 N-504-2
Volumetric Exam of Nozzle within 1.5 t of Weld Overlay	UT	In accordance with Appendix I. Nozzle geometry may limit this examination.	IWB-3500 N-638
Volumetric Exam of Completed Overlay	UT	Angle beam exam in accordance with qualified P.D.I. procedure implementing Appendix VIII.	IWB-3514 N-504-2
Pre-Service Exam of Completed Overlay and the Outer 25% of the underlying pipe wall to identify the original flaws.	UT	Angle beam exam in accordance with qualified P.D.I. procedure implementing Appendix VIII.	IWB-3514 N-504-2

General Note: The Edition and Addenda for the ASME Section XI acceptance criteria is the 1989 Edition with no Addenda. The weld overlay examinations comply with the recommendations of NUREG-0313, Revision 2, and also with Code Case N-504-2.

There is no ASME Section III Subsection that directly applies to inspection acceptance criteria for weld overlays. NUREG-0313 and Code Case N-504-2 specify an ultrasonic volumetric examination, using methods and personnel qualified through the EPRI NDE Center. Furthermore, NUREG-0313 states that the ultrasonic examinations should be performed in accordance with the requirements of the applicable edition of the ASME Code. The Code of record for the current 10-year in-service inspection interval is the 1989 edition of ASME Section XI with no Addenda. Therefore, the acceptance criteria that will be used for the volumetric examinations will be those of IWB-3514, "Standards for Examination Category B-F, Pressure Retaining Dissimilar Metal Welds, and Examination Category B-J, Pressure Retaining Welds in Piping."

Pressure Testing

The completed repair shall be given a system leakage, in-service or functional test in accordance with ASME Section XI, IWA-5000, provided the system pressure boundary has not been penetrated.

Unusual Difficulty in Meeting Specified Requirements

Preheat and post weld heat treatments (PWHT) are required for welding on P3 Group 3 LAS nozzle material by ASME Section III, Subparagraph NB4622.7. These requirements are impractical without draining the reactor vessel, and may even distort the P3 components involved (nozzle and reactor pressure vessel). To drain the vessel requires a full-core fuel offload. If the vessel were drained, the radiation dose rates around the nozzle would increase significantly, resulting in additional personnel exposure. Therefore, consistent with ALARA practices and prudent utilization of outage personnel, there will be no vessel drain down for this repair. The weld overlays will be completed with water on the inside surface of the nozzles and connected piping. This approach (i.e., no vessel drain down) minimizes fuel movement and thereby enhances nuclear safety.

The alternative, as described below, provides an acceptable level of quality and safety while neither draining the reactor vessel nor applying preheat and post weld heat treatments. Therefore, the alternative alleviates the impracticality of following certain code requirements for this repair activity.

ALTERNATIVE FROM REPAIR REQUIREMENTS

The repair will utilize ASME Code Case N-504-2, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping," and Code Case N-638, "Similar and

Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper bead Technique," with the following exceptions and clarifications.

Clarification of Code Case N-504-2 for Applicability to Nickel-based Austenitic Steel

Code Case N-504-2 was prepared specifically for austenitic stainless steel material. An alternate application to nickel-based austenitic materials (i.e. Alloy 52) is requested due to the specific configuration of the nickel-based austenitic weldment.

Exception to Code Case N-504-2 Paragraph (b)

Code Case N-504-2 paragraph (b) requires that the reinforcement weld metal shall be low carbon (0.035% maximum) austenitic stainless steel. A nickel-based filler is required and Alloy 52 has been selected in place of low carbon austenitic stainless steel.

Exception to Code Case N-504-2 Paragraph (e)

Code Case N-504-2 paragraph (e) requires as-deposited delta ferrite measurements at least a 7.5 FN for the weld reinforcement. These measurements are not to be performed for this overlay, as the nickel filler is a fully austenitic material, containing no ferrite.

Exception to Code Case N-504-2 Paragraph (h)

Code Case N-504-2 paragraph (h) requires a system hydrostatic test of completed repairs if the repaired flaw penetrated the original pressure boundary or if there is any observed indication of the flaw penetrating the pressure boundary during repairs. A system leak test of completed repairs will be used in lieu of a hydrostatic test.

Clarification of Code Case N-638 Applicability

Code Case N-638 shall be applied to the P3 Group 3 LAS nozzle material.

Exception to Code Case N-638 Paragraph 1(a)

Code Case N-638 paragraph 1(a) requires the maximum area of an individual weld based on the finished surface shall be 100 square inches. The area for the temper bead weld in this weld overlay design will be approximately 300 square inches.

BASIS FOR THE ALTERNATIVE

Clarification of Code Case N-504-2 for Applicability to Nickel-based Austenitic Steel

The weldment being addressed is austenitic material having a mechanical behavior similar to austenitic stainless steel. The weldment is designed to be highly resistant to IGSCC and is compatible with the existing weldment and base metal materials. Accordingly, this alternative provides an acceptable level of quality and safety. Therefore, Code Case N-504-2 should be interpreted to apply equally to both materials.

Exception to Code Case N-504-2 Paragraph (b)

A consumable welding wire highly resistant to IGSCC was selected for the overlay material. This material, designated UNS N06052 F No. 43 is a nickel-based alloy weld filler material, commonly referred to as Alloy 52, and will be applied using the GTAW process. Alloy 52 contains nominally 30% chromium that imparts excellent corrosion resistance to IGSCC. By comparison, Alloy 82, is identified as an IGSCC resistant material in NUREG 0313 Revision 2 and contains nominally 20% chromium while Alloy 182 has a nominal chromium composition of 15% chromium. Alloy 52 with its high chromium content provides a high level of resistance to IGSCC consistent with the requirements of the code case. Therefore, this alternative provides an acceptable level of quality and safety.

Exception to Code Case N-504-2 Paragraph (e)

The composition of nickel-based Alloy 52 is such that delta ferrite does not form during welding. Ferrite measurement requirements were developed for weld deposits of the 300 series stainless steels that require delta ferrite to develop resistance to IGSCC. Welds of Alloy 52 or Alloy 152 are 100% austenitic and contain no delta ferrite due to the high nickel composition (approximately 60% nickel and low iron content). Alloy 52 with its high chromium content provides a high level of resistance to hot cracking and IGSCC consistent with the purpose for the delta ferrite requirements for stainless steels of the code case. Therefore, this alternative provides an acceptable level of quality and safety.

Exception to Code Case N-504-2 Paragraph (h)

In lieu of the hydrostatic pressure test requirements defined in Code Case N-504-2, the required pressure test shall be performed in accordance with the Second 10-year Interval ISI Program Plan and Code Case N-416-1 with the exception that the volumetric examination performed shall be an ultrasonic examination of the weld overlay.

Clarification of Code Case N-638 Applicability

Code Case N-638 was developed for temper bead applications to similar and dissimilar metals. It permits the use of machine (GTAW) welding at ambient temperature without the use of preheat or PWHT on Class 1, 2, and 3 components.

Temper bead welding methodology is not new. Numerous applications over the past decade have demonstrated the acceptability of temper bead technology in nuclear environments. Temper bead welding achieves heat affected zone (HAZ) tempering and grain refinement without subsequent PWHT. Excellent HAZ toughness and ductility are produced. Use of Code Case N-638 has been accepted in Regulatory Guide 1.147 Revision 13 as providing an acceptable level of quality and safety.

A 48-hour post weld hold prior to acceptance inspection is required by Code Case N-638 and will be done to assure that no delayed cracking occurs.

Exception to Code Case N-638 Paragraph 1(a)

Cold Case N-638 specifies a limit of 100 square inches for a temper bead weld. Because of the diameter of nozzle N1B (30 3/32"), this restriction would limit the weld overlay length to 1 1/16" on the LAS nozzle material. This distance could be justified as adequate axial length to provide for load redistribution from the weld overlay back into the nozzle without violating applicable stress limits of Section III for primary local and bending stresses and secondary peak stresses. However, this axial length will not permit a complete examination of the outer 25% of the nozzle thickness as required by Code Case N-504-2. In order to perform a qualified exam of the required volume, the axial length of the overlay on the LAS nozzle will be extended to 3 1/8", encompassing an area of 300 square inches for the temper bead weld.

CONCLUSION

Weld overlays involve the application of weld metal circumferentially around the pipe in the vicinity of the flawed weld to restore ASME Section XI margins. Weld overlays have been used in the nuclear industry as an acceptable method to repair flawed welds. The use of overlay filler material, which provides excellent resistance to IGSCC, develops an effective barrier to crack extension by corrosion processes.

The piping and other components have been evaluated (to the original ASME design code requirements) for the effects due to shrinkage induced into the system during installation of the overlay. The actual shrinkage will be measured. All required documents will be reconciled to the original design code, and updated to reflect these as-built values.

The design of the overlay for the nozzle safe-end uses methods that are standard in the industry for size determination of pipe-to-pipe overlays. There are no new or different approaches used in this overlay design which are considered first of a kind or inconsistent with previous approaches. The overlay is designed as a full structural overlay in accordance with the recommendation of NUREG 0313 Revision 2, which was implemented by Generic Letter 88-01 and by Code Case N-504-2 and ASME Section XI Paragraph IWB-3640, 1989 Edition with Appendix C (1989 Addenda).

Temper bead techniques, as defined by Code Case N-638, will produce the tough corrosion resistant overlay deposit that meets or exceeds all code requirements for the weld overlay.

PPL concludes that the repair plan is justified and presents an acceptable level of quality and safety to satisfy the requirements of 10 CFR 50.55a(c)(3)(i). Furthermore, this evaluation demonstrates that compliance with the 1989 Edition of ASME Section XI with no addenda (the current Code of record for Susquehanna Unit 1) would result in unusual difficulty without a compensating increase in the level of quality and safety pursuant to 10 CFR 50.55a(c)(3)(ii)

A similar proposed alternative to the requirements of 10 CFR 50.55a(c)(3)(iv) has been approved previously by the NRC for the Duane Arnold Energy Center by NRC letter dated November 19, 1999 and for Nine Mile Point Unit 2 by NRC letter dated March 30, 2000. Also, a similar proposed alternative to the requirements of 10 CFR 50.55a(c)(3)(iv) has been submitted by Pilgrim on October 2, 2003 and by TMI on November 3, 2003,

DURATION OF PROPOSED ALTERNATIVE

The proposed alternative applies to the repairs of RPV nozzle to safe-end weld for the scheduled outage and for the remaining service life of this weld.