ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 2

EVALUATION OF DISSIMILAR METAL WELD INDICATION AT WELD RCRD-2-52

(SEE ATTACHED)

WCAP-16845-NP
Revision 0

February 2008

Metallurgical Investigation of Recorded Indications at the Check Valve to Pipe Dissimilar Metal Weld at Browns Ferry Unit 2 Nuclear Generating Station

Westinghouse

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Metallurgical Investigation of Recorded Indications at the Check Valve to Pipe Dissimilar Metal Weld at Browns Ferry Unit 2 Nuclear Generating Station

Gutti Rao
Joyce Conermann
Warren Junker
Brian Ottinger
Materials Center of Excellence

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Reviewer: Lance Harbison*
MCOE

Approved: Michael A. Burke*, Manager
Materials Center of Excellence

*Electronically approved records are authenticated in the electronic document management system.

Westinghouse Electric Company LLC
P.O. Box 355
Pittsburgh, PA 15230-0355

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1 INTRODUCTION

This document summarizes the evaluations and the results of a metallurgical investigation of the recorded ultrasonic (UT) indications at the check valve to pipe dissimilar metal weld joint (No. RCRD-2-52) at Browns Ferry Unit 2 nuclear generating station. The indications were recorded during the 2007 spring outage inspection while conducting a manual UT of the weld (Reference 1). The inspection was being performed as part of the implementation process of TVA's Risk Informed ISI Program. The affected weld joint consisted of a 4 inch diameter schedule 80 ASME SA 333 GR 6 carbon steel pipe joined to ASME SA 182 GR F316 austenitic stainless steel valve body, joined by ER 309 stainless steel filler metal.

An approximately 4.5 inch long ring section consisting of 2.5 inches of carbon steel pipe joined to a 1.5 inches of stainless steel valve body by a 0.5 inches of crown weld was shipped to Westinghouse hot cell facilities for investigation. A view of the as-received pipe weld sample is illustrated in Figure 1(a). The piping was reportedly procured initially as schedule 160 and was counter bored at the weld joint to an approximate schedule 80 wall thickness. It was also reported that the recorded indication was positioned the between 3 and 4 o'clock (90° and 120°) locations from the punch marked Top Dead Center (TDC), looking into the valve from the pipe end. The location of the punch mark and the suspected location of the field indication are illustrated in Figure 1(b).

The Westinghouse investigation included the following major tasks:

- Surface Examinations
- NDE Examinations
- Sectioning Plan
- Metallographic Examinations
- Fractographic Examinations
- Chemistry Assessments
- Hardness Measurements
- Review of pipe welding and UT inspection procedures
- Mechanistic and Root Cause Considerations

The overall purpose of the investigation is to establish the cause and mechanism of occurrence of indications/cracking in the pipe weld and further to develop information that would be helpful in mitigating the potential for similar occurrence at Browns Ferry.

2 EXAMINATIONS AND TESTS

The following describes the examinations and tests conducted on the 4.5 inch long pipe section containing the pipe to valve weld received from TVA.

2.1 SURFACE EXAMINATIONS

The as-received surface condition of the ring sample containing the weld was examined visually and by light optical microscopy for evidence of cracking, surface attack, deposits, corrosion or any other surface distress. The examinations were conducted both on the outside diameter (OD) and inside diameter (ID) surfaces. The results of the surface examinations were documented by photographic recordings. The results are illustrated in Figures 2 through 6. The results are discussed in Section 3.

2.2 NDE EXAMINATIONS

Non destructive examinations (NDE) were conducted on the as-received weld sample to confirm the field reported indication as well as to identify the presence any additional indications. Initial NDE efforts were focused on identifying the reported indication by light optical microscopy and dye penetrant tests. When the effort failed to confirm the field findings, Westinghouse embarked on a detailed NDE examination procedure on the entire weld sample by employing light optical microscopy (LOM), Radiographic testing (RT), and fluorescent dye penetrant testing (PT) examination techniques. A detailed description of the NDE procedures and results is summarized in the Attachment 'A' of the report. The results of the NDE examinations are illustrated in Figures 7 through 10. Westinghouse also reviewed the site UT examination procedures. A discussion of the procedures and the results is included in the appendix.

2.3 SECTIONING PLAN

Based on the results of the NDE examinations and the suspected locations of the indications, a sectioning plan was developed for destructive examination of the weld sample. The sectioning plan provided test samples employed in various examinations and tests conducted under the scope of the current investigation. The sectioning plan is illustrated in Figures 11 and 12.

2.4 METALLOGRAPHIC EXAMINATIONS

Metallographic Examinations were conducted by light optical microscopy on axial sections transverse to the pipe weld. The sections were positioned to go through major weld indications recorded during the laboratory NDE examination. The metallographic examinations were conducted both in the 'as-polished' and in the 'polished and etched' conditions, to establish depth and distribution of cracking, crack initiation sites, crack propagation directions, the base metal and weld microstructures, the cracking morphology and its relation to the local microstructure. The results of the metallographic examinations are illustrated in Figures 13 through 25. The results are discussed in Section 3.

2.5 FRACTOGRAPHIC EXAMINATIONS

Fractographic examinations were conducted on freshly opened cracks in the laboratory by employing light optical and scanning electron microscopy (SEM) techniques. The purpose of the fractographic examinations is to establish the crack initiation sites, propagation directions and the general fracture morphology. The results of the fractographic examination are illustrated in Figures 26 through 30.

2.6 CHEMISTRY ASSESSMENTS

Wet chemistry analysis of the weld and base materials was conducted to examine if they conformed to the specification requirements. The results of the wet chemistry analysis of the carbon steel pipe, stainless steel valve body, and the weld filler materials are summarized in Table 1.

Semi quantitative chemistry assessment of the fracture surface compositions was conducted by energy dispersive spectroscopy (EDS) to identify the constituents and further to aid in the mechanistic assessment of the fracture process. Typical results of the EDS analysis of the fracture constituents is illustrated in Figures 31 and 32.

2.7 MICRO HARDNESS MEASUREMENTS

Micro hardness measurements were conducted on a polished section of the weld to establish the strength levels of the base and weld materials and further to examine the properties of the transition or mixing zone where major cracking was observed. The results of the micro hardness measurements are illustrated in Figure 33 and in Table 2.

2.8 REVIEW OF TVA'S WELDING AND UT INSPECTION PROCEDURES

As part of the investigation, Westinghouse reviewed TVA's material procurement, weld fabrication and weld inspection records that were made available. The results of the review were utilized in developing the investigation tasks and in the interpretation of the investigation results. The records are included in Attachment B.

2.9 MECHANISTIC AND ROOT CAUSE CONSIDERATIONS

Based on the overall results of the investigation, the mechanism and cause of cracking in the pipe weld was established and the contributors to the crack initiation and crack progression were identified.

3 RESULTS AND DISCUSSION

The results of the surface examination of the pipe weld sample in the as-received condition are illustrated in Figures 1 through 6. Figure 1(a) shows the appearance of the as-received sample with punch marks made in the field for referencing the field indication. Figure 1(b) is a schematic representation of the sample showing the location of the field indication, looking from the pipe into the valve body.

The outside diameter (OD) surface appearance of the pipe weld sample in the as-received condition is illustrated in Figures 2 and 3. The surface appeared smooth with no evidence of cracking, corrosion or any mechanical distress. The punch marks seen on the OD surface on the valve side corresponds to the 12 o'clock location or top dead center. (The valve and pipe were oriented horizontally.) Figures 4 through 6 illustrate the inside diameter surface appearance of the pipe to valve weld. The caliper pointers show the position of the suspected UT indication recorded at the site. Several important observations can be made from the ID surface examination results: the weld root pass appeared irregular and of non uniform thickness; the circumferential machining marks in the counter bore region of the carbon steel pipe appeared to be deep and significant; and the carbon steel counter bore region adjacent to the weld showed evidence of significant pitting (Figure 6). Another important observation from Figure 6 is the presence of a circumferential crack in the carbon steel adjacent to the weld interface. These observations suggested potential deviations from the normally expected conditions associated with the welding process.

TVA's in-service inspection reported that an indication was recorded between 90° and 120° (3 o'clock and 4 o'clock) orientations in the weld at the ID, looking from the pipe side in to the valve. Detailed surface examinations by light optical microscopy and dye penetrant tests failed to confirm the reported ID surface indication at the 90 to 120 degree location. The Westinghouse NDE examination procedures were then extended on to the entire weld sample by employing fluorescent dye penetrant (PT), Radiographic (RT) and Ultrasonic (UT) examination techniques. A brief summary of the NDE procedures and the results is summarized in the Attachment 'A' of the report. The RT examination results of the 90 to 120 degree segment are illustrated in Figures 7 through 10. Although PT examination failed to reveal any indications, volumetric examinations by UT and RT confirmed the presence of at least two indications at the suspected field indication location. The fluorescent dye penetrant examination results of the remaining ID surface are illustrated in Figure 10. PT indications were recorded at several isolated regions around the circumference.

Based on the results of the NDE evaluations, a detailed sectioning plan was developed to facilitate test samples employed in the various examinations and tests. The sectioning plan is summarized in Figures 11 and 12.

The results of the metallographic examinations are illustrated in Figures 13 through 25. The metallographic examinations were focused on axial sections of the pipe weld, taken through three most significant indications, namely the deepest indication at 270° orientation, and two other indications at 90° and 180° orientations, respectively. Figure 13 illustrates the appearance of the as-cut face at 270°corresponding to the field indication. The presence of an approximately 80% through wall crack initiated from the ID surface can be seen here. Figure 14 illustrates the as-polished condition of the 270 section showing that the crack followed carbon steel to weld interface. Figures 15 and 16 illustrate the higher magnification micrographs of the crack in the as-polished condition. The metallography results of the cracking morphology in the 'polished and etched' condition are illustrated in Figures 17 through 20. Detailed examination of the cracking morphology illustrated here showed that the crack primarily initiated at the geometric discontinuity at the weld interface on the ID and progressed primarily through the dilution or the mixing zone in the weld metal at the interface. The crack was covered with heavy oxide deposits at the crack mouth and all the way up to the crack tip region. Intergranular attack and oxide penetration was also seen in the weld metal along the crack progression. The metallography results of the indications at 90° and 180° orientations are illustrated in Figures 21 through 24. The results showed that both of these indications are associated with crack penetration into the carbon steel material at the weld interface. They were both associated with initiation at the geometric discontinuity at the weld interface on the ID and progression along the interface but in the carbon steel matrix. Again, heavy oxide deposits were seen in the crack and at the crack mouth region in both cases. As was indicated in Figure 22, the oxide deposit was heavy enough to completely bridge the crack mouth region. This could have potentially prevented the PT technique from detecting the indication on the ID surface. Typical microstructures of carbon steel and weld metal can be seen in Figure 25.

The results of the scanning electron fractography of the cracks freshly opened in the laboratory are illustrated in Figures 26 through 30. Figure 26 illustrates the crack opening procedure employed in the laboratory in opening the deepest crack at 270°. A low magnification fractograph of the freshly opened crack showing the laboratory fractured and field fractured regions is shown in Figure 27. The fracture surface shows the weld interface with islands of weld metal. Higher magnification SEM fractographs in

Figures in Figures 28 and 29 illustrate the morphology of interdendritic attack in the weld metal islands. Figure 30 illustrates the formation of iron oxide crystal deposits in the crack.

The fracture constituents and oxide deposits were identified by semi quantitative EDS spectroscopy. Figures 31 and 32 illustrate the typical results of EDS spectroscopy results of the fracture constituents. A comparison of oxygen and chromium peaks differentiates the iron oxide deposits from weld metal islands. Wet chemistry analysis of samples from the carbon steel pipe, the stainless steel valve body and the 309 weld deposit materials was conducted to examine their conformance to the specification requirements. The results are summarized in Table 1. The chemistry analysis results suggested that the materials generally met the specifications with the exception of the Nitrogen content in the weld metal.

Micro hardness traverse measurements were made across the weld interface on the polished samples to assess in strength levels of base and weld materials, and to gain more understanding of the transition or mixing zone where the major crack was detected at 270° orientation. The results are summarized in Figures 33 and in Table 2. These results suggested the occurrence of a thin hardened zone at the interface in the weld metal potentially due to dilution, inadequate pre heat and cleaning effects associated with the welding. These conditions are likely to contribute to the observed cracking.

A review of the materials procurement, weld fabrication and weld inspection records of the subject weld from TVA was conducted to examine any potential deviations and to identify contributing factors to the cracking. The records are included in Attachment-B of the report. The review suggested no abnormalities in the procurement and weld inspection during fabrication. The review also indicated that no cracking was detected during weld fabrication.

4 SUMMARY AND CONCLUSIONS

The OD surface examination of the as-received pipe weld sample showed a clean surface with no evidence of cracking, deposits, or other mechanical distress marks. This suggested that the cracking did not initiate on the OD and that there was no through wall leak from the ID. The inside diameter surface examinations however clearly identified deviation from normally expected conditions from the weld process. The examinations showed evidence of irregular weld beads, deep machining grooves and pitting in the counter bore and the presence of a circumferentially oriented crack in the carbon steel immediately adjacent to the weld interface in the heat affected zone. The procurement and fabrication records and the weld profile geometry suggested that significant machining at the counter bore was needed to prepare the joint for welding and that the ligament thickness was reduced significantly at the weld, favorable to stress enhancement. These observations suggested a potential for the presence of higher residual stresses from restraint or fit up and from stress concentration effects at the weld joint.

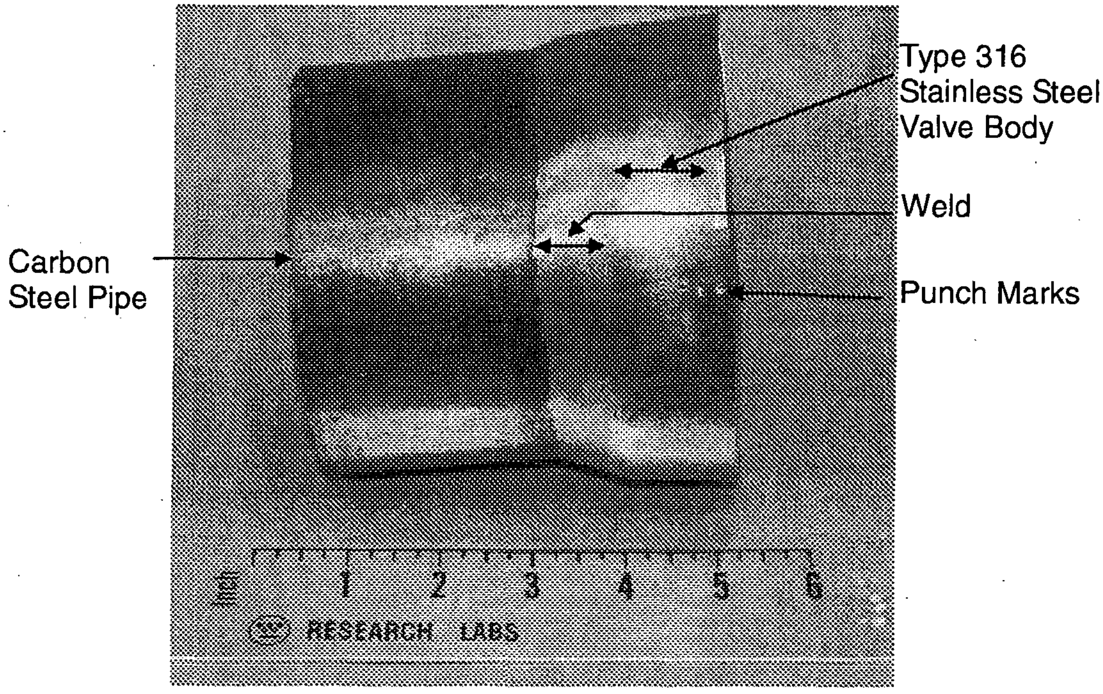
The metallographic examinations suggested that cracking was initiated on the ID surface at the weld interface where an unusually sharp geometric discontinuity due to excessive root bead penetration was present. The initiation of isolated cracks at multiple locations around the circumference suggested that residual stress conditions associated with the weld may have played a role in the cracking. The metallographic examinations revealed that the crack progression occurred both in the carbon steel as well as in the Type 309 stainless steel weld metal dilution zone immediately adjacent to the interface where resistance to oxidation is minimized due to the chromium depletion and/or other dilution affects in the mixing zone. The presence of heavy oxide deposits at the crack mouth as well as within the cracks, all the way up to the crack tip regions, revealed by the metallographic examinations suggested that corrosion played a significant role in the cracking process. The observations also point out that the oxygenated conditions of the piping system played a role in the cracking process. Microhardness measurements supported the existence of hardened zone in the diluted weld metal region which is likely to support higher residual stresses.

Based on the overall results of the investigation it is concluded that the observed cracking in the TVA check valve to pipe weld joint occurred by pitting and general corrosion in the carbon steel and intergranular stress corrosion cracking (IGSCC) in the diluted weld metal at the weld interface. The presence of geometric discontinuity and residual stresses from pipe restraint conditions most likely contributed to the crack initiation. Oxygenated conditions and aqueous environment in the presence of weld residual stresses most likely contributed to the crack progression.

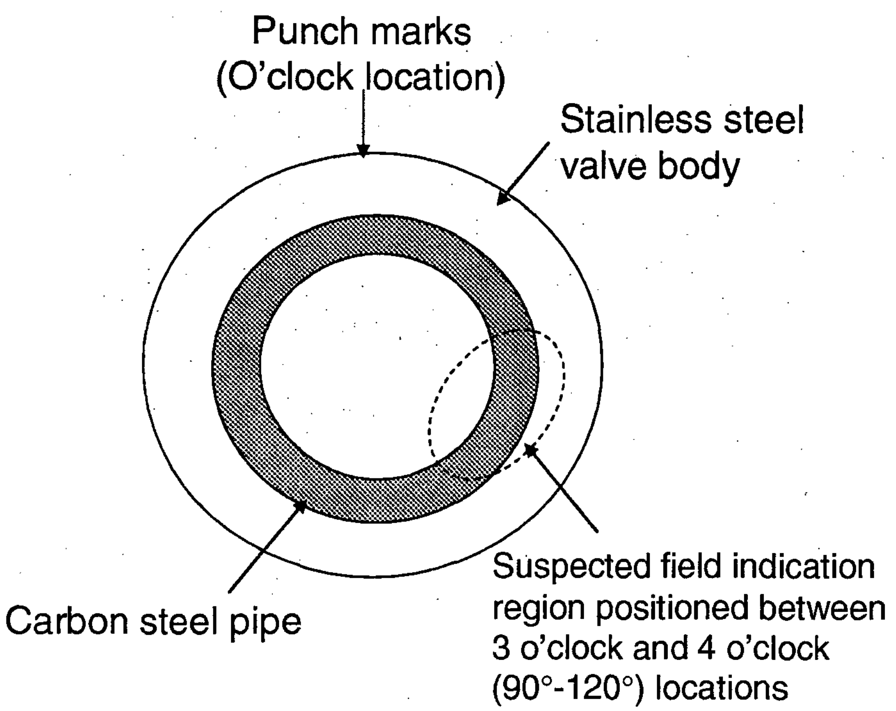
Table 1 Chemistry Analysis Results of Carbon Steel Pipe, Stainless Steel Valve and the Weld Filler Materials

Heat No.	Element (wt. %)								
	C	Mn	P	S	Si	Ni			
A1A2	0.19	1.13	0.014	0.021	0.18	0.032			
ASME SA333 Grade 6 Requirements	0.30 max.	0.29-1.06	0.025 max	0.025 max	0.10 min	--			
Heat No.	**Element (wt. %)**								
	C	**Mn**	**P**	**S**	**Si**	**Ni**	**Cr**	**Mo**	**N**
A1A	0.060	1.83	0.081	0.009	0.75	13.74	17.53	2.19	0.12
ASME SA182 Gr. F316 Requirements	0.08 max	2.00 max	0.045 max	0.030 max	1.00 max	10.0-14.0	16.0-18.0	2.0-3.0	0.10 max
Heat No.	**Element (wt. %)**								
	C	**Cr**	**Cu**	**Mn**	**Mo**	**Ni**	**P**	**S**	**Si**
A1A3	0.050	23.40	0.097	1.91	0.21	12.50	0.014	0.006	0.45
ASME SFA5.9 ER309 Requirements	0.12 max	23.0-25.0	0.75 max	1.0-2.5	0.75 max	12.0-14.0	0.03 max	0.03 max	0.30-0.65

Table 2	Vickers Hardness Traces Across Weld- Low Alloy Steel Interface, Piece A3B	
Trace A	**Location on Specimen (readings made 0.006" apart)**	**Hardness Values (Vickers, 500g)**
1	weld	191
2	weld	179
3	weld	204
4	transition	170
5	low alloy steel	176
6	low alloy steel	158
7	low alloy steel	138
Trace B		
1	weld	164
2	weld	162
3	weld	158
4	weld	166
5	transition	304
6	low alloy steel	186
7	low alloy steel	164
8	low alloy steel	144
9	low alloy steel	139
Trace C		
1	weld	193
2	weld	164
3	weld	181
4	weld	160
5	transition	238
6	low alloy steel	141
7	low alloy steel	144
8	low alloy steel	139
9	low alloy steel	144



(a) As-received Sample



(b) View looking from pipe into valve

Figure 1 Schematic Representation of the Geometry of As-received Sample Showing the Location of Suspected Field Indication

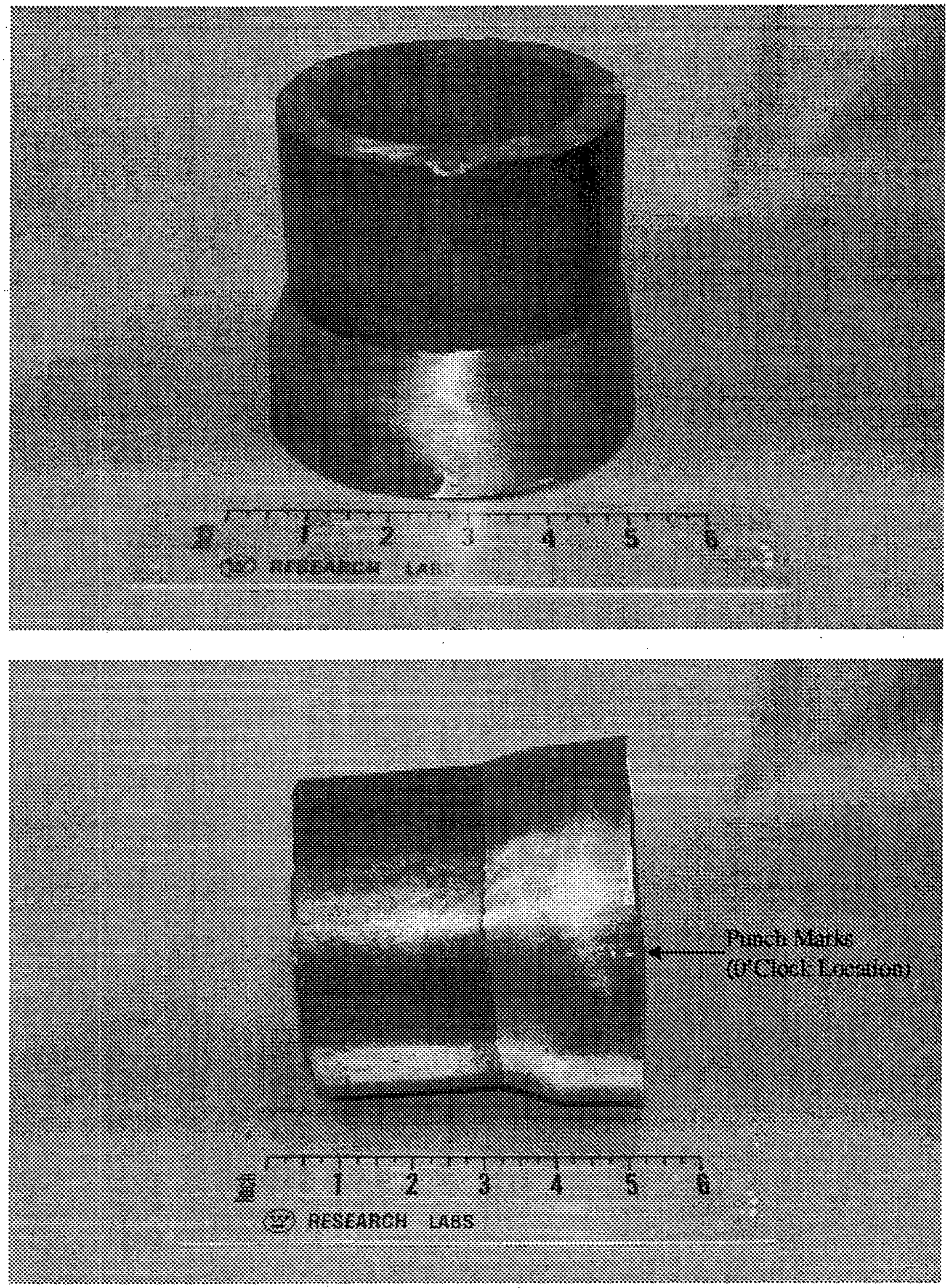


Figure 2 Side Views Showing the OD Surface Condition of the As-received Sample

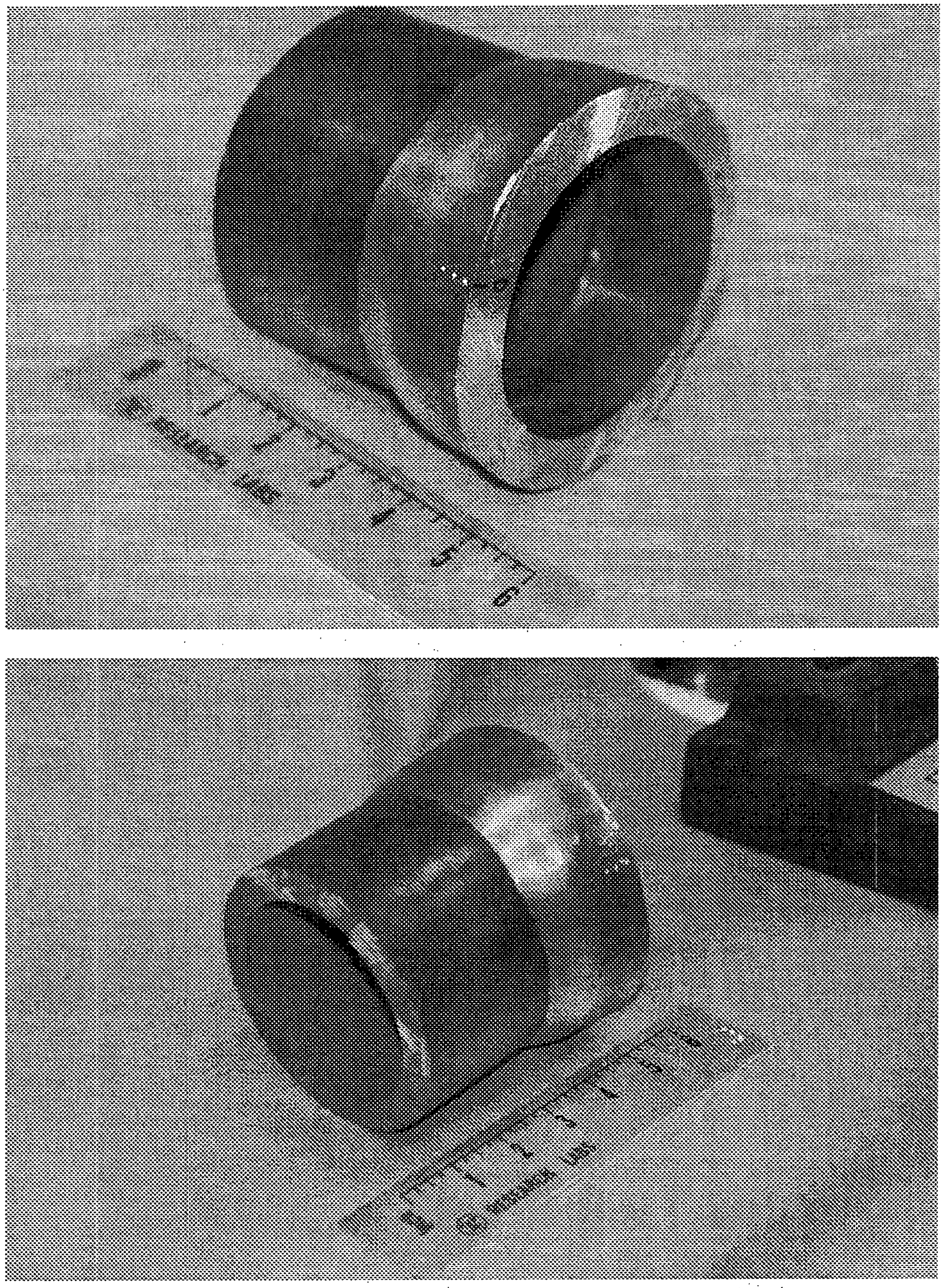


Figure 3 Side Views Showing the OD Surface Condition of the As-received Sample – Punch Marks at 0'Clock Location of Value Body can be Seen

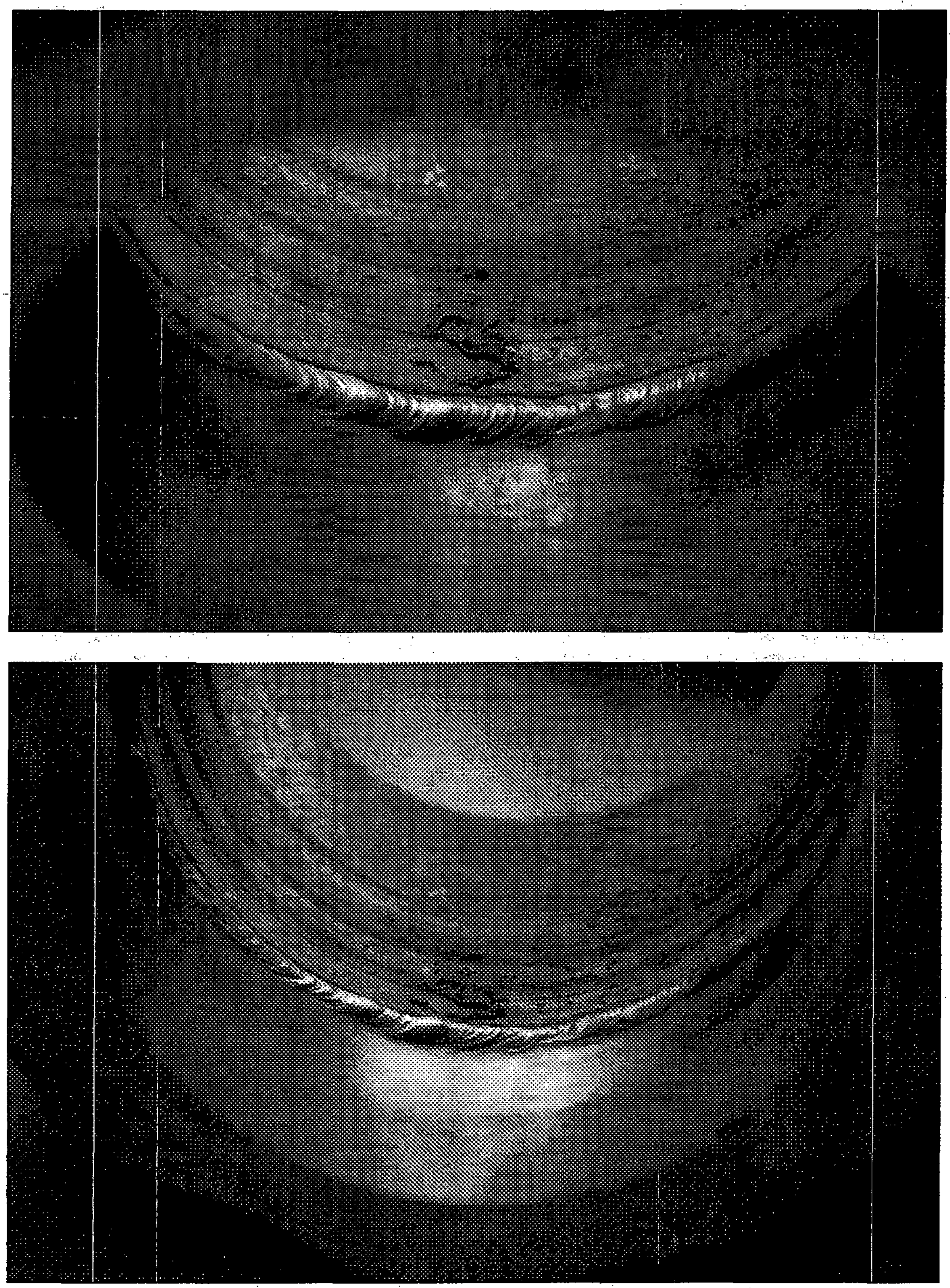


Figure 4 Appearance of the ID Surface Condition of the Weld in the As-received Sample

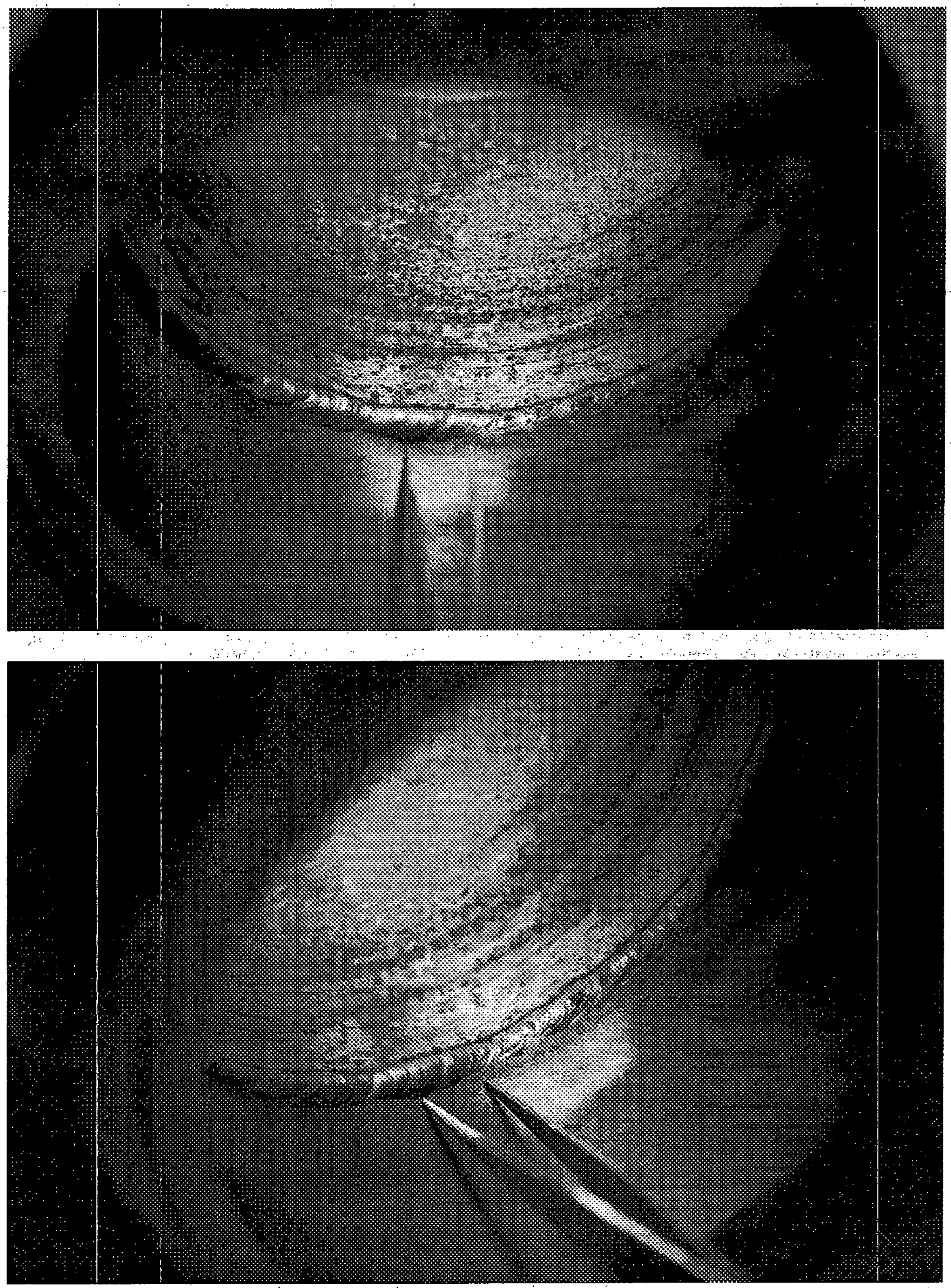


Figure 5 **ID Surface Condition of the Weld in the As-received Sample – The Caliper Points to the Region Corresponding to 4 to 6 o'clock Location where Suspected UT Indication was Reported by Site Personnel**

Figure 6 ID Surface Appearance of the Weld at the Carbon Steel Interface – Note the Presence of Pitting in the Carbon Steel at the Weld Heat Affected Zone and Cracking at the Weld Interface

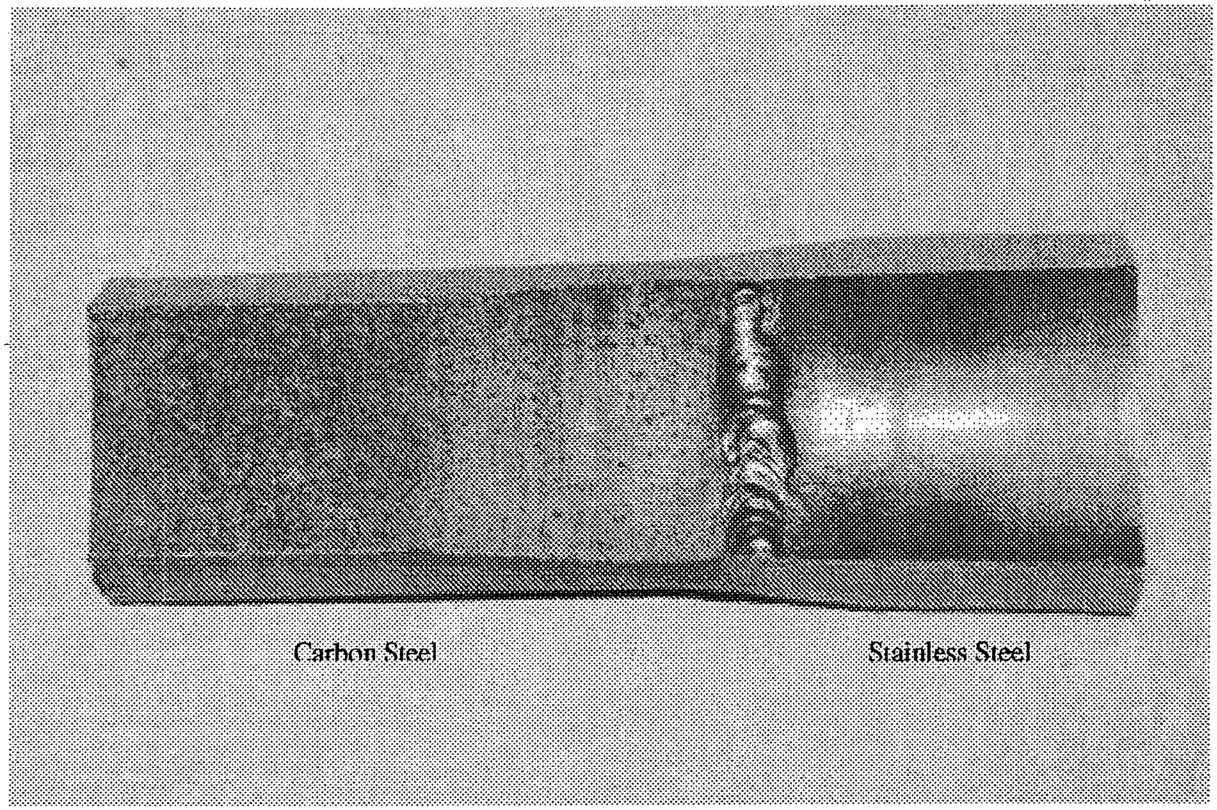


Figure 7 Image of the Inside Surface of the90°-120° Segment

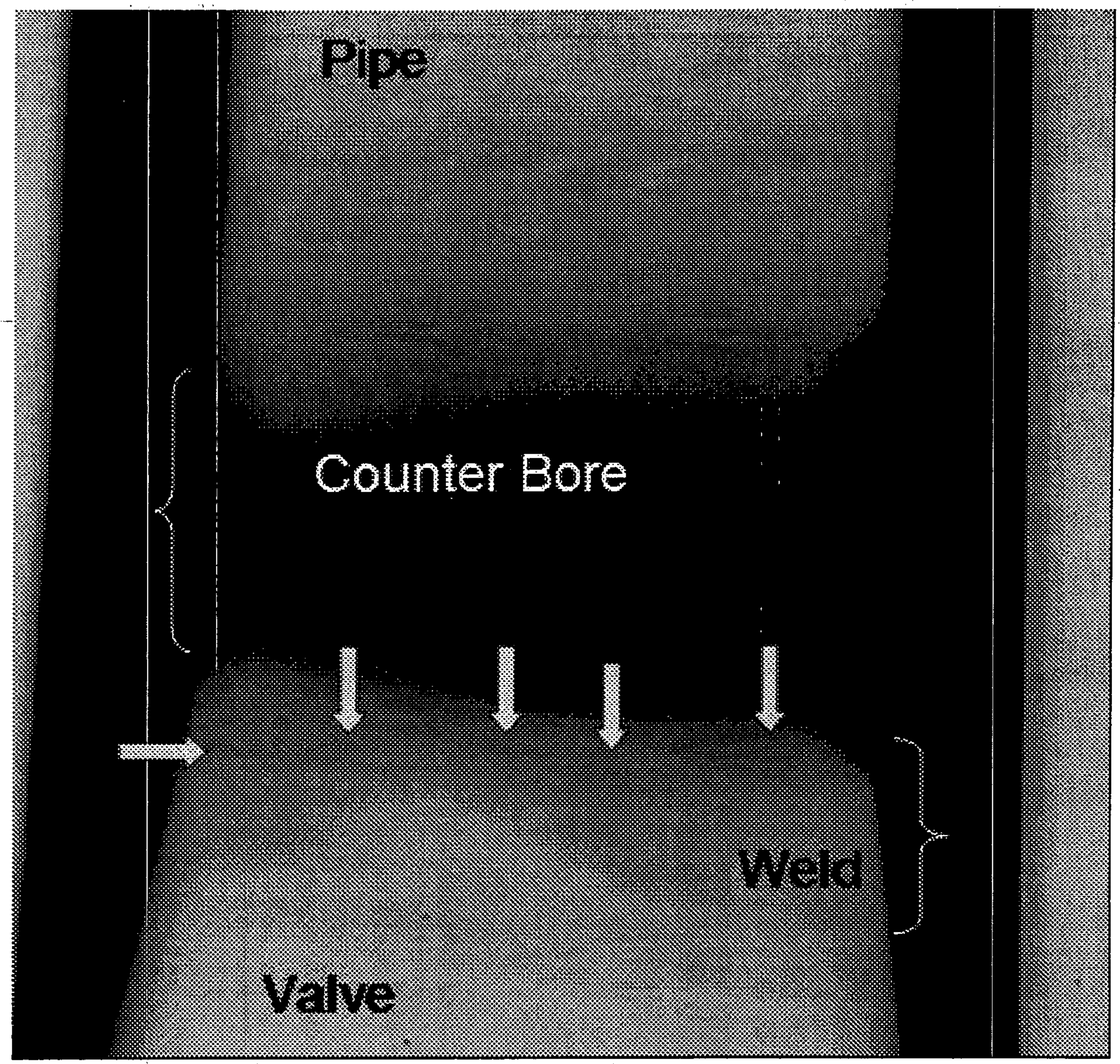


Figure 8 **Digitized Radiograph of the Section of Pipe-Valve Weld Assembly Corresponding to the Indications Found in the Field Ultrasonic Examination – Note the radiograph was taken with the id of the assembly against the film. The arrows show the locations of the radiographic indications.**

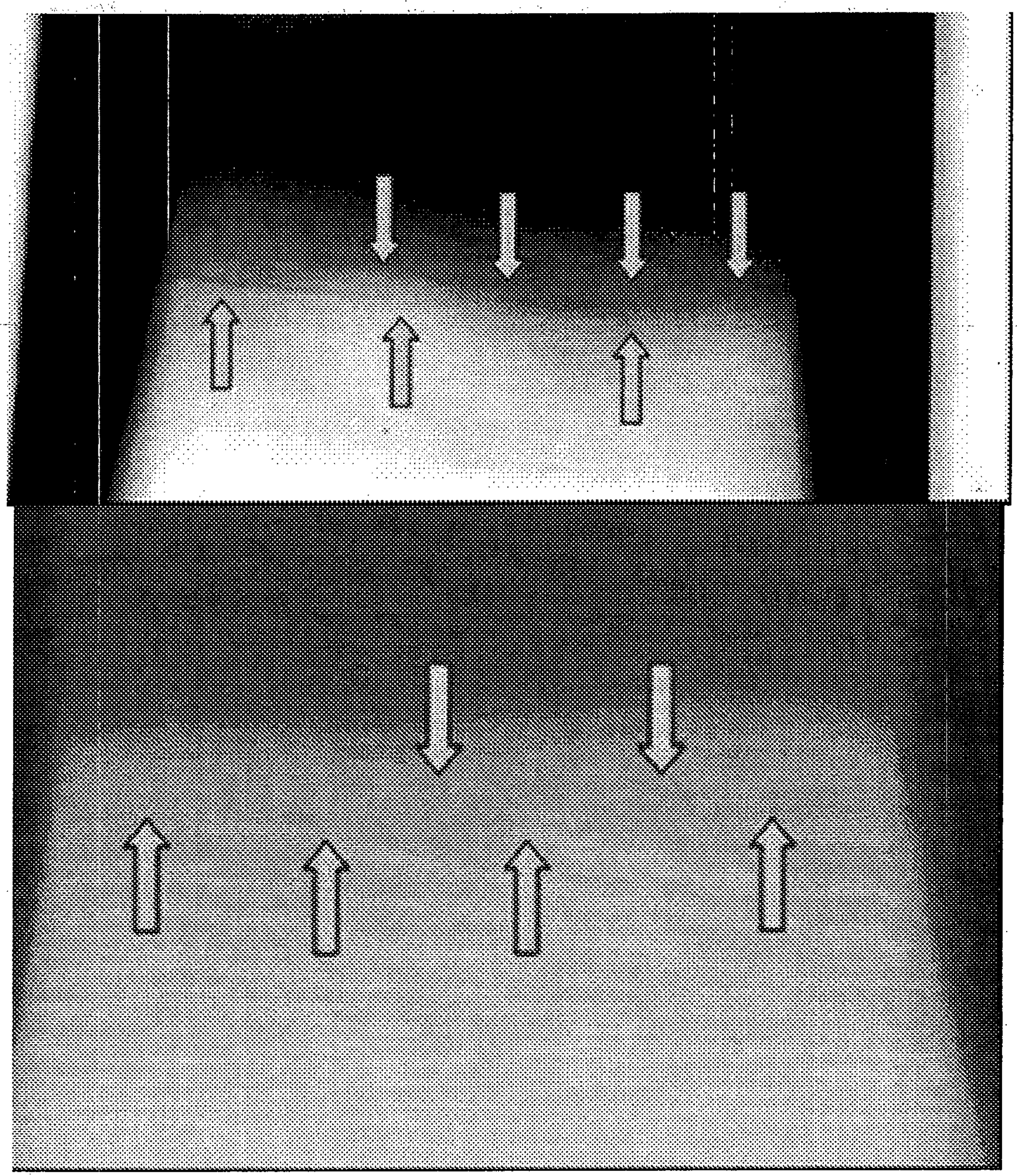


Figure 9 Enhancement of the X-ray Radiographs in the Vicinity of the weld – Upper image is from the image in Figure 8 while the lower is for a radiograph taken with the II of the component away from the film. The arrows show the location of the radiographic indications.

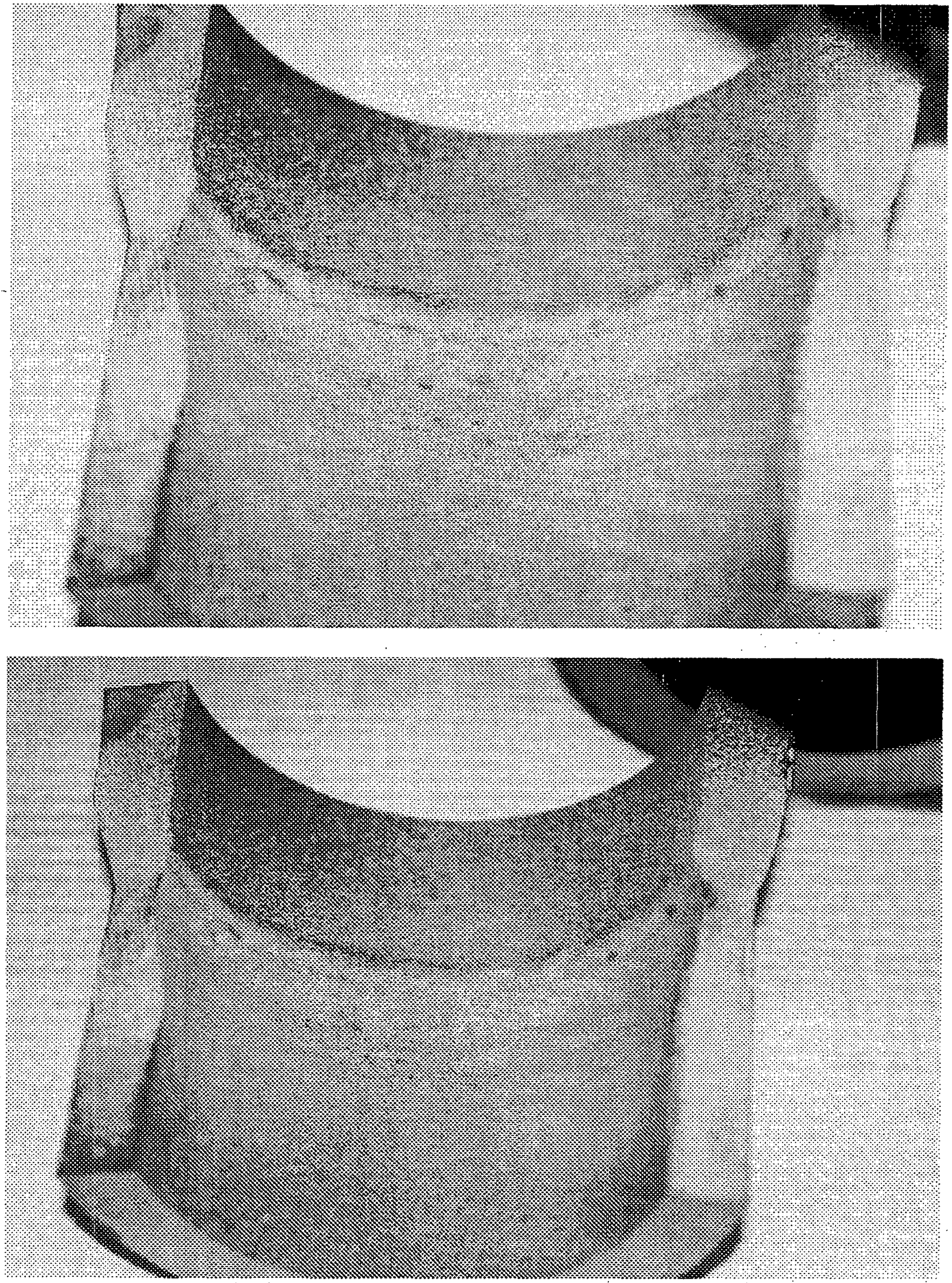


Figure 10 Fluorescent Dye Penetrant Examination Results of the ID Surface of the Pipe to Valve Weld Sample

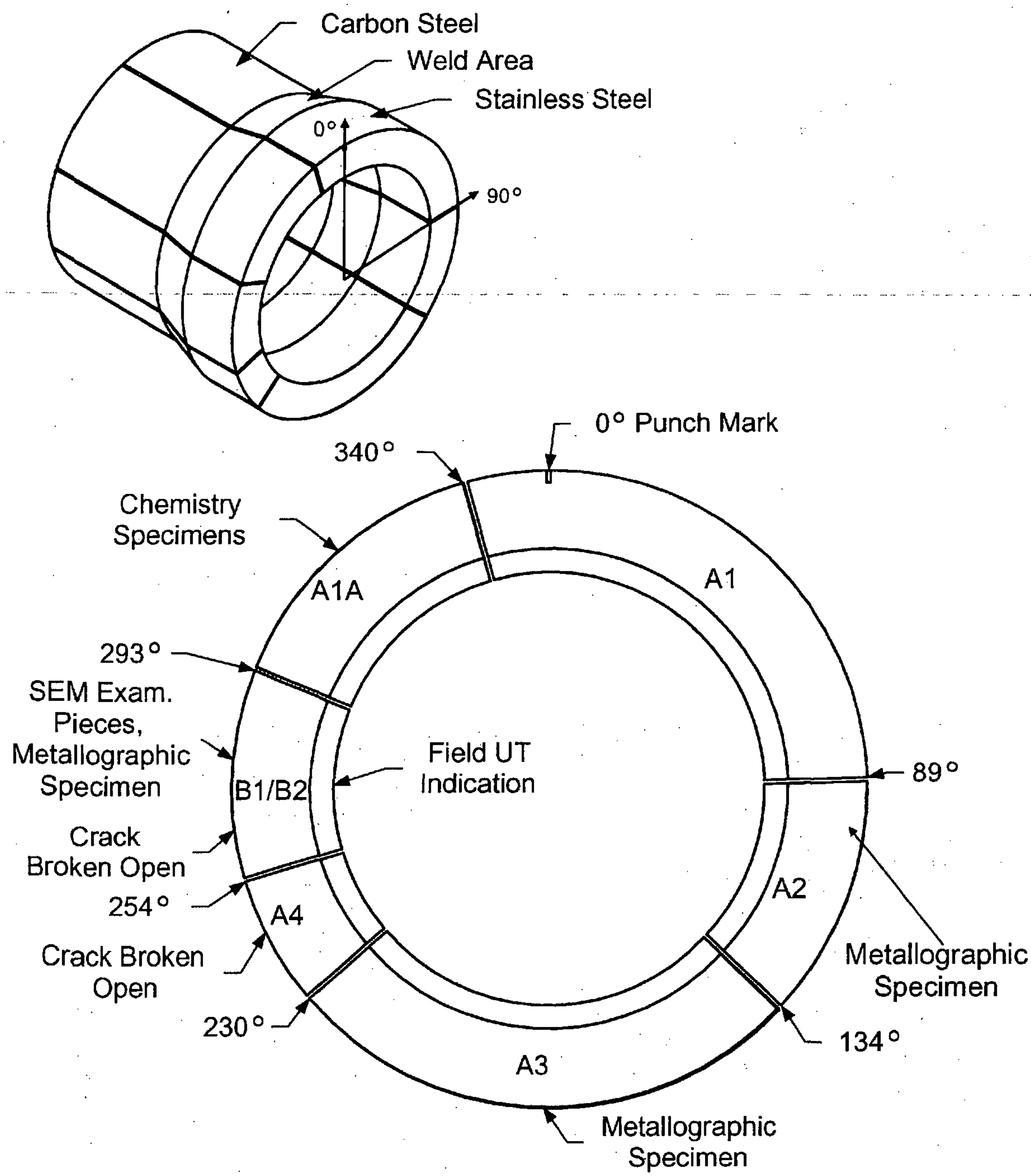


Figure 11 **Schematic Representation of Pipe to Valve Weld Sample Illustrating the Orientation of Initial Axial Cuts and Sample Identifications (Looking from the Value Body into the Pipe)**

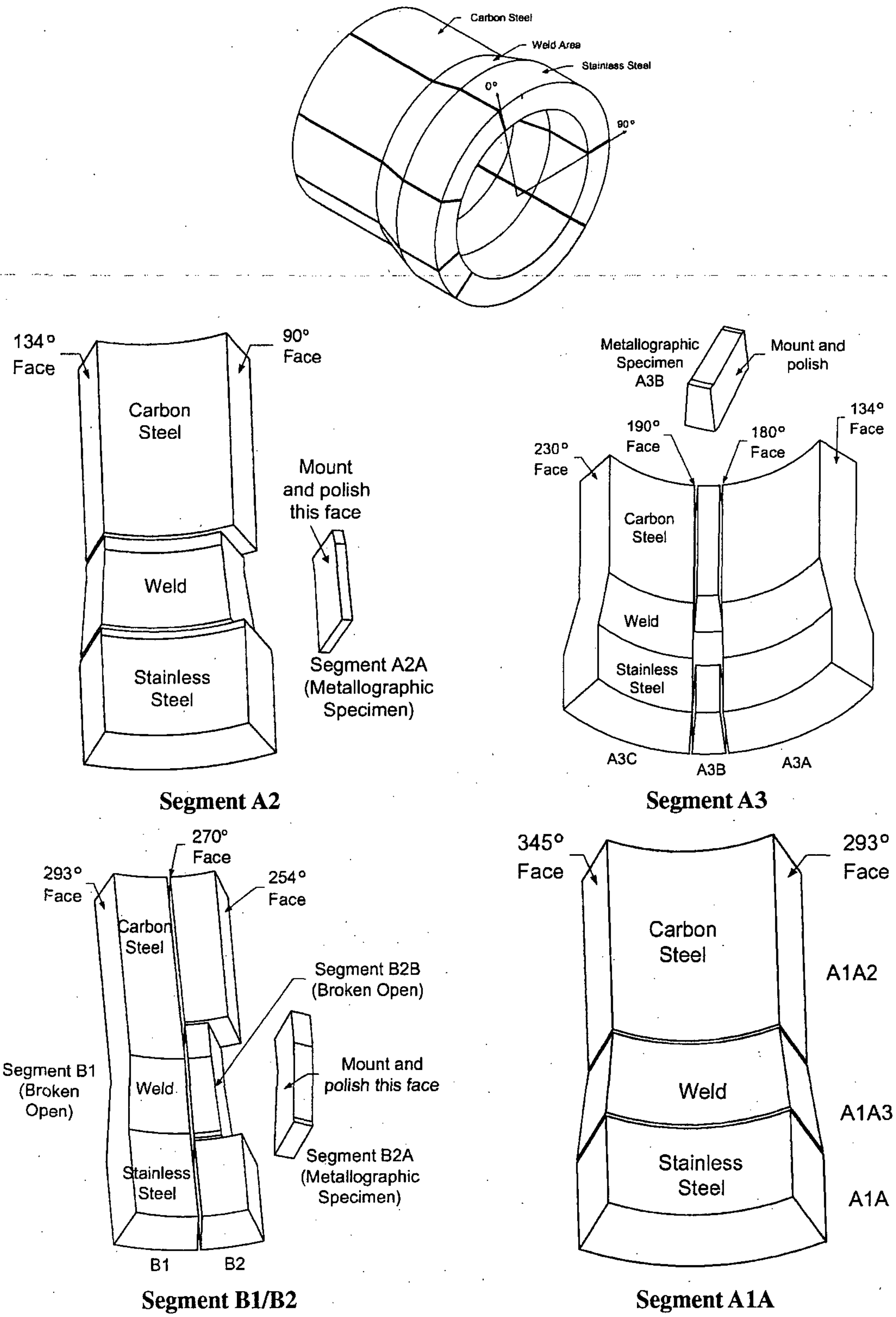
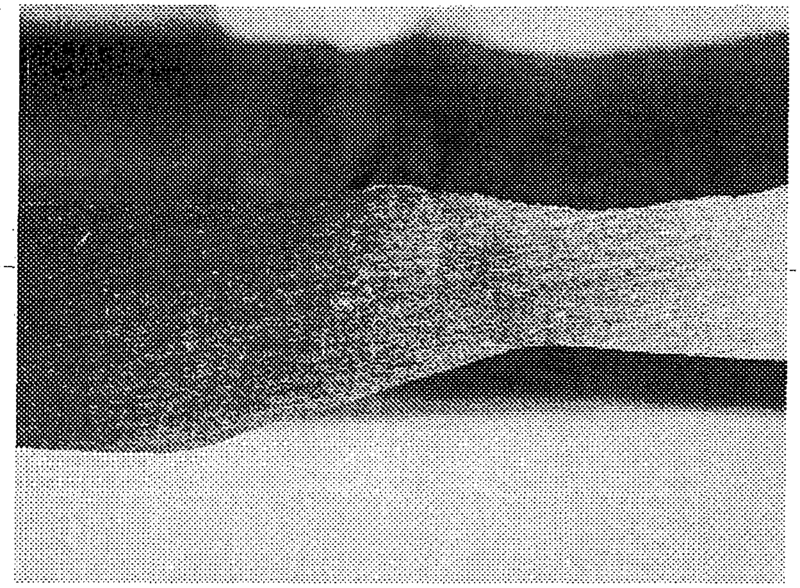


Figure 12 **Schematic Representation of Sectioning Procedure Employed in Securing Test Samples for Various Examinations and Tests**



(a)

(b)

Figure 13 Appearance of 270° Axial Cut Face Revealing the Presence of 80% Through Wall Crack (B2A Segment)

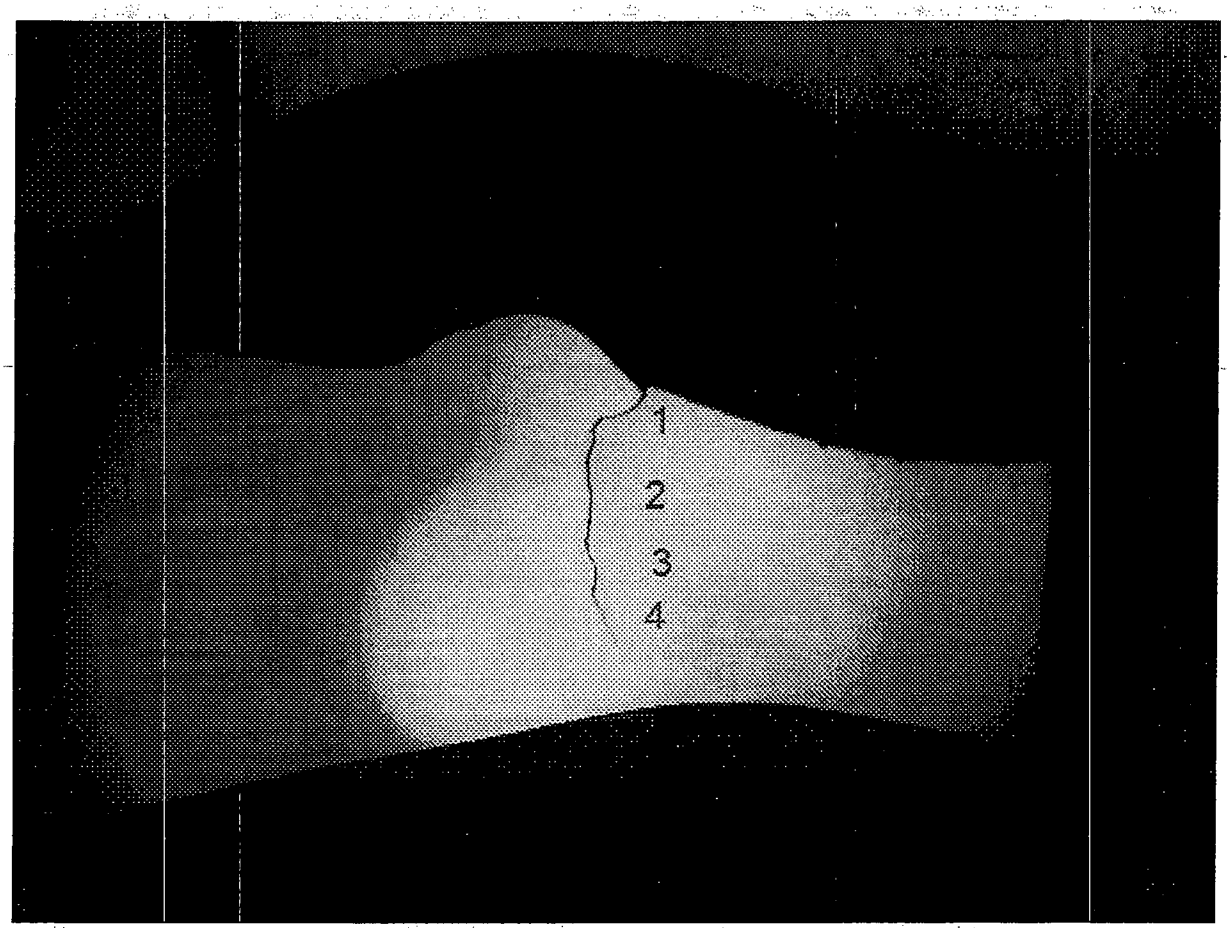
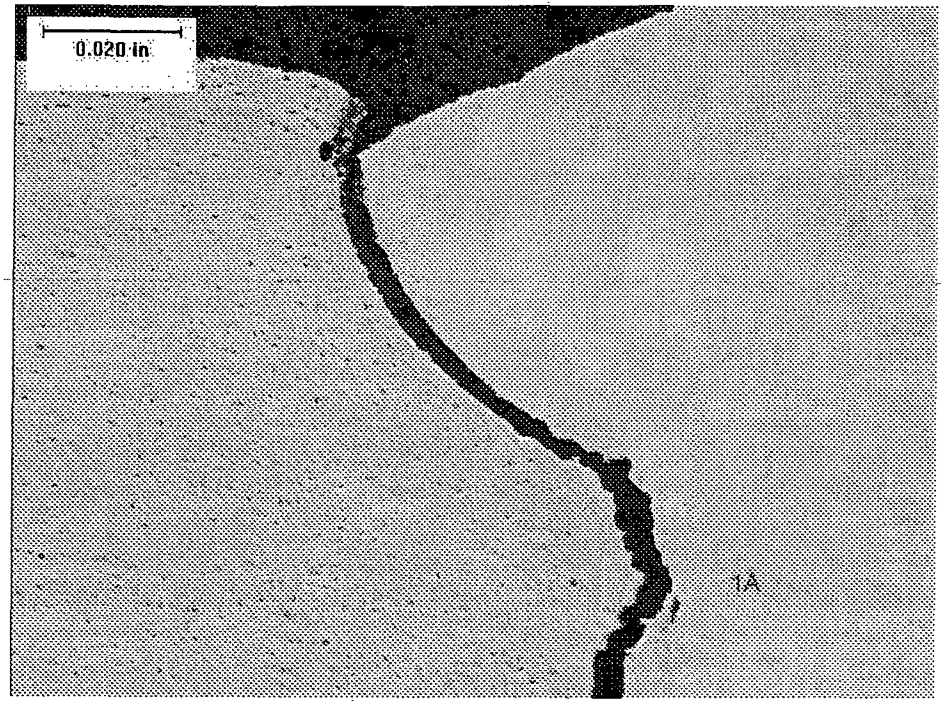


Figure 14 Metallography Results in the As-polished Condition of Axial Section at 270° Orientation Showing the Deepest Crack at the Carbon Steel Interface

Metallography Piece B2A



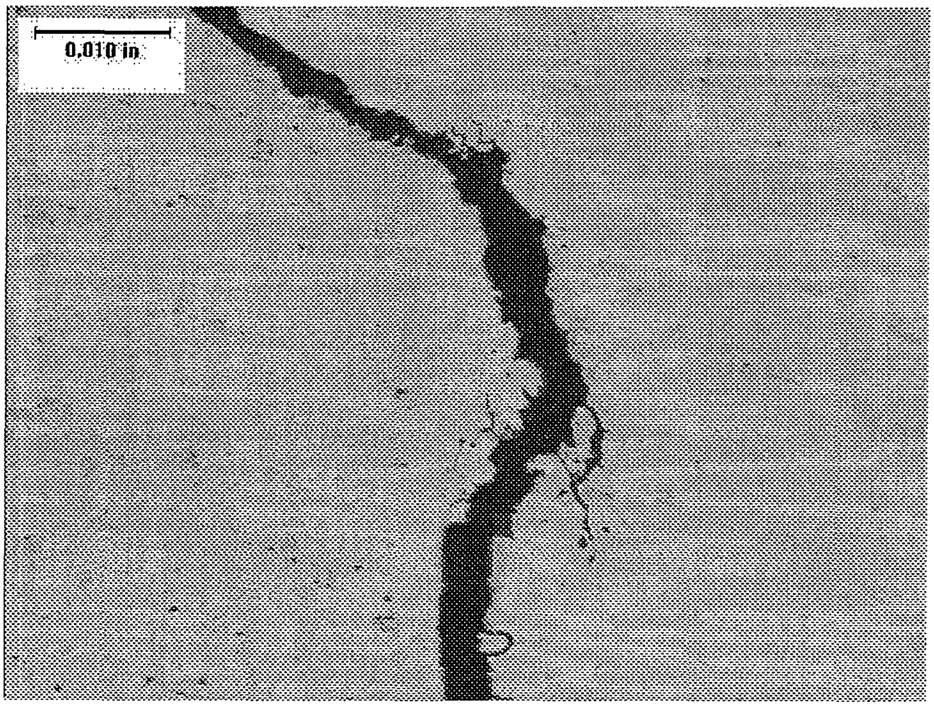


Figure 15 Metallography Results in the As-polished Condition of 270° Section Illustrating the Morphology of Crack in the Weld Metal (Specimen B2A)

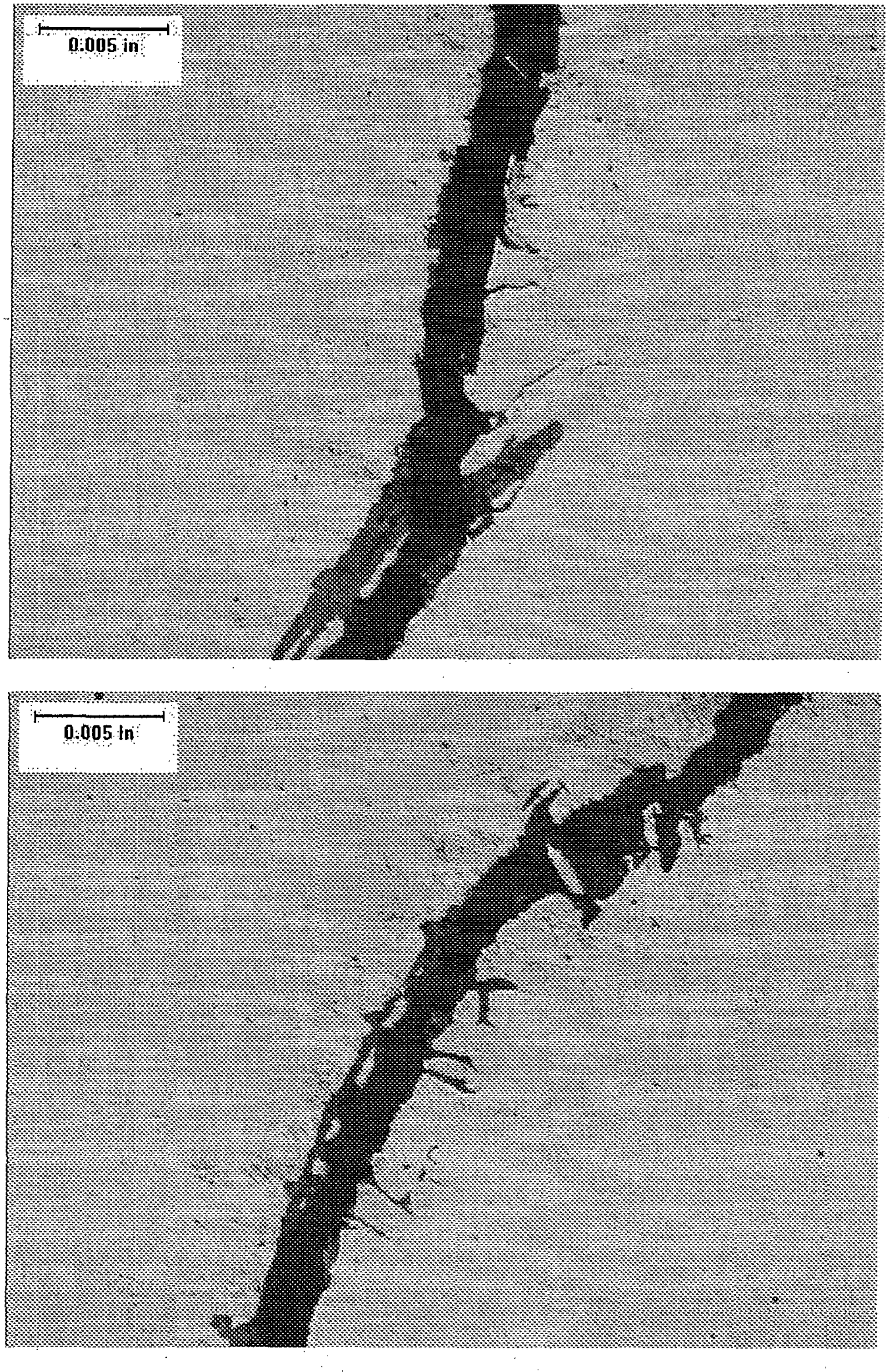
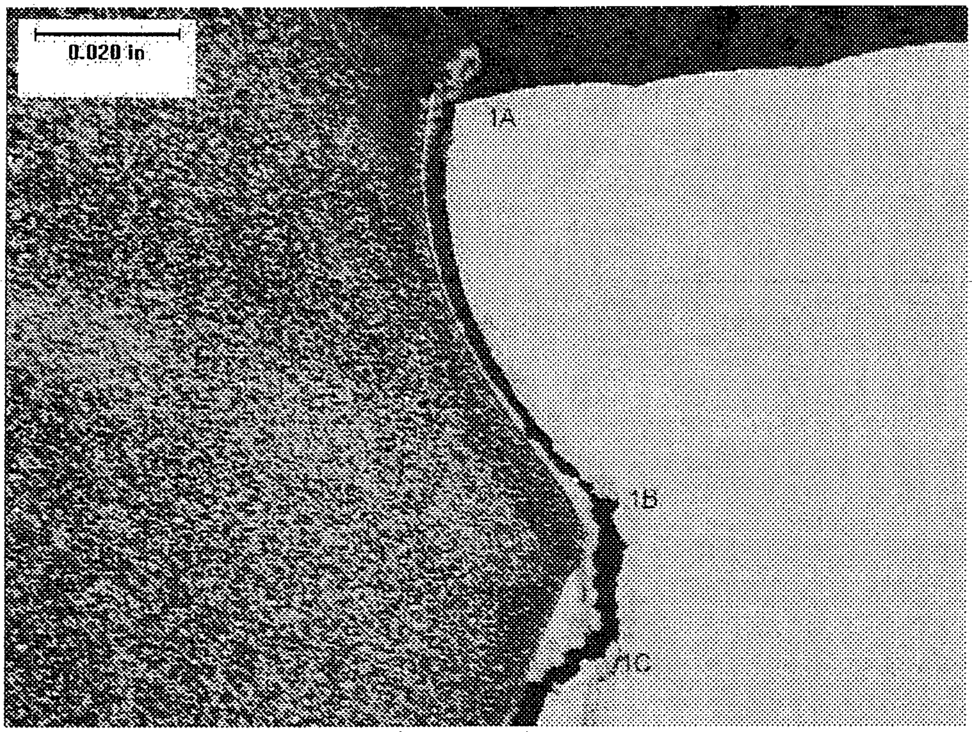


Figure 16 Metallography Results in the As-polished Condition of Axial Section at 270° Illustrating the Cracking Morphology in the Weld Metal (Specimen B1A)

Metallography Piece B2A (Nitch Etch)



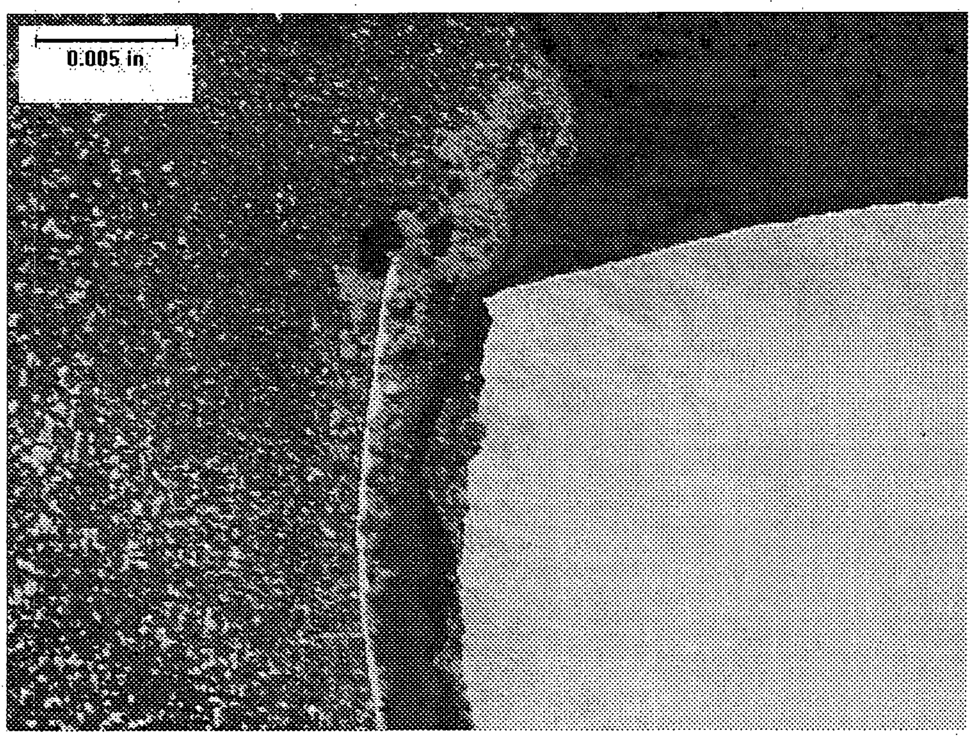


Figure 17 Morphology of Crack at 270° Orientation (Specimen B2A Polished and Etched Condition)

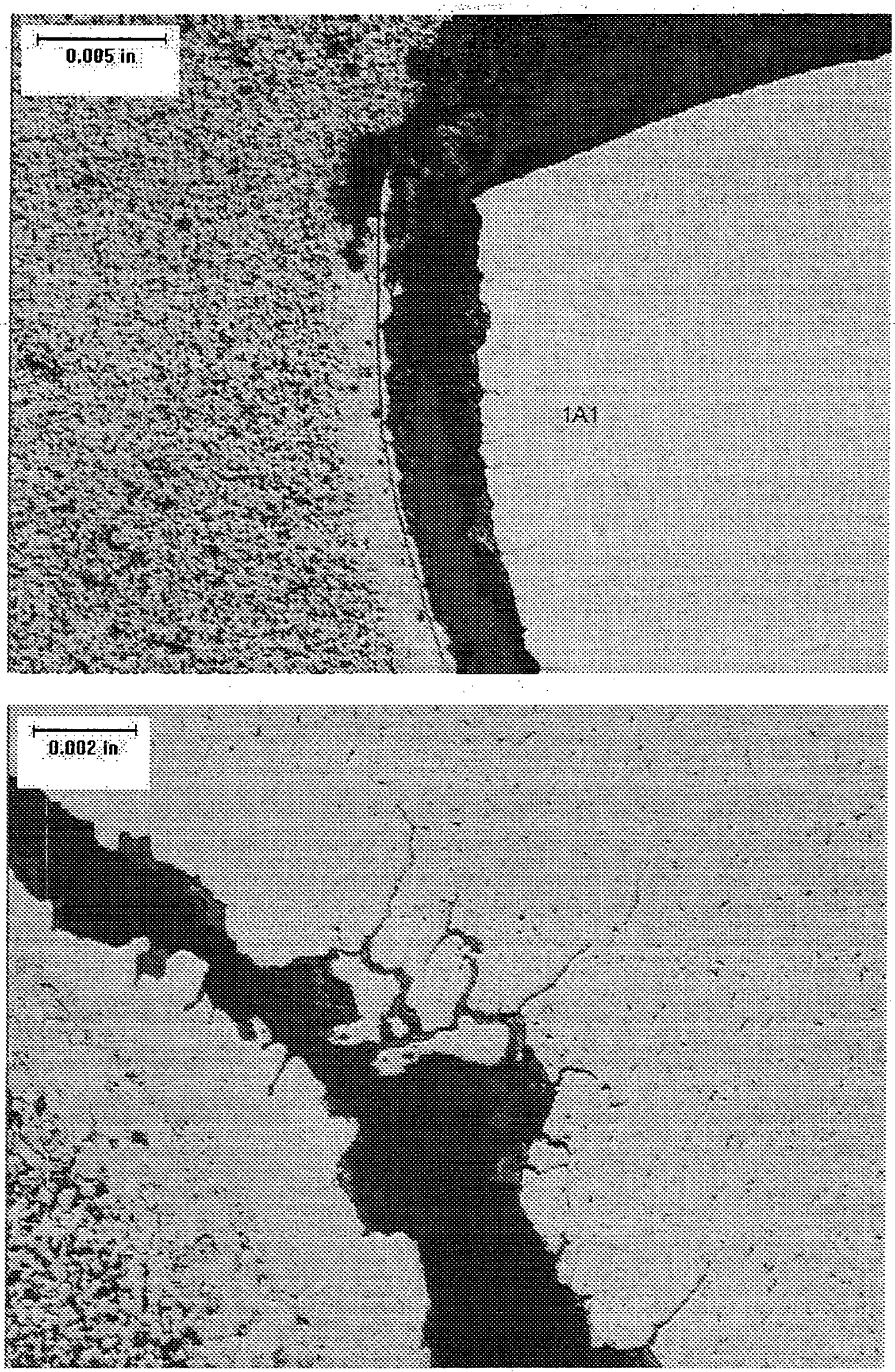


Figure 18 **Morphology of Crack at 270° Orientation (Specimen B2A Polished and Etched Condition)**

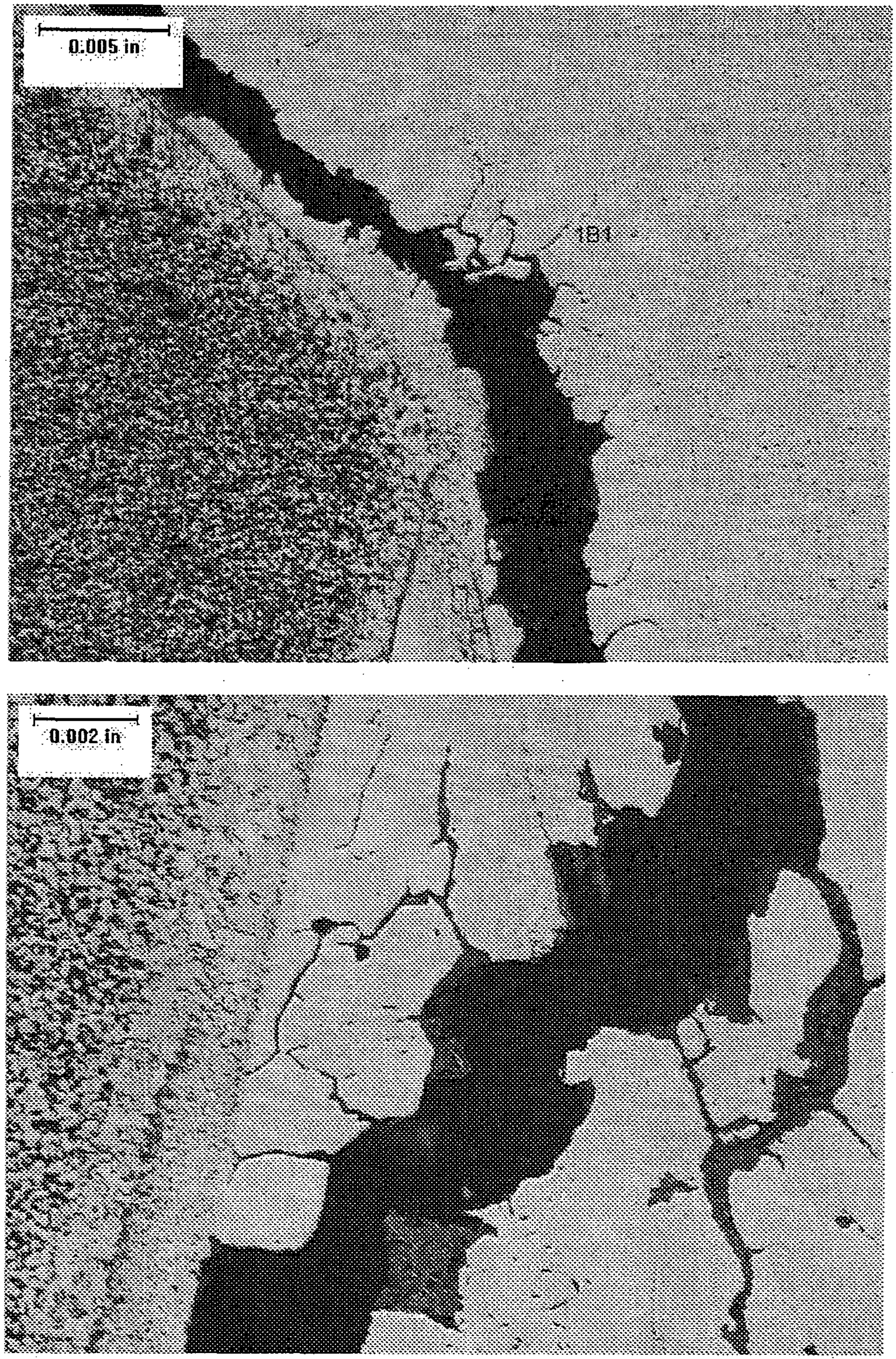


Figure 19 **Morphology of Crack at 270° Orientation (Specimen B2A Polished and Etched Condition)**

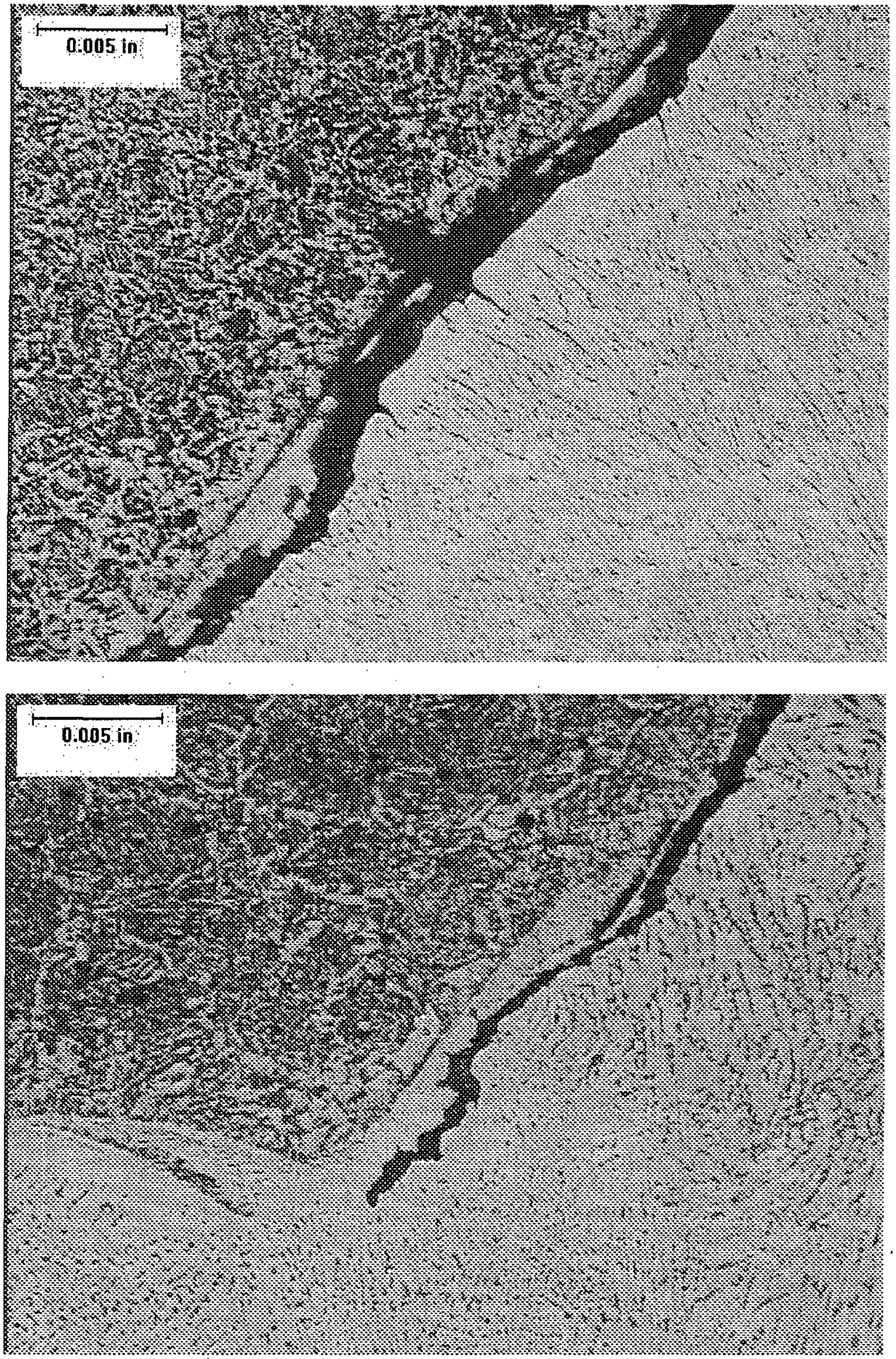
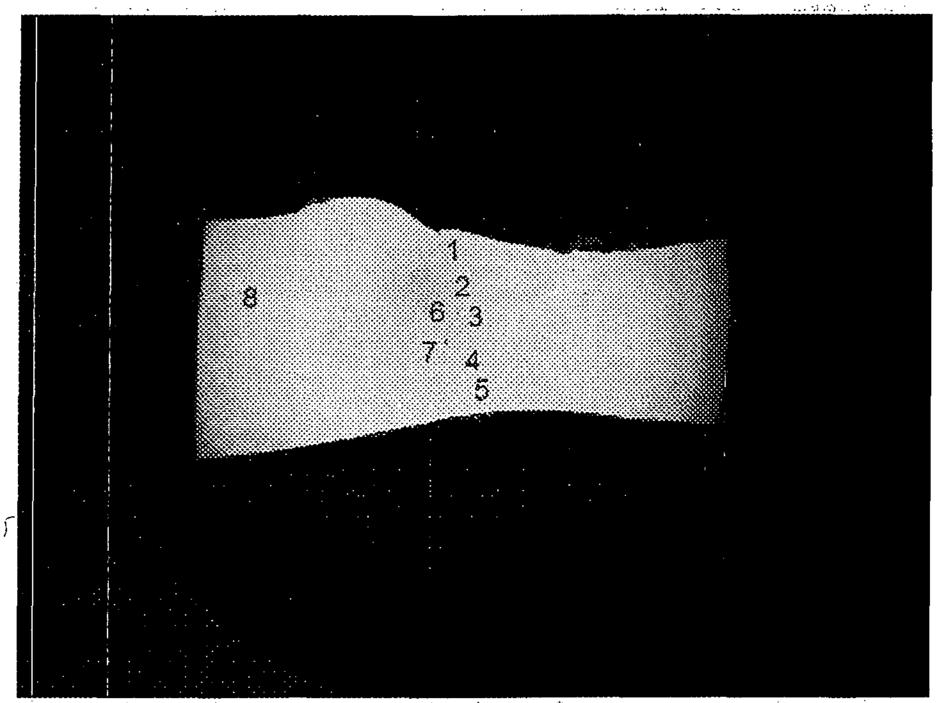
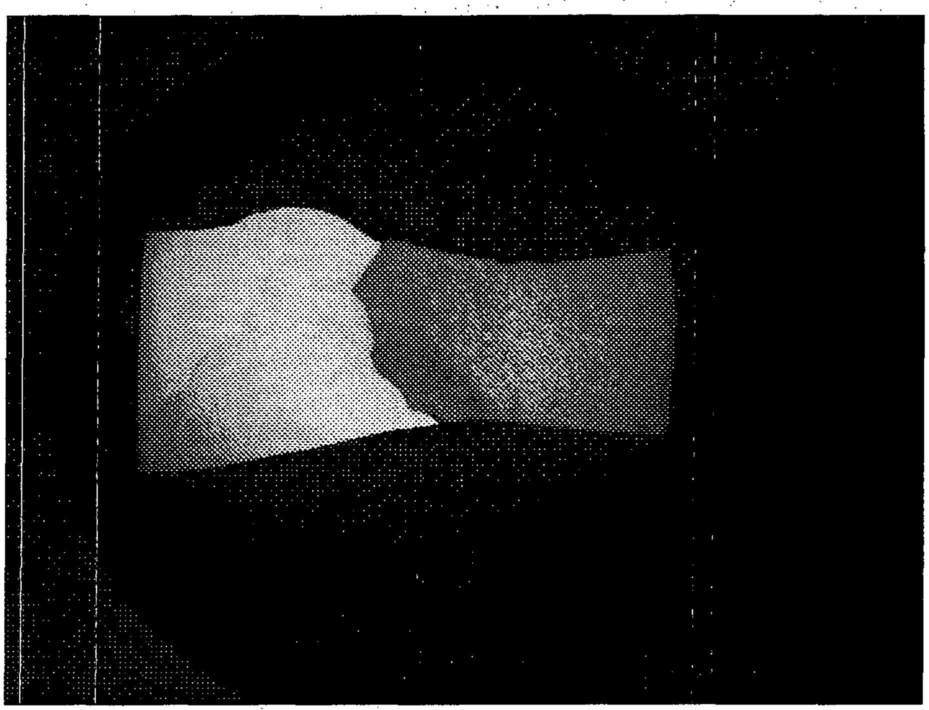


Figure 20 **Morphology of the Crack-tip of the Deepest Crack seen at 270° (Specimen B2A Polished and Etched Condition)**



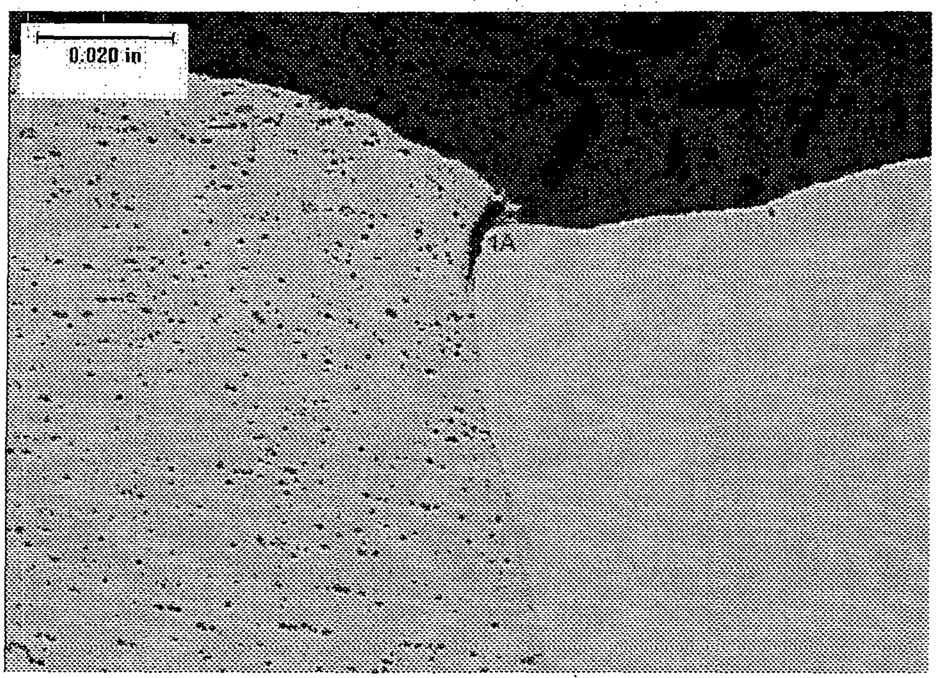
(a) As-Polished Condition



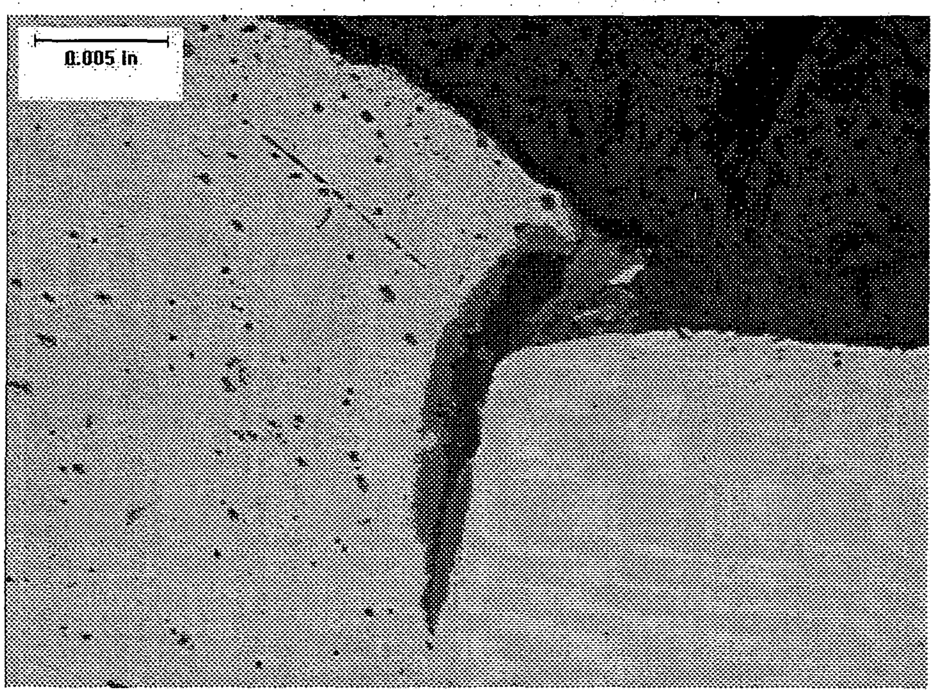
(b) Polished and Etched Condition

Figure 21 A3B Mount Showing the Section at 180°Orientation – Showing in the a) As-polished and b) Polished and Etched Conditions

Metallography Piece A3B

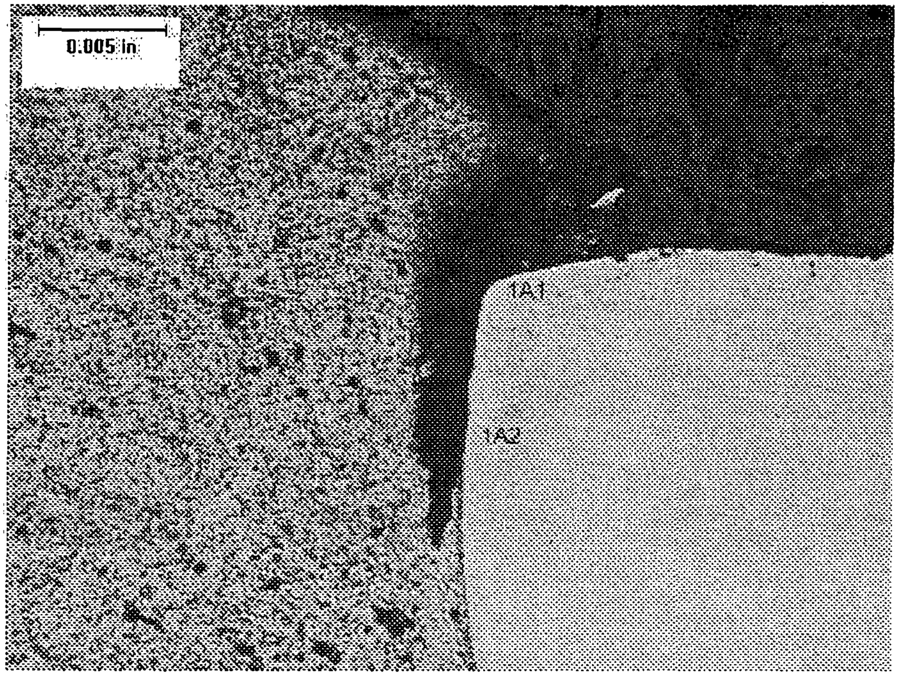


(a)

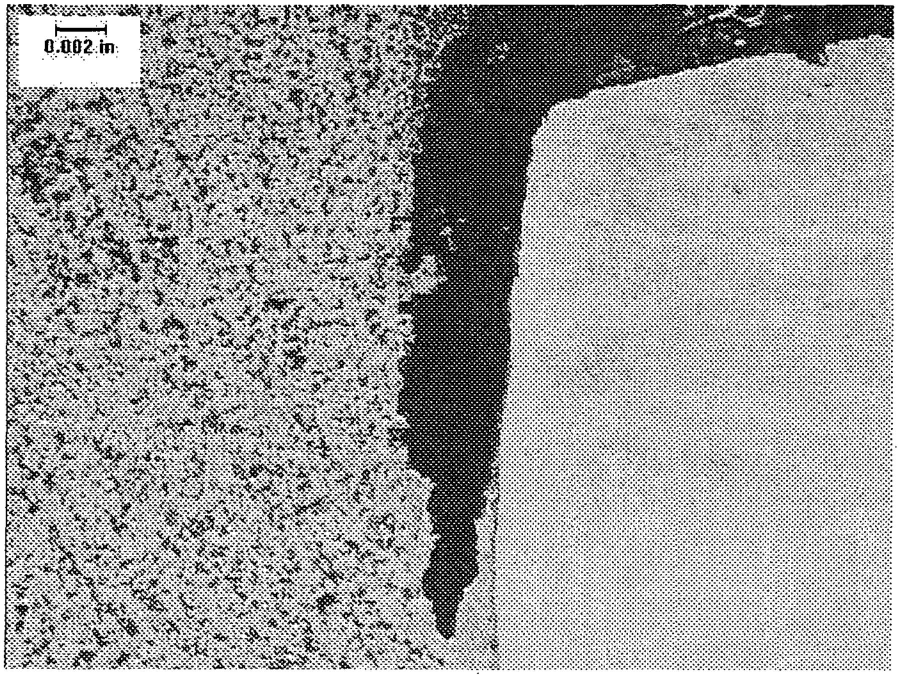


(b)

Figure 22 Metallography Results of an Axial Section through the Indication at the 180° Orientation Shown in the "As-Polished" Condition (Piece A3B)



(a)



(b)

Figure 23 Metallography Results Shown in the 'Polished and Etched' Condition of the Crack at 180° Orientation

Metallography Piece 2A2 (Glycerergia)

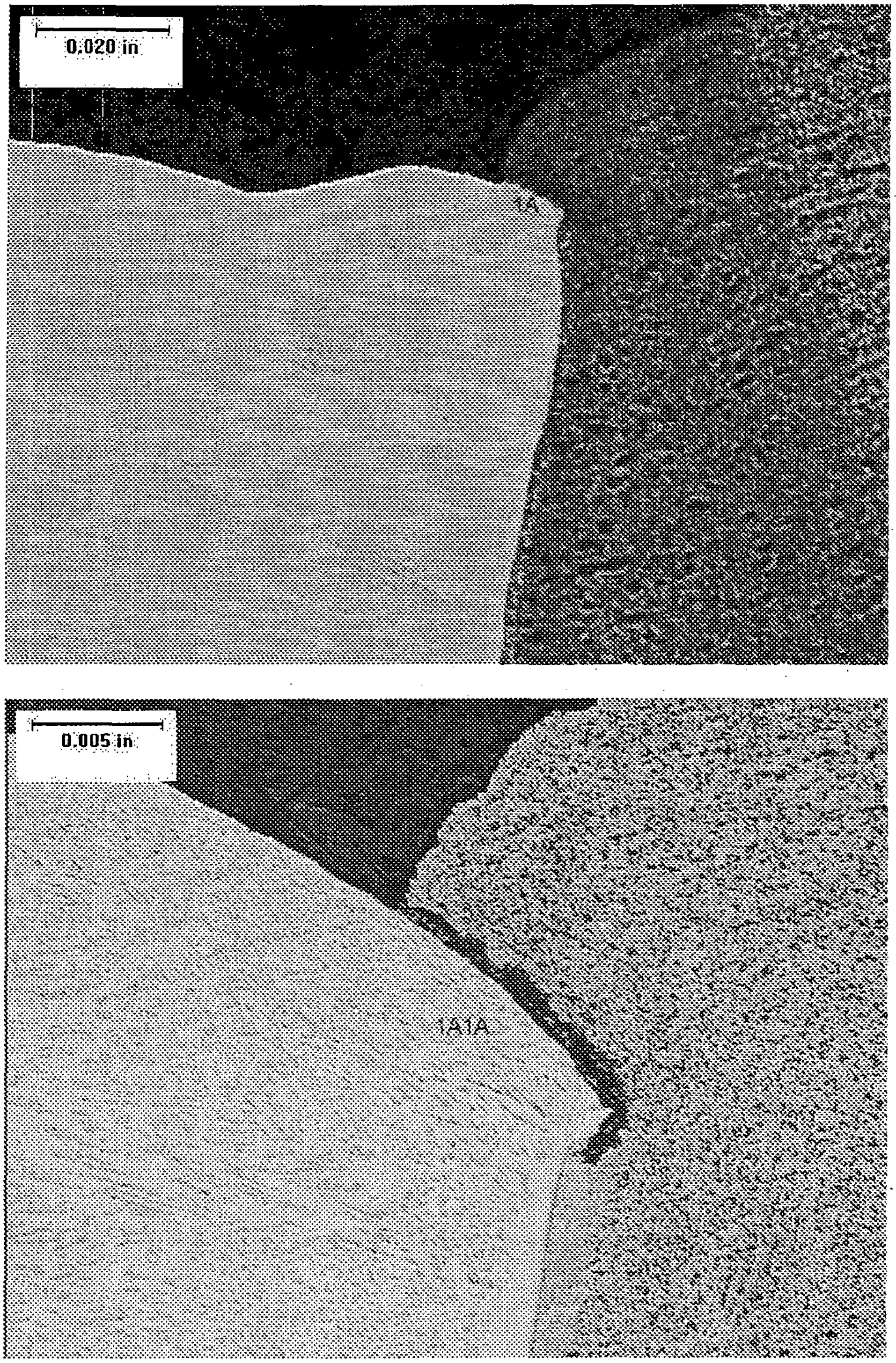


Figure 24 Morphology of Crack in the Carbon Steel Side, on 90° Section (Specimen A2A Polished and Etched Condition)

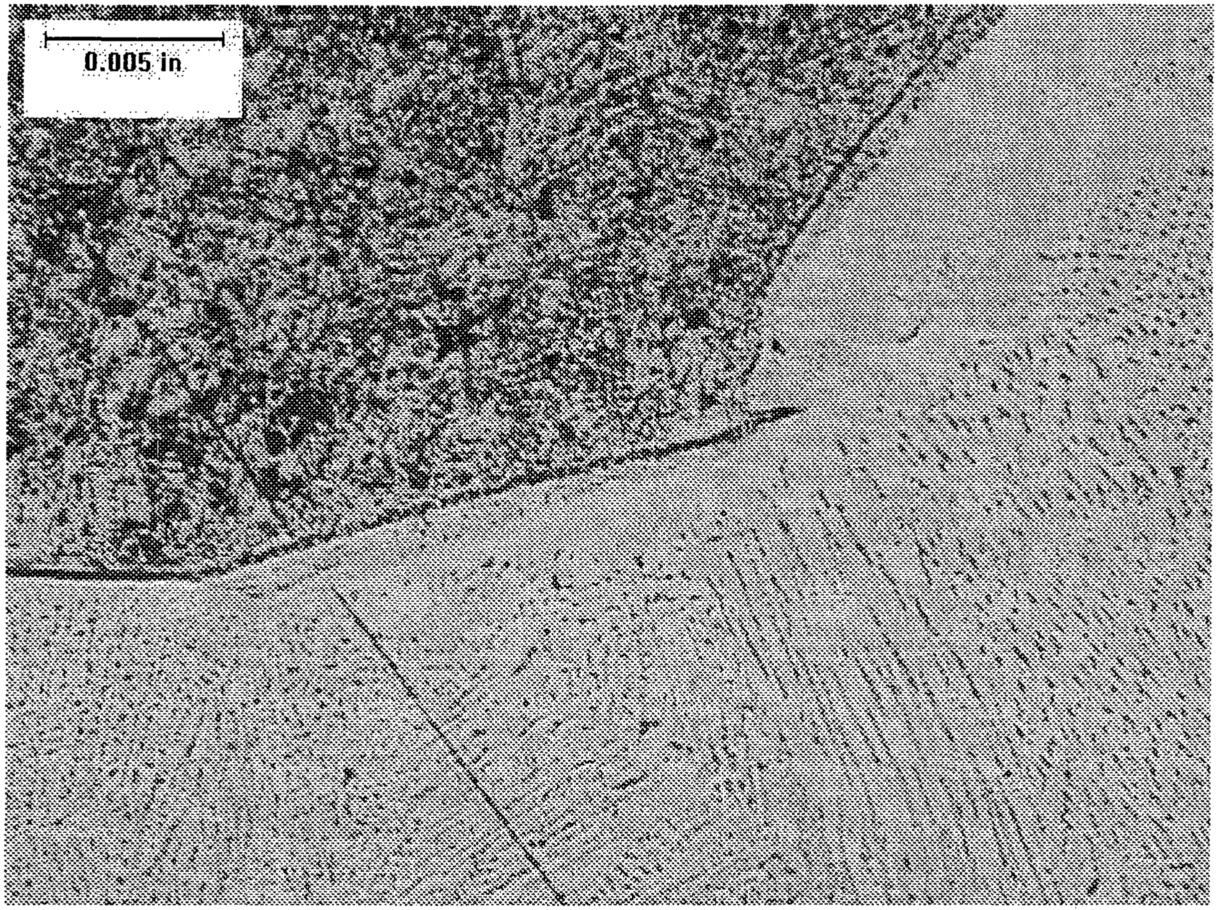
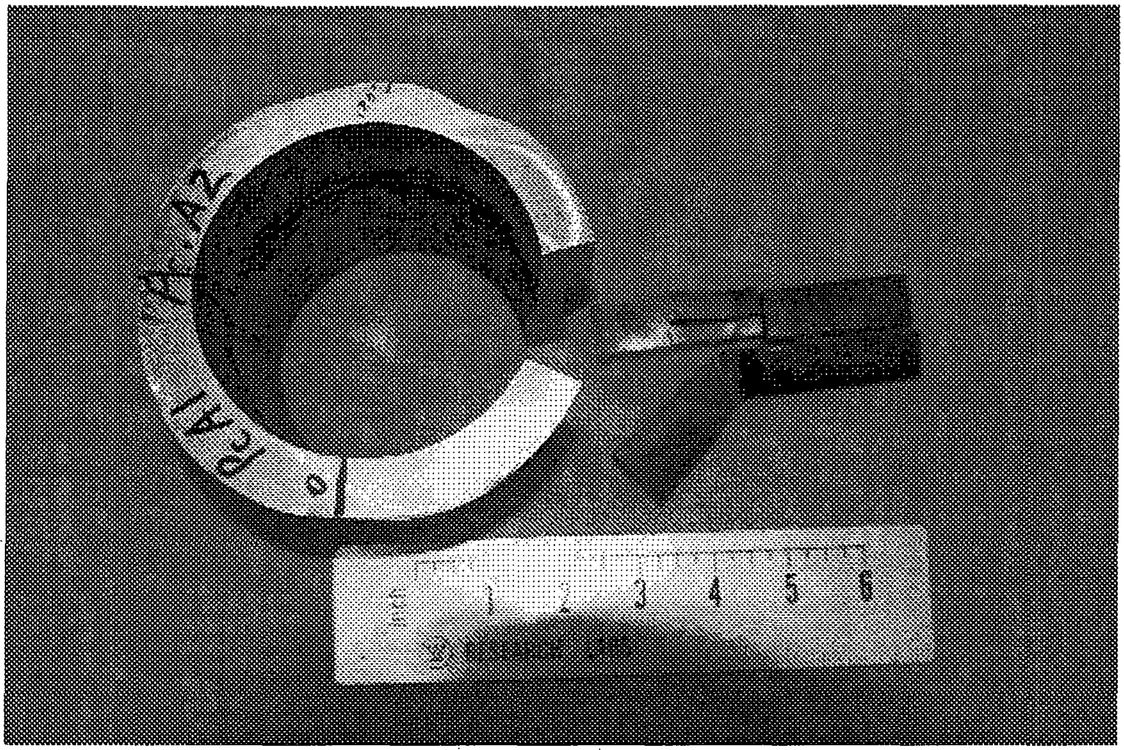


Figure 25 Metallography Results Illustrating the Typical Microstructures of the Carbon Steel and Weld Metal in Sample A3B



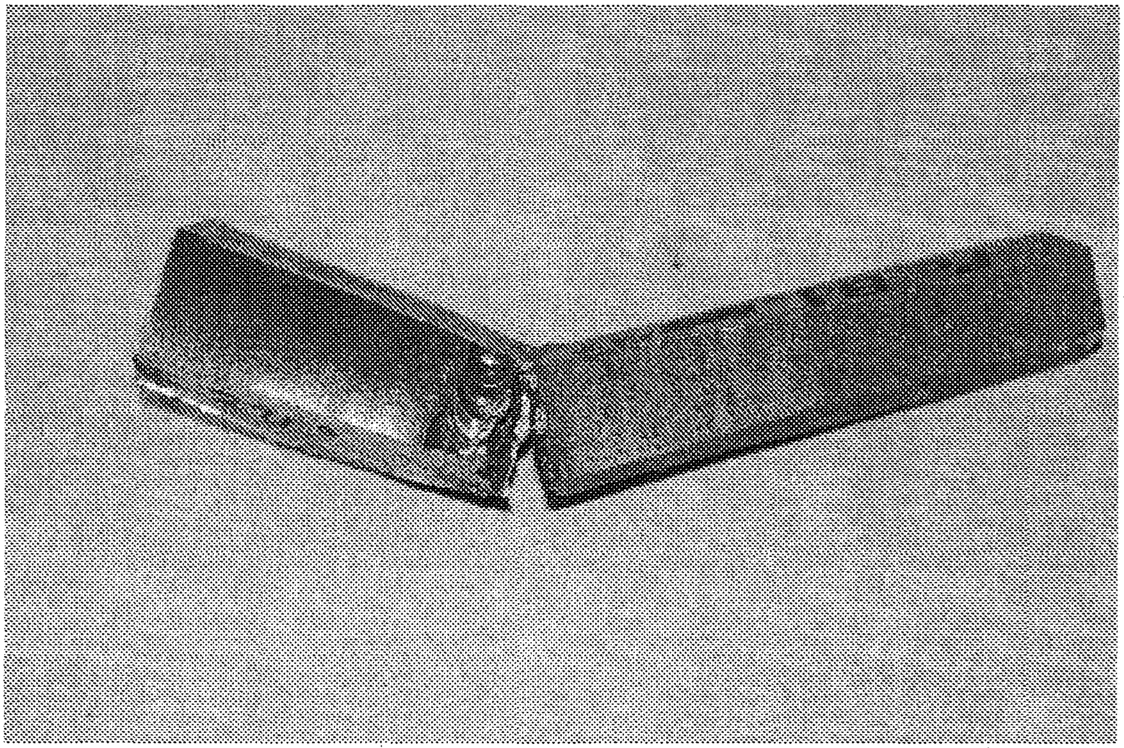
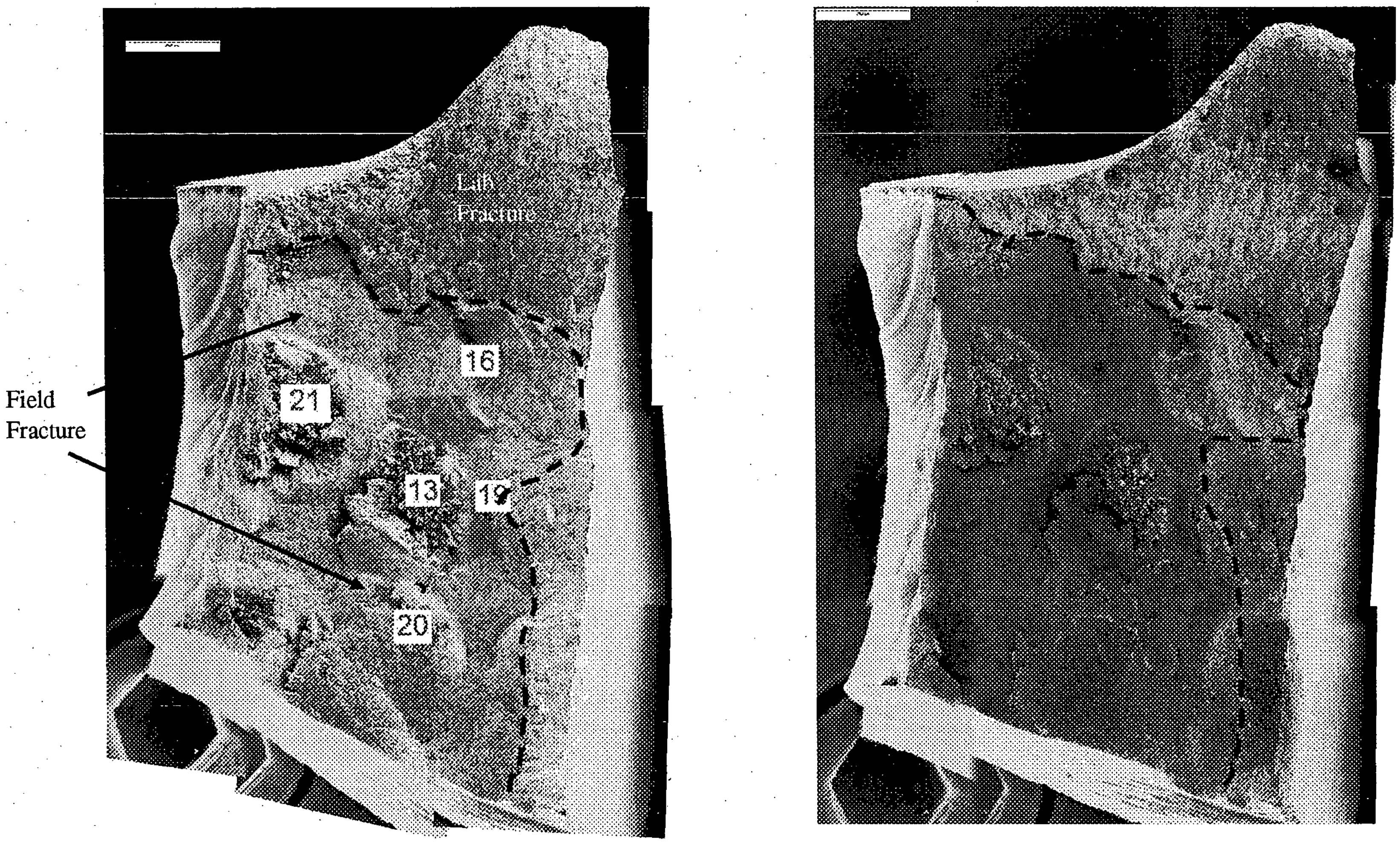
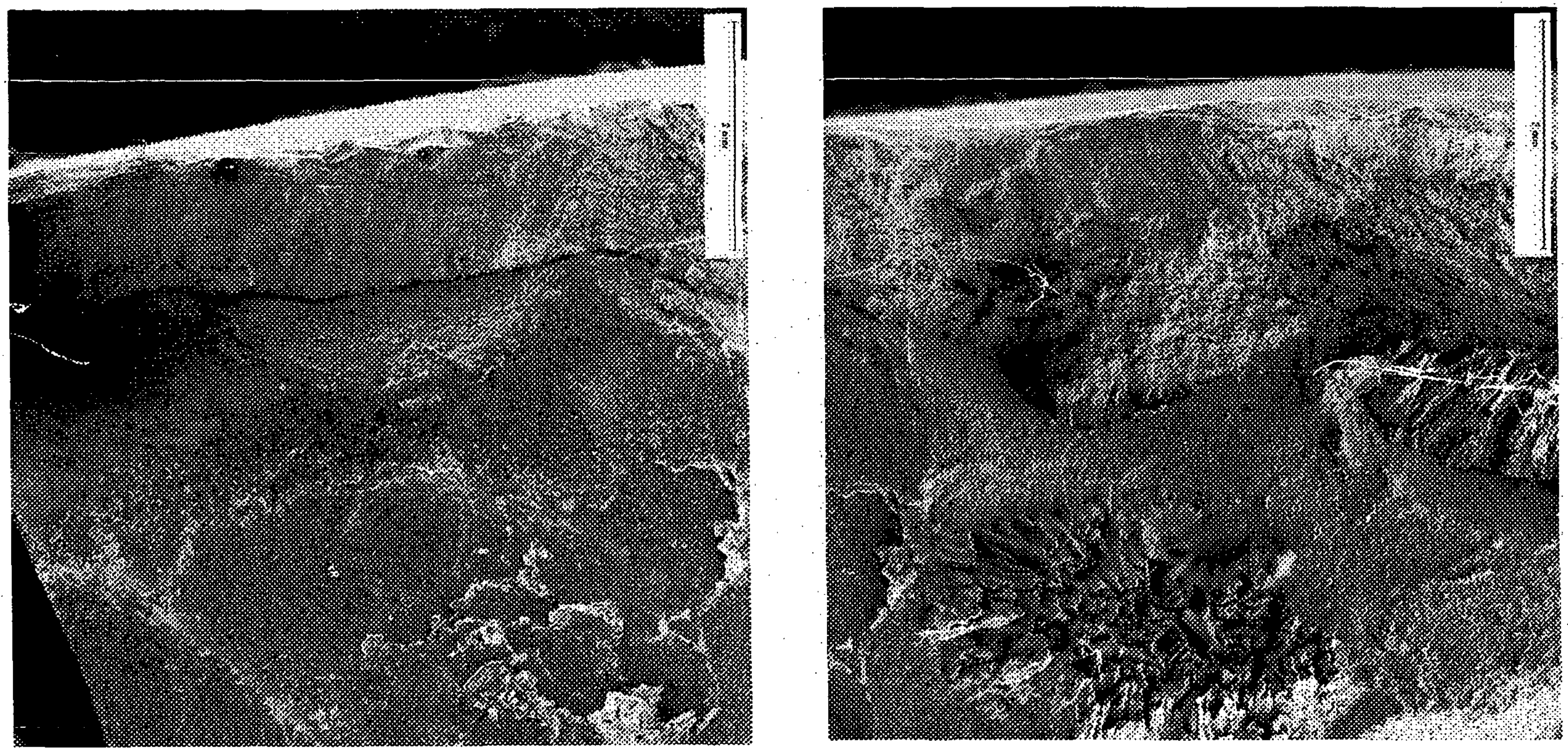


Figure 26 Sectioning Procedure Illustrating the Opening of the Crack at 270° o'clock Orientation



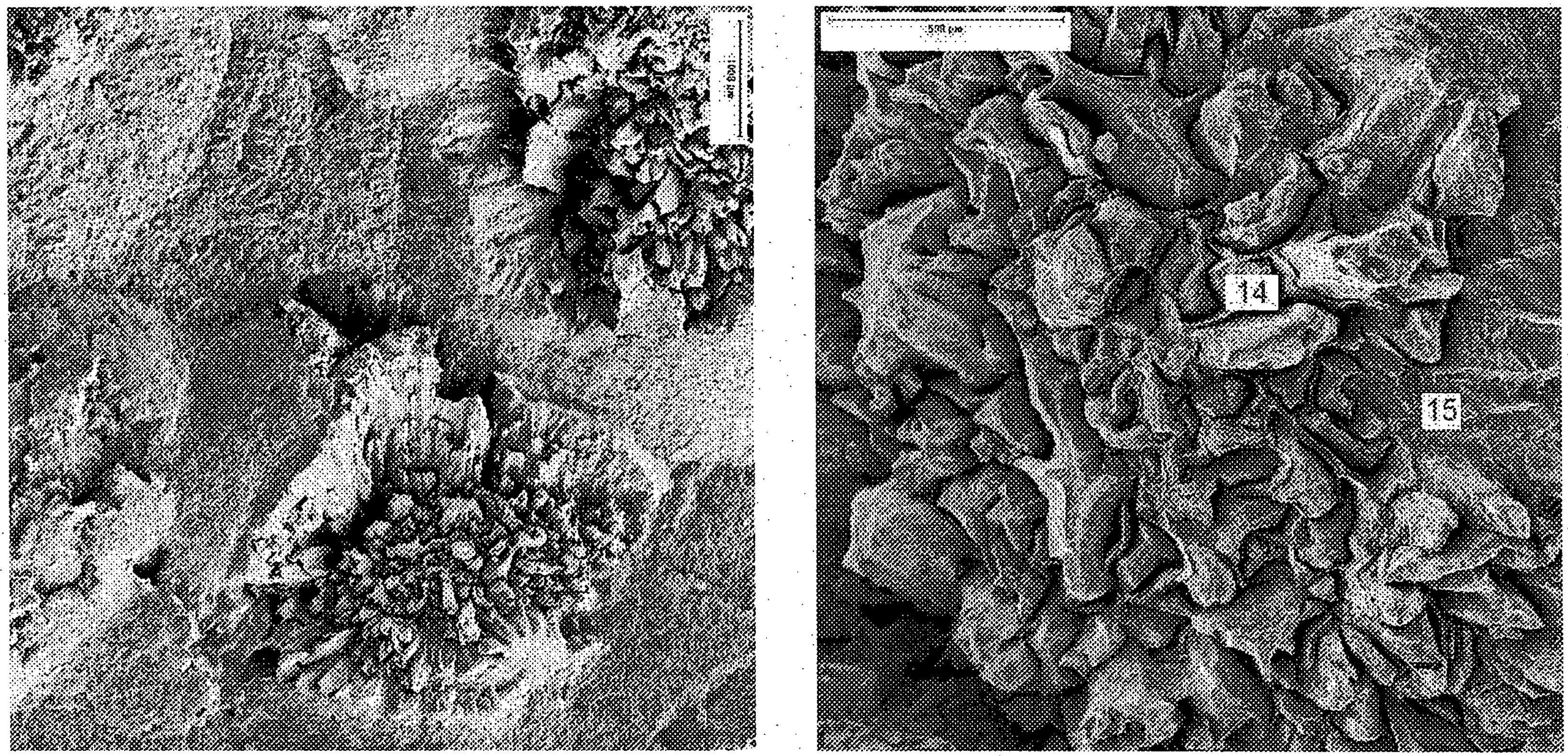
(a) (b)

Figure 27 Lower Magnification SEM Fractograph of Freshly Opened Crack at 270° Orientation – Showing the Carbon Steel Face with Islands of Weld Metal



(a) (b)

Figure 28 Scanning Electron Fractograph of the Freshly Opened Crack at 270° Location – Delaminated Carbon Steel Interface and Islands of Weld Metal can be Seen



(a) (b)

Figure 29 SEM Fractograph of 270° Crack Illustrating the Appearance of Carbon Steel Surface and Weld Metal Islands at the Interface

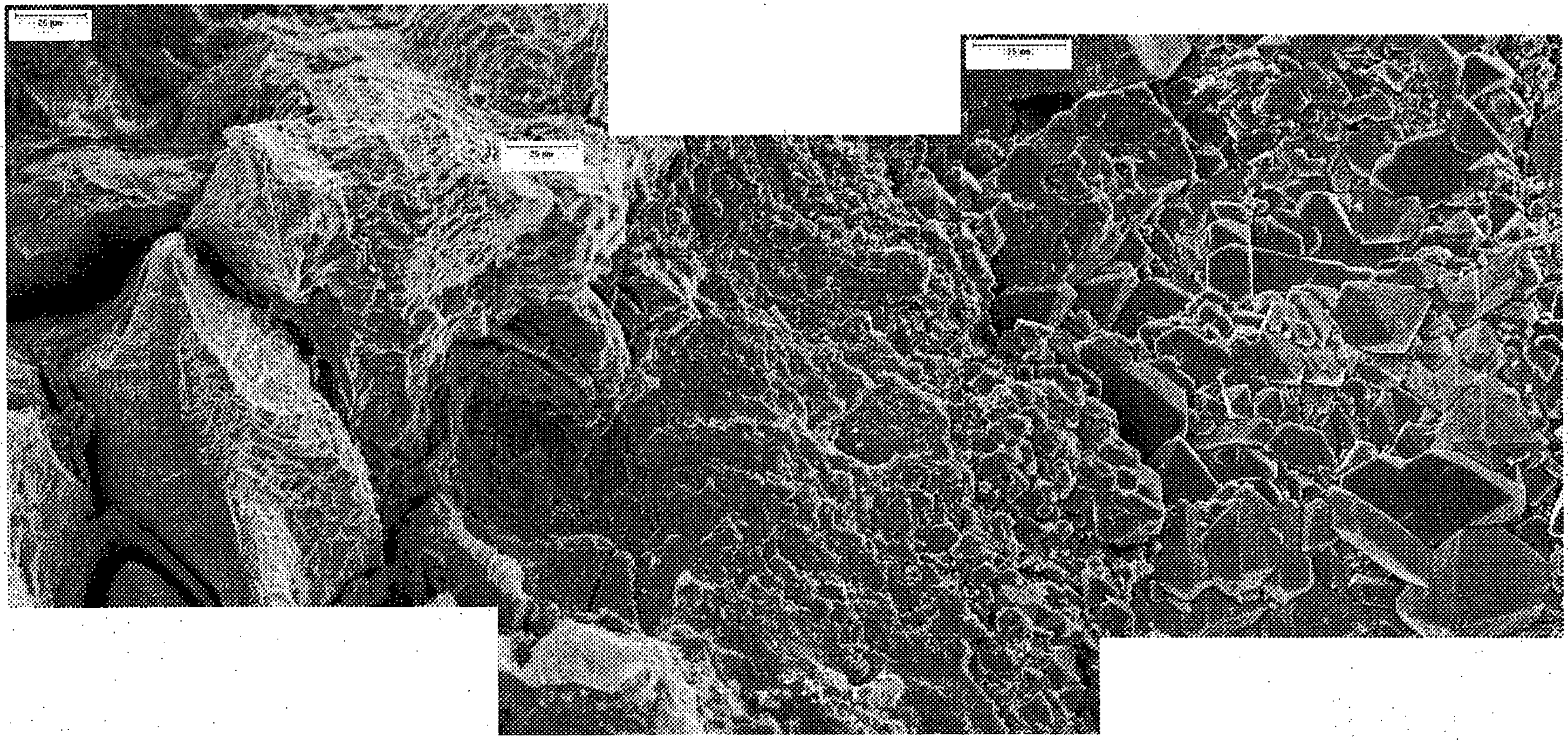
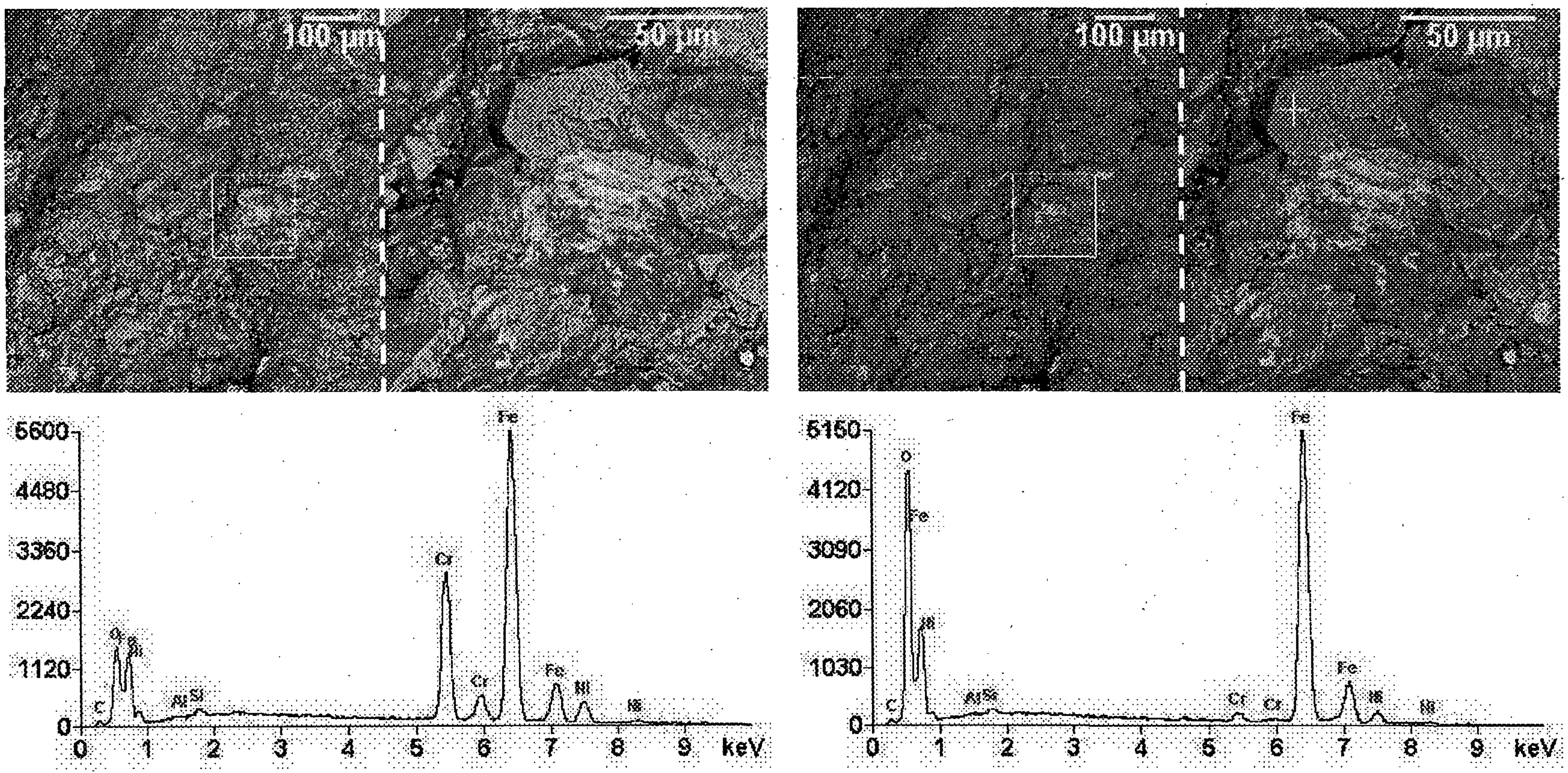


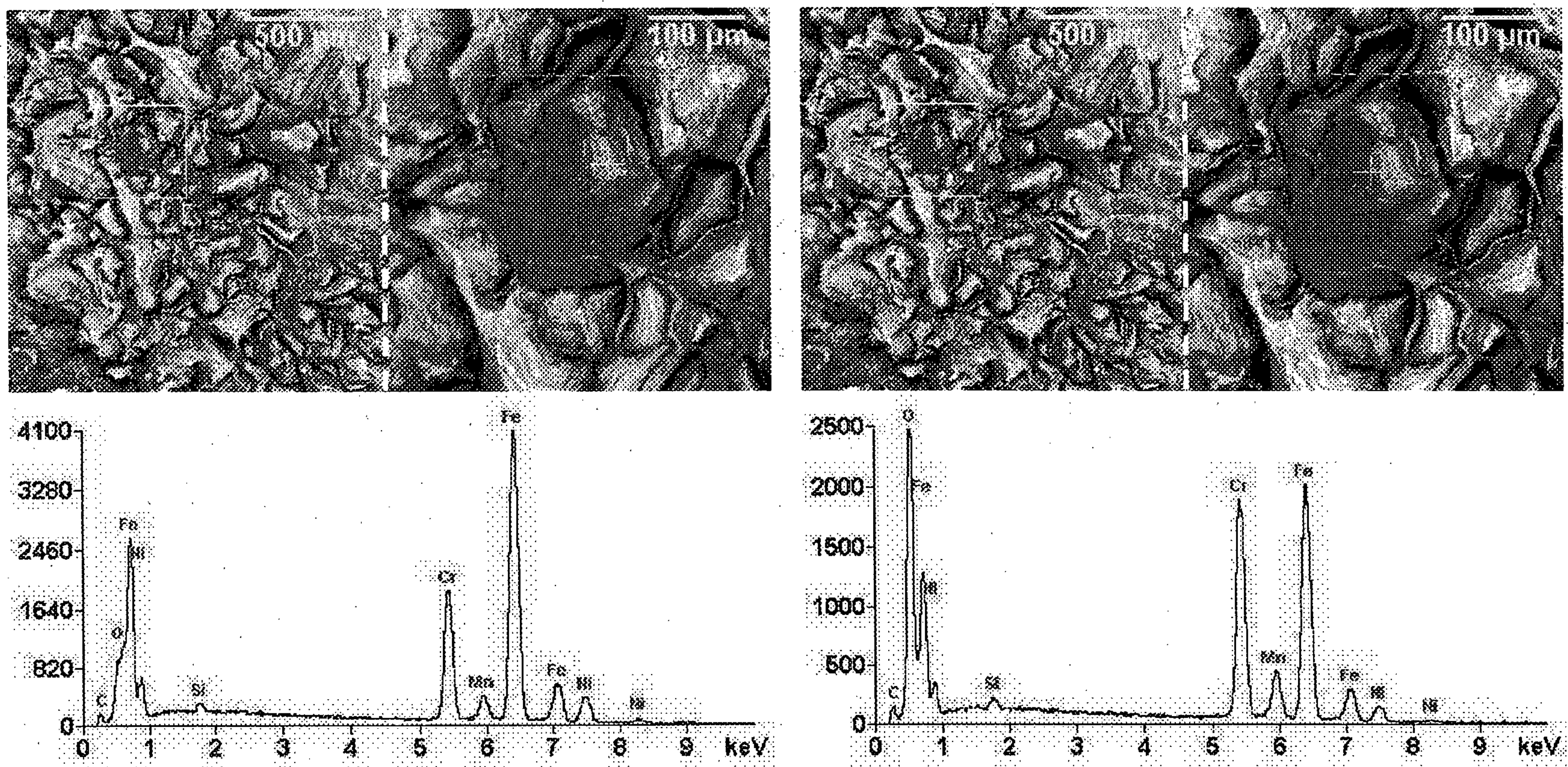
Figure 30 SEM Fractograph of 270° Crack Showing Weld Metal and Iron Oxide Regions on the Fracture Face



(A) Bright Weld Metal Patch

(b) Oxide Particle

Figure 31 EDS Spectrums Illustrating the Weld Metal and Iron Oxide Regions on the Fracture Face



(a) Weld Metal

(b) Oxide Area

Figure 32 EDS Spectrums Illustrating the a) Weld Metal and b) Iron Oxide Regions on the Fracture Face

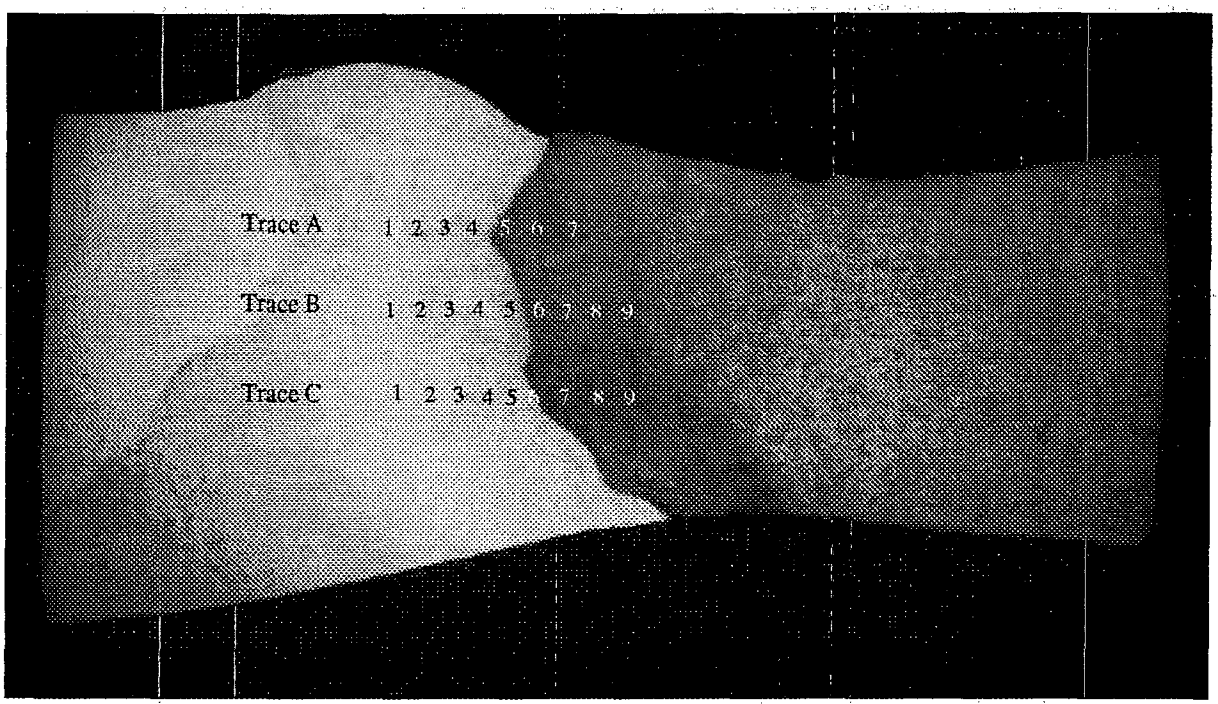


Figure 33 Piece A3B, Weld Mount Prepared for Microhardness Measurements

ATTACHMENT A
NDE EXAMINATIONS

As part of the failure investigation for the Browns Ferry pipe to valve weld, non-destructive examinations were conducted to locate the indication that had been identified during the field inspections. The information provided initially was that there was a possible crack on the inside of the component in the weld toward the pipe at between 3 and 4 o'clock as viewed from the pipe side of the component where 12:00 o'clock was coincident with punch mark on the remaining portion of the valve. The inspections that were conducted were performed strictly to confirm the location of the field indication so that the destructive examination could identify the underlying discontinuity. None of the inspections conducted during the investigation sought to identify the presence of additional discontinuities.

The fist inspection conducted was a dye penetrant examination using red dye. Dye was applied to the ID of the assembly and allowed to dwell. The excess was removed and developer applied. No indications were identified. The component was cleaned in an ultrasonic cleaned for more than an hour and the test repeated. Again nothing was identified. Since the indications that had made the weld suspect arose from an ultrasonic examination an ultrasonic inspection was conducted. In the interim the field inspection report became available that placed the indication at between 3.0 and 4.1 inches from the punch marks in the clockwise direction as viewed from the pipe side of the assembly. Further the indication had been identified using high angle (60 and 70 degree shear and longitudinal wave inspections). Rather than duplicate the field inspection a simpler approach was taken. The ends of the assembly were milled smooth to allow an ultrasonic transducer to be mounted on the ends of the component. A simple manual inspection from the end faces using 2.25 MHz longitudinal wave transducer was conducted. Indications were identified in the area of interest from both the pipe and valve side of the component. The response from the pipe side of the component suggested that the discontinuity was associated with at least two axial locations separated by perhaps 1/10 of an inch located within the weld on the pipe side of the weld center. The indication was stronger from the valve side with its maximum being a single response at the location thought to be the greatest extent through wall as found in the field examination. The laboratory ultrasonic examination confirmed the location of the indication and was qualitatively similar to the field results.

Having identified the location of the indication no further characterization of the indication was conducted and the destructive examination of the assembly commenced. A section was cut from the assembly between 2.8 and 4.3 inches clockwise from the punch marks as observed from the pipe side of the assemble. This section of the assembly contained the field indication confirmed by the laboratory ultrasonic examination. Figure 1 shows an image of the inside surface of the removed section. To assist in locating the discontinuity responsible for the ultrasonic indication, X-ray radiographs were taken of the section with it placed on the film with either the ID of the assembly toward or away from the film. The radiograph shown in Figure 2 is an overall view of the section. The counter bore on the pipe and the location of the weld are noted in the figure. Arrows highlight the location of the indication which occurs in various axial locations and is discontinuous in nature. The indication is generally toward the pipe side of the weld which is consistent with the location provided by the ultrasonic examination. Figure 3 shows enhanced image of the region showing the indication. The upper image is an enhancement of the indication in Figure 2 and the lower is the enhancement of the radiograph taken with the ID of the section away from the film. The indication in the latter was more diffuse than that of Figure 2. The images are consistent with a linear separation within the weld.

After the radiographic examination a visual inspection of the ID surface of the section identified the presence of a crack like feature on the surface where the x-ray indications were located. Why these had not been found by the dye penetrant examination is possibly due to the presence of a small ligament present on the inside surface that was breached when the section was cut from the component or crud present in the crack. The resolution of this dilemma awaits final destructive characterization.

A further investigation was conducted on the remaining portion of the assembly. The assembly was cut into two sections to facilitate handling and the surfaces were cleaned. A florescent dye penetrant examination was then conducted. Numerous small indications were identified in a location consistent with the discontinuity found in the removed section. Figure 4 shows the results of the dye penetrant examination.

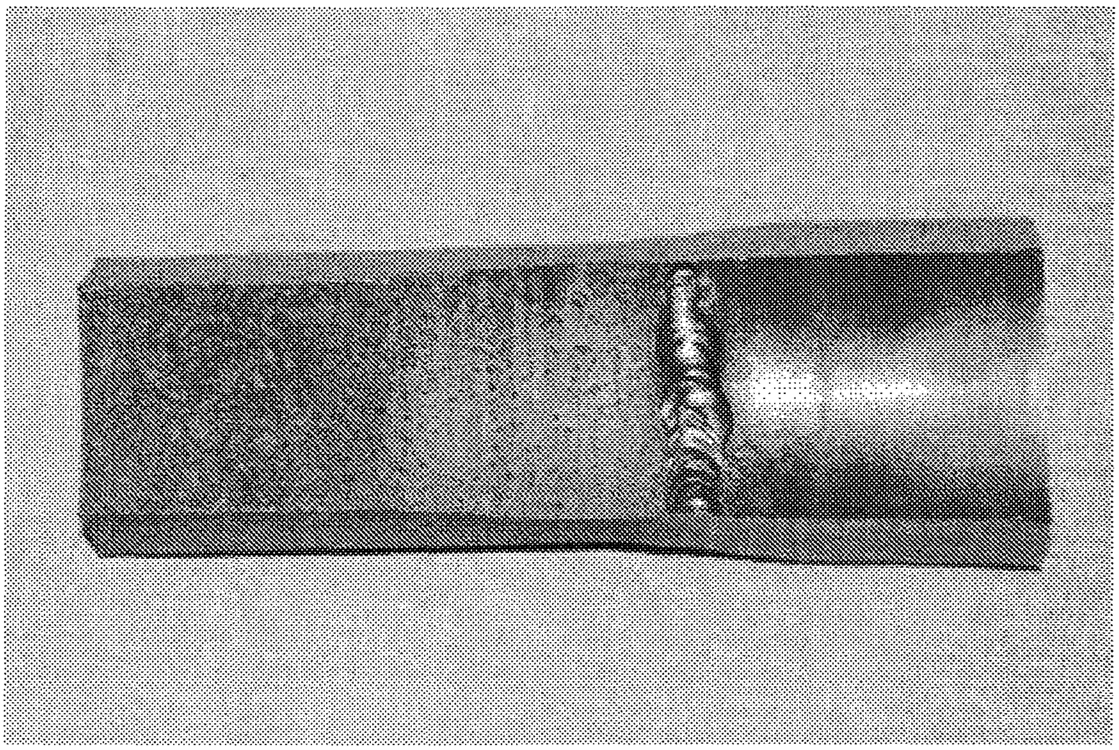


Figure A1 Image of the Inside Surface of the Removed Section – The Pipe Portion of the Assembly is Toward the Left

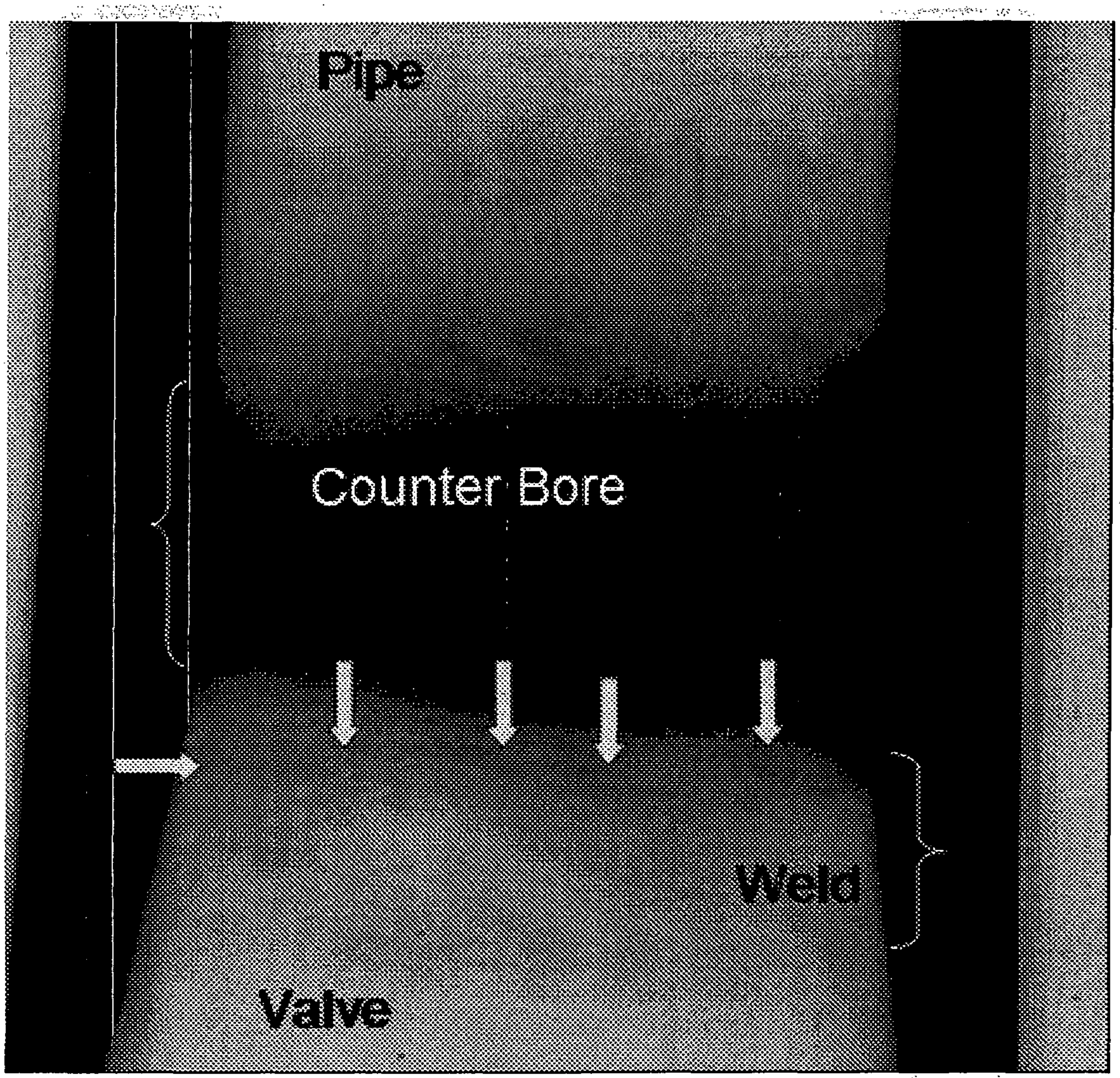


Figure A2 Digitized Radiograph of the Section of Pipe-Valve Weld Assembly Corresponding to the Indications Found in the Field Ultrasonic Examination – Note the radiograph was taken with the ID of the assembly against the film. The arrows show the locations of the radiographic indications.

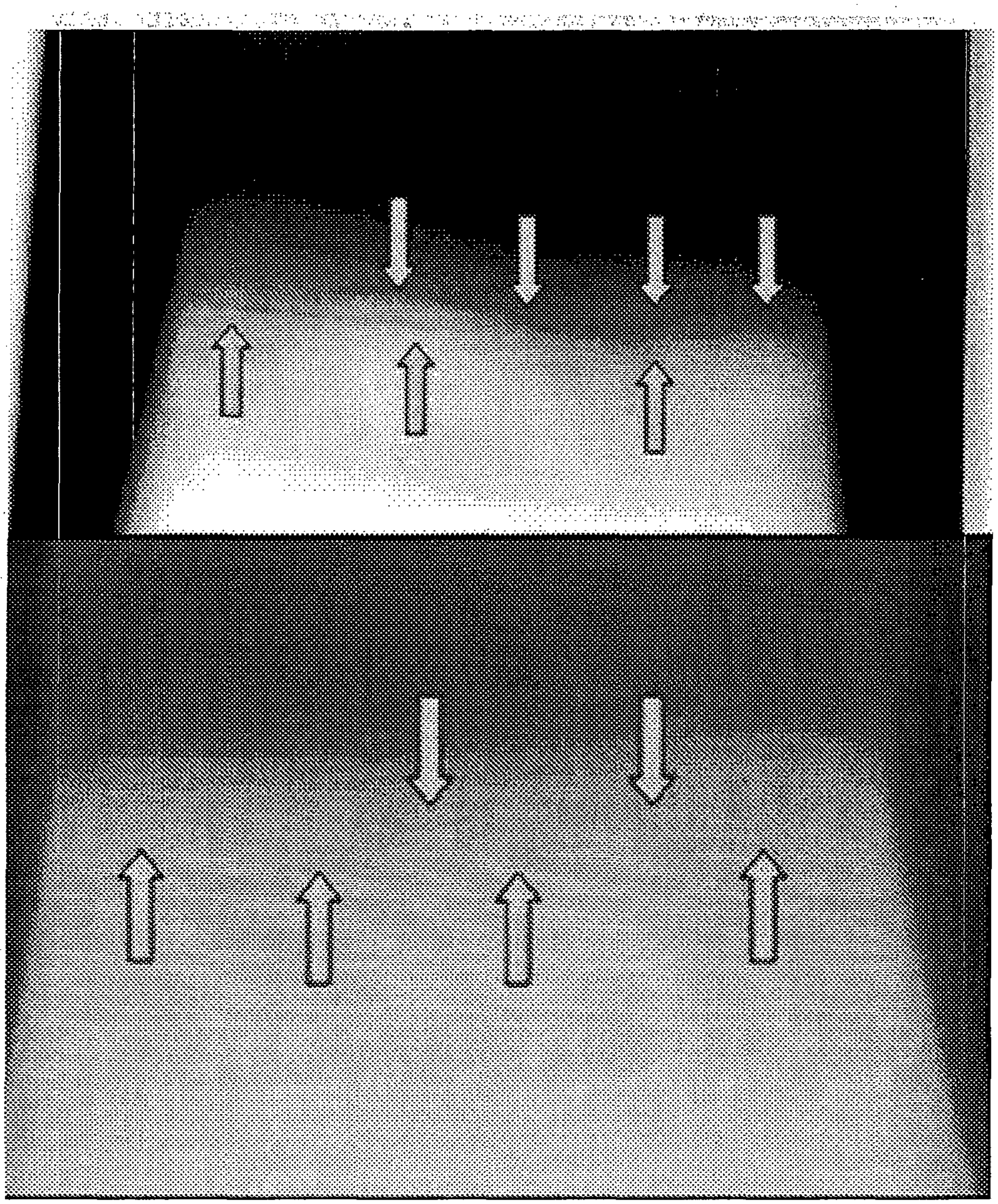


Figure A3 Enhancement of the X-ray Radiographs in the Vicinity of the Weld – Upper image is from the image in Figure 1 while the lower is for a radiograph taken with the II of the component away from the film. The arrows show the location of the radiographic indications.

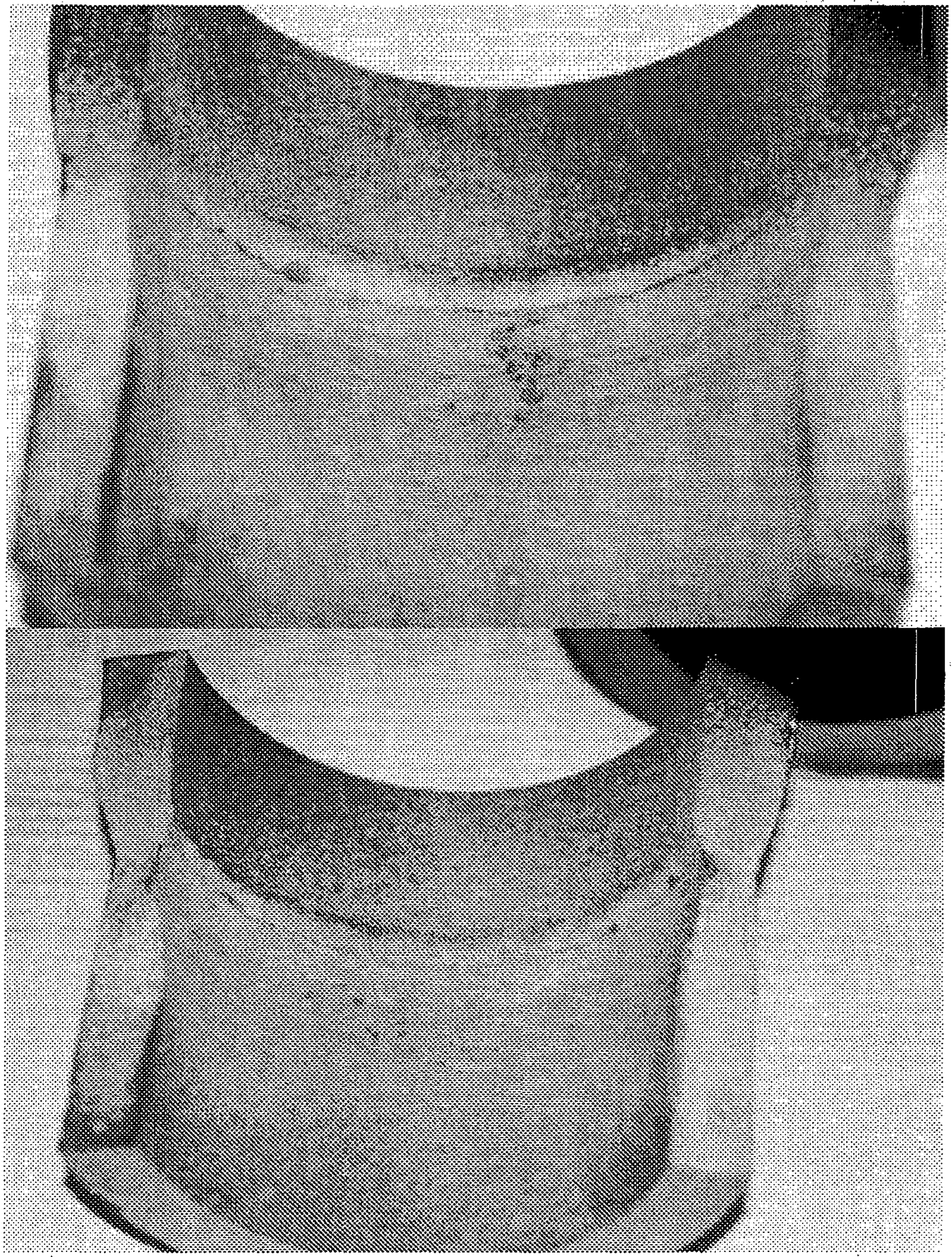


Figure A4 Florescent Dye Penetrant Results for the Remaining Portion of the Assembly – Both images are taken from the pipe end of the assembly. The indications in the counter bore region are believed associated with the original welding. The obvious indication in the counter bore in the upper image is at approximately the 180 degree orientation. The left surface in the upper image corresponds to approximately 4.3 inches from the 0 degree reference while the right surface of the lower image corresponds to approximately 2.7 inches from the 0 degree reference so that the right side of the upper image corresponds to the left side of the lower image.

ATTACHMENT B
MATERIAL PROCUREMENT, WELD FABRICATION AND INSPECTION RECORDS

TENNESSEE VALLEY AUTHORITY		EXAMINATION SUMMARY AND RESOLUTION DATA SHEET		REPORT NUMBER: R074	
PROJECT: BFN UNIT: 2		CYCLE: 14		COMPONENT ID: RCRD-2-52	
EXAMINATION METHOD				SYSTEM: RWCUS	ISI DWG. NO. 2-ISI-0272-C-C
MT ☐	PT ☐	UT ☒	VT ☐	CODE CLASS:	CATEGORY: R-A
PROCEDURE: N-UT-82		REV: 2	TC: N/A	CONFIG.: VALVE TO PIPE	
EXAMINER: WADE HOLLOWAY LEVEL: II		EXAMINER: LEVEL:		EXAMINER: LEVEL:	EXAMINER: LEVEL:

This report contains the data associated with the manual ultrasonic examination of RCRD-2-52 to meet the requirements of ASME Section XI, category R-A, item number R1.16D, and BWRVIP-75.

This exam was performed using equipment, procedures and personnel qualified in accordance with ASME Section XI, Appendix VIII as amended by 10CFR50.55a final rule.

The component configuration is a 4" diameter, Sch 80 carbon steel pipe, welded to a forged stainless steel valve.

Both refracted longitudinal (RL) and shear wave search units were used as defined in procedure PDI-UT-10. The ultrasonic examination is limited due to the taper configuration of the dissimilar metal weld.

During the examination, a planar indication was detected that was oriented in the circumferential direction with a recorded length of 1.10 inches. The indication was detected using a 60° shear wave and a 60° RL wave search units. The indication was sub sequentially confirmed using a 70° shear wave and a 70° RL wave search units.

Due the inherent component geometry, it is not possible to obtain depth measurements of this indication using PDI ultrasonic qualified techniques. However, a best effort through wall sizing technique was applied and indicated as estimated remaining ligament of 0.20" in depth.

ASME Section XI Coverage:
Circumferential scan coverage was 100%. Axial scan coverage was 74%
Combined ASME Section XI Code coverage was 87%

Preliminary report for notification. Report will be finalized when all data is complete.
PER U2C14-017 generated.
[signature]

RESOLUTION BY: [signature] LEVEL: II DATE: 3/3/07	REVIEWED BY: [signature] LEVEL: III DATE: 3/3/07	ANII: DATE: PG. 1 OF

ISI report no. R-017

NOI no. U2C14-017

Component I.D. RCRD-2-52

Additional resolution details:

Weld configuration:

4" Carbon Steel, sch. 80 pipe to a forged stainless steel check valve. The joint configuration exhibits a dissimilar metal weld with a pipe wall thickness at the weld joint of .36" connected to a SS check valve body. The weld crown is tapered from the pipe to the valve at an angle of 18°. This configuration limits the ability to scan across the weld crown in the axial direction.

Examination technique:

The examination was performed in accordance with ASME Section XI, Appendix VIII qualified techniques for examination of dissimilar metal welds. The procedure utilized was TVA/ISO NDE Procedure N-UT-82 that implements the PDI Generic procedure PDI-UT-10.

Indication discrimination:

The joint configuration limited the ultrasonic examination angles to 60 and 70 degrees. The weld taper and width prevented the use of a 45° inspection angle.

The indication presented signal characteristics indicative of a planer reflector located in the weld. The reflector continued to return energy until the transducer contacted the weld taper. The higher examination angle returned more reflected energy than the lower examination angle. The reflector maintained echo dynamic motion during the axial raster scan and during skewing of the search unit.

The PDI dissimilar metal examination does not contain qualified through wall sizing techniques. However, a best effort through wall sizing technique was applied and indicated an estimated remaining ligament of 0.20" in depth.

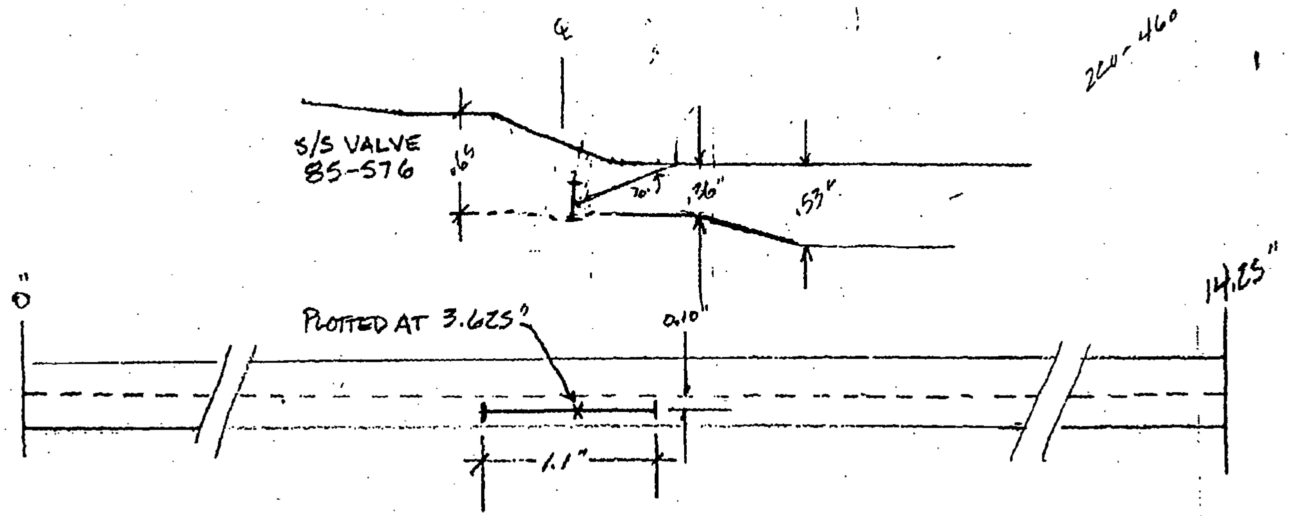
Conclusion:

The weld configuration does not allow for all of the indication discrimination tools defined in the PDI generic procedure. The discrimination tools utilized indicate the presence of a planer flaw located in the weld metal. The available data indicates the presence of a planer reflector that would not meet the ASME Section XI, Table IWB-3514-2, for allowable planer flaws.

3/3/07

pg 2

TVA Office of Nuclear Power	PROJECT: BFN SYSTEM: RWCU Unit: 2 WELD NO.: RCRD-2-50	REPORT NO.: R074

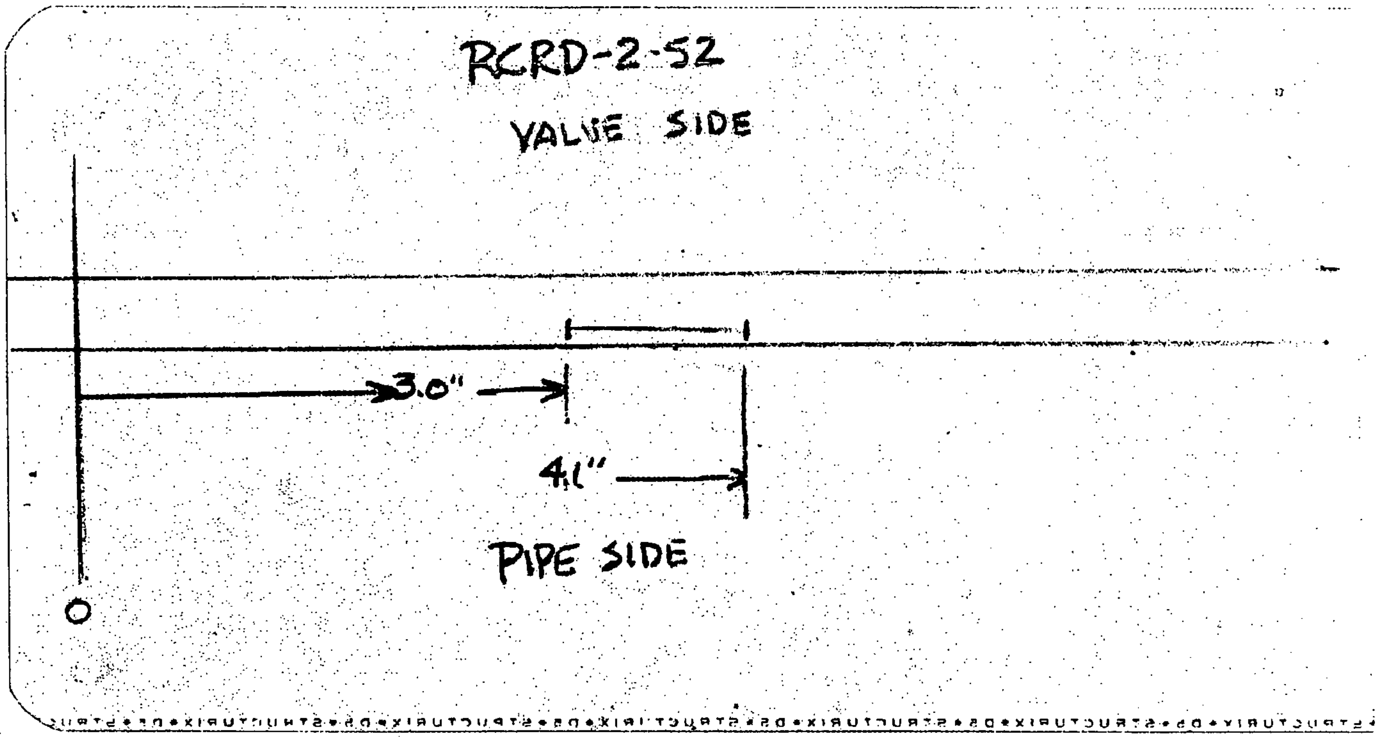


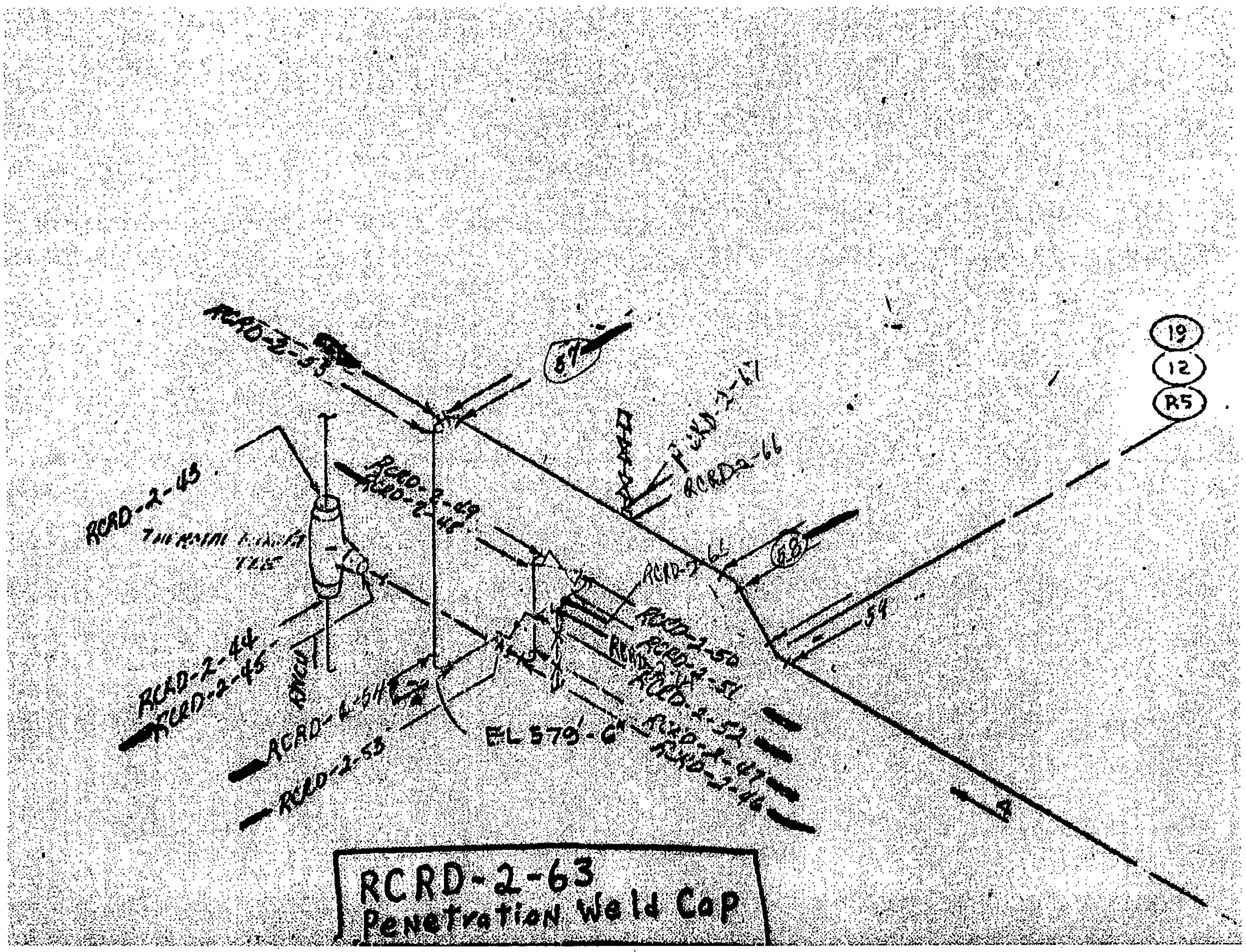
- Through wall size not available due to configuration and PA(?) technique
- Best effort through wall dimension provided

internally trimmed (back bevel)

BY: [signature] LEVEL: III DATE: 3/3/07 PAGE component bond OF counterbore

TVA 19669 (ONP-6-88)


RCRD-2-52
VALVE SIDE
3.0"
4.1"
PIPE SIDE
0


RCRD-2-63
Penetration Weld Cap
EL 579'-6"
RCRD-2-53
RCRD-2-43
RCRD-2-44
RCRD-2-45
RCRD-2-49
RCRD-2-48
RCRD-2-66
RCRD-2-67
RCRD-2-50
RCRD-2-51
RCRD-2-52
RCRD-2-47
RCRD-2-46
RCRD-2-55
67
68
54
19
12
R5

INDUSTRIAL LABORATORIES, INC.
RADIOGRAPHIC INSPECTION REPORT

Page 1 of 1

RT Number ______ IL/INC Job Number ______ RT ______

To: Browns Ferry Nuclear Plant TVA

Customer P.O. No. ______ Job Data Weldolet

Part Name or Ident. Joint # RCRD-2-52A

Acceptance Standard: ASME Sect III NB 5000

Location	Type of Weld	Level of Radiography
Lab (Field)	Backing Ring / Consumable Insert / (Other) Weld-o-let	Root (Final) Other

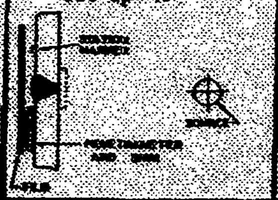
Welding Procedure	Welder I.D. No.	Filler Metal	Base Metal	(Pipe) Size Sch. / Dia.	Plate Thickness
				160 / ½	

Inspection Requirements	Radiation Thru
ASME Sect III Art 2 — (Nuclear) Non-Nuclear	Superimposed — One Wall (Two Walls) Plate Other

X-RAY / (ISOTOPE)	Type	Curies	Size	KV	MA	Focal Spot	Film Loaded & Type
ISOTOPE	Ir 192	58	3mm x 3mm	N/A	N/A	N/A	Kodak Single/Double "M"

S.F. Dist.	Time	No. Exps.	Req. Size	Sensi. Hole	Shim Thick.	Processed	Film Viewed
12"	8½ min	1	30	2T	N/A	X-Omat / (Manually) / Other	(Single) (Double)

Set Up "A"



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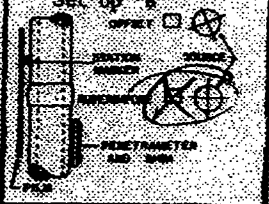
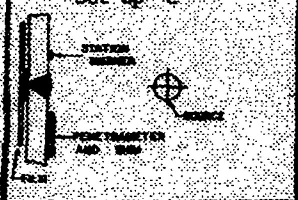


Set Up "C"



Other

Film I.D. & Location Key	Penetrameter size	[illegible]	Acceptable	Rejected	Porosity	Inclusions	Undercut	Shrinkage	Hot Tears	Cracks	Inc. Fus.	Inc. Penet.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Oxidation	OTHER	COMMENTS or N.A.D.
A	20	.005	✓		X		✓																Root unacceptable

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BY: [signature] Date 11/5/72

SNT-TC-1A Level III

CUSTOMER REVIEWER

BY: ______ Date ______

INDUSTRIAL LABORATORIES, INC.
RADIOGRAPHIC INSPECTION REPORT

Page 1 of 2

RT Number ______ IL/INC Job Number ______ RT ______

To: TVA Browns Ferry Nuclear Plant

Customer P.O. No. ______ Job Data Pipe Welds

Part Name or Ident. RWCU-2-45, 46, 47, 48, 52, 53

Acceptance Standard: ASME Sect III NB 5000

Location	Type of Weld	Level of Radiography
Lab / **(Field)**	Backing Ring / Consumable Insert / **(Other)** S Wire Butt	Root / **(Final)** / Other

Welding Procedure	Welder I.D. No.	Filler Metal	Base Metal	(Pipe) Size Sch. / Dia. / Plate Thickness
				160 / 4"

Inspection Requirements	Radiation Thru
(Nuclear) / Non-Nuclear — ASME Sect I Part 3	One Wall / **(Two Walls)** / Plate / Other

X-RAY / (ISOTOPE)	Type	Curies	Size	KV	MA	Focal Spot	Film Loaded & Type
ISOTOPE	IR-192	58	[illegible]	N/A	N/A	N/A	Kodak Single / (Double) "M"

S.F. Dist.	Time	No. Exps.	Req. Size	Sensi. Hole	Shim Thick.	Processed	Film Viewed
5"	1 min	4 per weld	7	2T	1/16 C/S	X-Omat / **(Manually)** / **(Other)**	**(Single)** / Double

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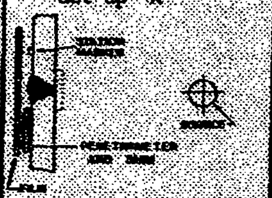

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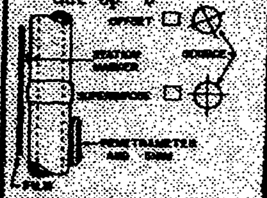

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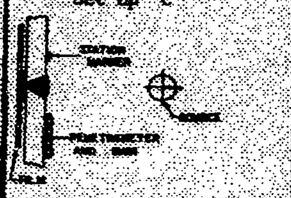

Source Contact Method

Film I.D. & Location Key	Penetrameter size	Sensitivity	Acceptable	Rejected	Porosity	Inclusions	Undercut	Shrinkage	Hot Tears	Cracks	Inc. Fus	Inc. Penet.	[illegible]	Oxidation	OTHER	COMMENTS or N.A.D.
#45 0-1	7		✓													
1-2			✓													
2-3			✓													
3-0			✓													
#46 0-1			✓													
1-2			✓													
2-3			✓													
3-0			✓	X												
#47 0-1			✓													
1-2			✓													
2-3			✓													
3-0			✓													
#48 0-1	✓		✓													

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BY: [signature] Date 1/14/76

SNT-TC-1A Level III

CUSTOMER REVIEWER

BY: ______ Date ______

INDUSTRIAL LABORATORIES, INC.
RADIOGRAPHIC INSPECTION REPORT

Page 2 of 3

RT Number ____________ IL/NNC Job Number ____________ RT ____

To: TVA BFNP

Customer P.O. No. ____________ Job Date ____________

Part Name or Ident. RCD-2-45, 46, 47, 48, 52, 53

Acceptance Standard:

Location		Type of Weld			Level of Radiography		
Lab	Field	Backing Ring	Consumable Insert	Other	Root	Final	Other

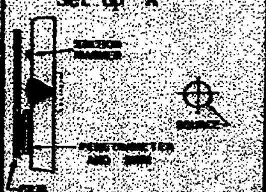
Welding Procedure	Welder I.D. No.	Filler Metal	Base Metal	Pipe Size Sch.	Pipe Size Dia.	Plate Thickness
				160	4"	

Inspection Requirements	Radiation Thru
Nuclear / Non-Nuclear	One Wall / Two Walls / Plate / Other

X-RAY / ISOTOPE	Type	Curies	Size	KV	MA	Focal Spot	Film Loaded & Type (Single / Double)

S.F. Dist.	Time	No. Exps.	Req. Size	Sensi. Hole	Shim Thick.	Processed (X-Omat / Manually)	Film Viewed (Single / Double)

Set Up "A"



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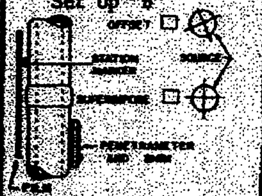

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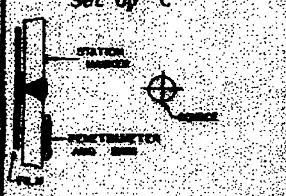

Other

Film I.D. & Location Key	Penetrameter size	[illegible]	Acceptable	Rejected	Porosity	Inclusions	Undercut	Shrinkage	Hot Tears	Cracks	Inc. Fus.	Inc. Penet.	[illegible]	Oxidation	OTHER	COMMENTS or N.A.D.
#2 1-2	?	OK	✓													
2-3			✓													
3-0			✓													
#52 0-1			✓													
1-2			✓													
2-3			✓													
3-0			✓													
#53 0-1			✓													
1-2			✓													
2-3			✓													
3-0	V	V	✓													

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SNT-TC-1A Level III

CUSTOMER REVIEWER

BY: ____________ Date ____________

DATA SHEET A
WP 9240

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT
QUALITY ASSURANCE RECORD
PIPING SYSTEMS
WELD INSPECTION DATA

Weld Number: RCRD-2-52
Nominal Pipe Size: 4"
Welding Procedure: GT/8-B-1
Isometric Drawing No.: ______

Work Plan No: 9240
ECN No: L1990

WELDERS	COMPONENTS	
Hilbert Bowman (10)	PIPE	to CHECK VALVE
	Identification Nos.	Identification Nos.
Filler Metal Identification & Size	NK# 47W600-677	2-85-576
ER 309 - 3/32" HT# C3452T		

	COMMENTS	DATE	NDT ENGINEER
Purge Dam In (Type)	NA	NR	NR
Fitup Inspection	NR	NR	NR
Procedure Compliance	OK	3-31-78	BKG
PT. Root per DPM 76E1	NR	NR	NR
PT. Gap per DPM 76E1	OK (NAD)	4-4-78	[illegible]
Root Inspection — ID. Visual	NR	NR	NR
Root Inspection — Radiographic	NR	NR	NR
Purge Dam Out (Type)	NA	NR	NR
Weld Gap per BF-13, Appendix 6	NR	NR	NR

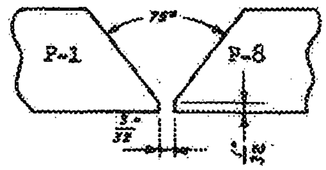
Data Approved: Yes (Yes or No) 4-5-78 (Date) R. K. Summers (Cognizant Engineer)

STER COPY

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT18-0-1 Rev.: 3 Date: 2-28-75

Basic joint types which may be used with this procedure are depicted in Drawings 1.M.1.2-3, 4, 10, 11, 12, 13, 14, 15.



TYPICAL
WELD JOINT DESIGN

Welding Conditions:

Increment	Root	Rem
Current	60-130 amp	60-130 amp
Pulse Rate	-	-
Polarity	DCSP	DCSP
Arc Voltage	10-14 volts	10-14 volts
Transfer Mode	-	-
Travel Speed (IPM)	3/4 min	1-3/4 min
Electrode Type	EWTH-2	EWTH-2
Electrode Size	3/32"	3/32"
Filler Metal Type	ER309	ER309
Filler Metal Size	1/16" or 3/32"	1/16", 3/32", 1/8"
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	Argon	Argon
Shielding Gas Flow Rate	15-25 cfh	15-25 cfh
Purging Gas	Argon	Argon
Purging Gas Flow Rate	5 cfh min	5 cfh min
Gas Cup Size	1/2" max	1/2" max
Gas Cup to Work Distance	1/2" max	1/2" max
Contact Tube to Work Dist.	-	-
Preheat	60 F min	
Interpass Temperature	350 F max	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

Reference documents: P.S. 1.M.1.2, PQR GT18-0-1

Prepared by: [signature]

Approved by: [signature]

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: December 10, 1970 W. P. Q. R. No. GT 18-0-1

Welding Process Gas Tungsten Arc Manual Semi-Automatic Automatic

Mtl. Type and Spec. SA-312 Type 304 To SA-333 Gr 1 P-No. 1 To P-No. 8

Thickness (and Dia. If Pipe) 3/8" x 6" dia. Thickness Range Qualified 1/16" Thru 3/4"

WELDING MATERIALS

Filler Metal F-No. 7 A-No. 7
Electrode F-No. A-No.
Spec. or Analysis: SA-371 Type ER309

Flux:
Other Additives: Welding grade Argon
Torch flow rate 30 cfh
Purge flow rate 5-7 cfh

WELDING PROCEDURE

Position Qualified: Vertical pipe 2
Qualifying For: F, H
Single or Multiple Pass: Multiple
Number of Arcs: One
Preheat Temp. 60° F Min.
Interpass Temp. 350° F max.
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Hobart

Type Current: DCSP
Joint Configuration: Single V, open butt

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min)
1	3/32"	60-70	12	-
2	3/32"	75-85	12	-
3-6	3/32"	75-100	12	-
Rem.	3/32	105-120	12	-

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions Width	Thickness	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
Transverse Q-6(b)	.753"	.315"	.237	18,900	79,750	Ductile - Pipe
Transverse Q-6(b)	.750"	.334"	.251	18,500	73,700	Ductile - Pipe

GUIDED BEND TESTS

Type	Specimen No.	Results
Root Q-7.2	2GR1	Acceptable
Root Q-7.2	2GR2	Acceptable
Face Q-7.2	2GF1	Acceptable
Face Q-7.2	2GF2	Acceptable

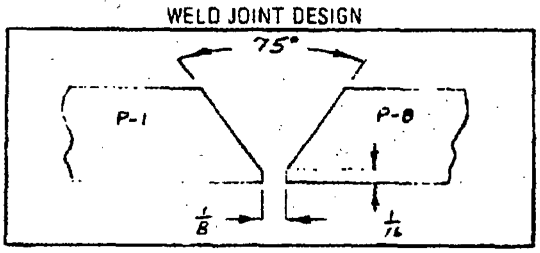
NON DESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear
HAZ	-20° F	52, 44, 85	60	.055", .047", .080"	65, 54, 96

WELD JOINT DESIGN



Dept. Conducting Test BFNP
Welder H. C. Carpenter Symbol 6B5
Test No.:
Testing Lab. Bend Tests - BFNP
Tensile & Impact Tests - PTL

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ASME Code.

By Robert L Harris

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date December 10, 1970 W. P. Q. R. No. GT18-0-1

Welding Process Gas Tungsten Arc Manual Semi-Automatic Automatic

Mat. Type and Spec. SA-312 Type 304 To SA-333 Gr 1 P-No. 1 To P-No. 8

Thickness and Dia. if Pipe) 3/8" x 6" dia. Thickness Range Qualified 1/16" Thru 3/4"

WELDING MATERIALS

Filler Metal F-No. 7 A-No. 7
Electrode F-No. A-No.
Spec. or Analysis: SA-371 Type ER309

Flux.
Other Additives: Welding grade Argon
Torch flow rate 30 cfh
Purge flow rate 5-7 cfh

WELDING PROCEDURE

Position Qualified: Horizontal Fixed Pipe (5G)
Qualifying For: F, V, OH
Single or Multiple Pass: Multiple
Number of Arcs: One
Preheat Temp 60° F Min.
Interpass Temp. 350° F Max.
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Hobart

Type Current: DCSP
Joint Configuration: Single V, open butt

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
1	3/32"	60-70	12	-
2	3/32"	75-85	12	-
3	3/32"	85-100	12	-
4	3/32"	90-110	12	-
Rem.	3/32"	100-120	12	-

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions Width	Dimensions Thickness	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
Transverse	.763"	.291"	.222	16,500	74,320	Ductile - Pipe
Q-6(b)						
Transverse	.749"	.289"	.217	16,100	74,190	Ductile - Pipe
Q-6(b)						

GUIDED BEND TESTS

Type	Specimen No.	Results
Root Q-7.2	5GR1	Acceptable
Root Q-7.2	5GR2	Acceptable
Face Q-7.2	5GR3	Acceptable
Face Q-7.2	5GR4	Acceptable

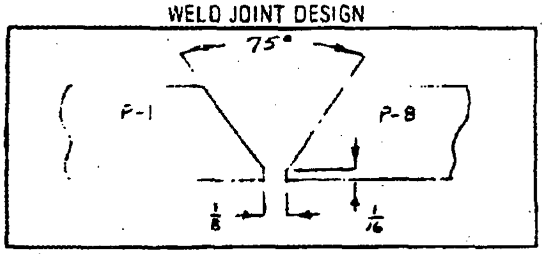
NON DESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear
HAZ	-200 F	102, 92, 131	108	.079", .080", .060"	82, 69, 100

WELD JOINT DESIGN



Dept. Conducting Test BFNP
Welder H. C. Carpenter Symbol 6B5
Test No.:
Testing Lab Bend tests - PTL
Tensile & Impact Tests - PTL

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ASME Code.

By Robert L Harris

FORM 6 - PROCUREMENT DATA SHEET **PEG PKG NO. CMM127E**
QA RECORD **PAGE 1 OF 3**

RIMS/EDMS NO: R27 070412 333		REV NO: 0
SUPERSEDED RIMS NO: N/A		QA LEVEL: 3
TECHNICAL EVALUATION PKG NO: 01006521-BFNM1		PDS EXPIRATION DATE: N/A
TECHNICAL EVALUATION RIMS NO: R27 070412 331		
TIIC NO: **CMM127E**	COMMODITY CODE: N/A	SOLE SOURCE: [☐] YES [☒] NO
MAILING LIST: N/A	QA PROGRAM IMPOSED: [☐] YES [☒] NO	
PROPOSED SUPPLIER: WESTINGHOUSE		
ITEM INTENDED END USE: SERVICE FOR PIPE CUTOUT		
ITEM DESCRIPTION: SERVICE, CONTRACT, Q LEVEL: QA 3 , APPLICATION: OFF SITE SUPPORT VENDOR TO PERFORM METALLURGICAL EVALUATION OF WELD RCRD-2-52 4" DIAMETER SCHEDULE 80, A-333, GR 1, CARBON STEEL PIPE TO A-182 FORGED STAINLESS STEEL CUTOUT TO DETERMINE THE CAUSE OF WELD FLAW INDICATION (I.E. IGSCC OR SERVICE INDUCED ETC.)		
MANUFACTURER/VENDOR: WESTINGHOUSE ELEC CORP		PART NO: NOT SPECIFIED
EXTERNAL NOTES & ATTACHMENTS: 1. Vendor shall provide complete Metallurgical report of the cutout sample provided by TVA 2. TVA Technical contact for this service is Mr. Travis Shults at 256-729-2040. T2050-Except Prior Executi S1054-TVA right of access		
QA PROGRAM & VENDOR SUBMITTALS/DOCUMENTATION: N/A		
INTERNAL NOTES & ATTACHMENTS: /*C - COMMENT*/ 1. Purchasing: Please contract the Technical Engineer (Mr. Travis Shults Ext. 2040) for this service for any additional information required. Receiving: Please contact Travis Shults for material cutout and handle the material per SNM since it has radioactive contamination. N1051-No Bid Rev Non-ASL N1097-No Stock Level Assg		
ADDITIONAL INFORMATION: N/A		
PREPARED BY: PEG ENGINEER: MAJMUDAR, ARUN		DATE: 04-11-07 16:48
REVIEWED BY: INDEPENDENT REVIEWER: SOUTH, JULIAN		DATE: 04-12-07 09:47
APPROVED BY:		DATE:

FORM 6 - PROCUREMENT DATA SHEET
QA RECORD

PEG PKG NO. CMM127E
PAGE 2 OF 3

PROCUREMENT ENGINEERING MANAGER: TERRY, WILLIAM R	04-12-07 13:38

DISTRIBUTION:
[☒] RIMS/EDMS
[☐] MATERIAL & PROCUREMENT
[☐] N/A
[☐] NUCLEAR PROCUREMENT
[☐] NUCLEAR STORES

FORM 7 - RECEIPT VERIFICATION/INSPECTION REQUIREMENTS

PEG PKG NO. CMM127E
PAGE 3 OF 3

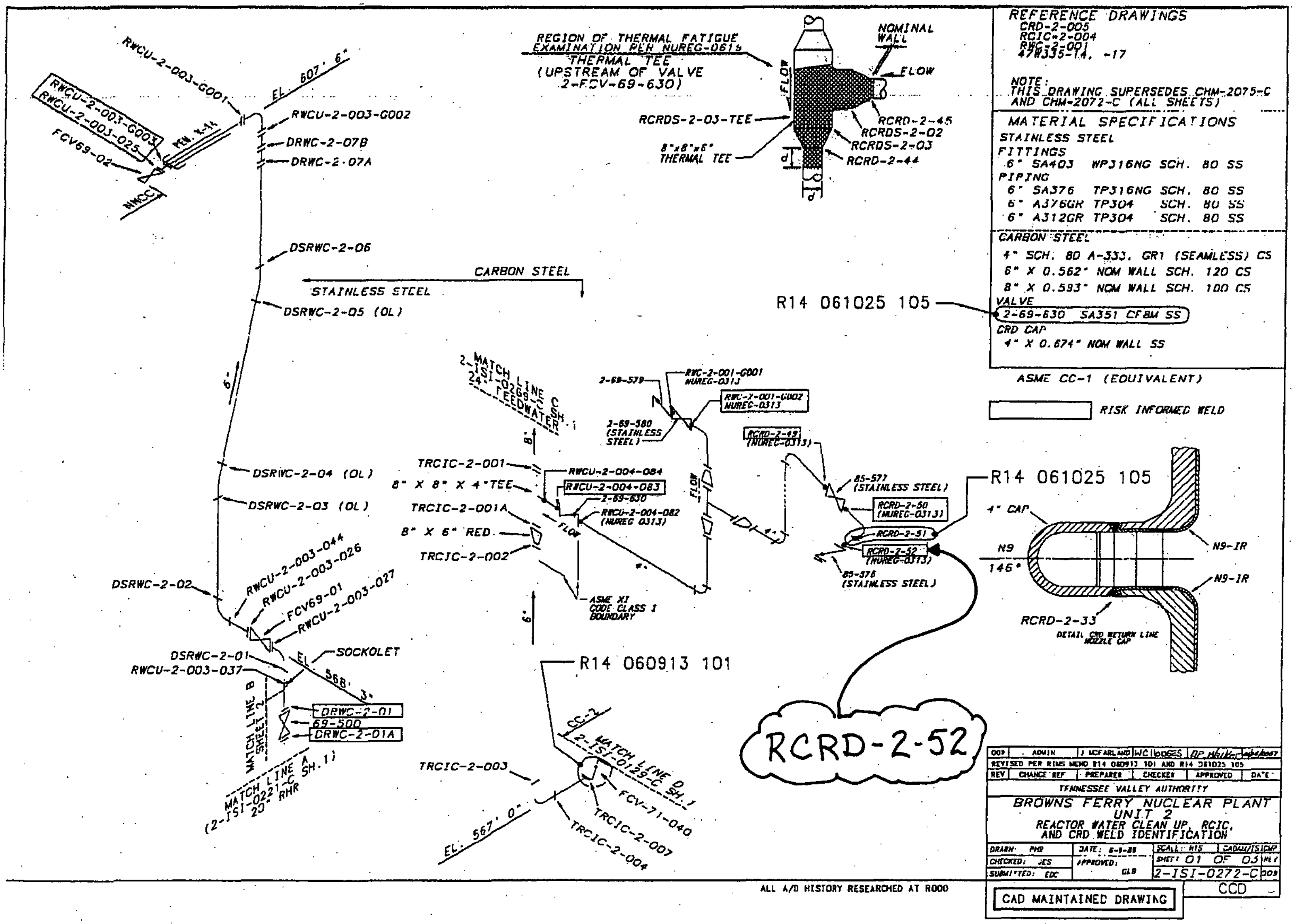
THC NO./DESCRIPTION: CMM127E					**QA LEVEL:** 3
INSPECTION ATTRIBUTE	**INSPECTION REQUIREMENT**				
NOMENCLATURE	**N/A**	**STD**	**SAT**	**UN SAT**	**SPECIAL REQUIREMENTS**
PHYSICAL DAMAGE	☒	☐			
MATERIAL ID	☒	☐			
VEN/MFG REC/SUBM	☒	☐			
PROTECTIVE COV.	☒	☐			
COATING	☒	☐			
PRES/DES/ GAS	☒	☐			
CLEANLINESS	☒	☐			
PHY/CHEM PROP	☒	☐			
SIZE/SHAPE	☒	☐			
LUBRICANTS	☒	☐			
RESIST. TEST/ELECTRICAL INSUL	☒	☐			
DIMENSIONS	☒	☐			
WORKMANSHIP	☒	☐			
SPEC. INSPECT.	☒	☐			
S. HAN/STORAGE	☒	☐			
SOURCE SURVEILLANCE/INSPEC	☒	☐			
SHELF LIFE	☒	☐			
TRACEABILITY	☒	☐			
TAGGING/POST INSPEC	☒	☐			
HARDNESS TESTING	☒	☐			
TVA APPR OF DOC	☒	☐			
WELD PREP	☒	☐			
	☒	☐			
	☒	☐			
	☒	☐			
	☒	☐			
NOTES: None.					

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 2

INSERVICE INSPECTION WELD ISOMETRIC DRAWING, 2-ISI-272-C, SHEET 1, FOR WELD RCRD-2-52

(SEE ATTACHED)



REFERENCE DRAWINGS
CRD-2-005
RCIC-2-004
RWC-2-001
47W335-14, -17
NOTE:
THIS DRAWING SUPERSEDES CHM-2075-C AND CHM-2072-C (ALL SHEETS)
MATERIAL SPECIFICATIONS
STAINLESS STEEL
FITTINGS
6" SA403 WP316NG SCH. 80 SS
PIPING
6" SA376 TP316NG SCH. 80 SS
6" A376GR TP304 SCH. 80 SS
6" A312GR TP304 SCH. 80 SS
CARBON STEEL
4" SCH. 80 A-333, GR1 (SEAMLESS) CS
6" X 0.562" NOM WALL SCH. 120 CS
8" X 0.593" NOM WALL SCH. 100 CS
VALVE
2-69-630 SA351 CF8M SS
CRD CAP
4" X 0.674" NOM WALL SS
ASME CC-1 (EQUIVALENT)
RISK INFORMED WELD
R14 061025 105
REGION OF THERMAL FATIGUE EXAMINATION PER NUREG-0619
THERMAL TEE
(UPSTREAM OF VALVE 2-FCV-69-630)
NOMINAL WALL
FLOW
RCRDS-2-03-TEE
RCRD-2-45
RCRDS-2-02
RCRDS-2-03
RCRD-2-44
8"x8"x6" THERMAL TEE
RWCU-2-003-G001
EL. 607' 6"
RWCU-2-003-G003
RWCU-2-003-025
FCV69-02
RWCU-2-003-G002
DRWC-2-07B
DRWC-2-07A
DSRWC-2-06
CARBON STEEL
STAINLESS STEEL
DSRWC-2-05 (OL)
6"
DSRWC-2-04 (OL)
DSRWC-2-03 (OL)
DSRWC-2-02
RWCU-2-003-044
RWCU-2-003-026
FCV69-01
RWCU-2-003-027
SOCKOLET
DSRWC-2-01
RWCU-2-003-037
EL. 568' 3"
DRWC-2-01
69-500
DRWC-2-01A
MATCH LINE B SHEET 2
MATCH LINE A (2-ISI-0221-C SH.1) 20" RHR
MATCH LINE C 2-ISI-0269-C SH.1 24" FEEDWATER
2-69-579
RWC-2-001-G001 NUREG-0313
RWC-2-001-G002 NUREG-0313
2-69-580 (STAINLESS STEEL)
TRCIC-2-001
RWCU-2-004-084
8" X 8" X 4" TEE
RWCU-2-004-083
2-69-630
TRCIC-2-001A
RWCU-2-004-082 (NUREG 0313)
8" X 6" RED.
TRCIC-2-002
ASME XI CODE CLASS I BOUNDARY
RCRD-2-49 (NUREG-0313)
85-577 (STAINLESS STEEL)
RCRD-2-50 (NUREG-0313)
RCRD-2-51
RCRD-2-52 (NUREG-0313)
85-578 (STAINLESS STEEL)
R14 061025 105
4" CAP
N9
146°
N9-IR
N9-IR
RCRD-2-33
DETAIL CRD RETURN LINE NOZZLE CAP
R14 060913 101
RCRD-2-52
TRCIC-2-003
MATCH LINE D 2-ISI-0129-C SH.1
FCV-71-040
TRCIC-2-007
TRCIC-2-004
EL. 567' 0"
REVISED PER RIMS MEMO R14 060913 101 AND R14 061025 105
REV CHANGE REF PREPARER CHECKER APPROVED DATE
TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT UNIT 2
REACTOR WATER CLEAN UP, RCIC, AND CRD WELD IDENTIFICATION
SHEET 01 OF 03
2-ISI-0272-C
ALL A/D HISTORY RESEARCHED AT R000
CAD MAINTAINED DRAWING

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 2

NOTIFICATION OF INDICATION (NOI)-U2C14-017

(SEE ATTACHED)

NOTIFICATION OF INDICATION FORM

PART I - FINDINGS

NOI No. U2C14-017 Plant/Unit BFN 2 ISI Dwg./Sh. No. 2-ISI-0272-C, SHT. 1 of 3

Examination Report No. R-074 Component ID RCRD-2-52

Description of Indication (Sketch/Photograph if Required for Clarification): Ultrasonic examination of 4" CS/SS Weld RCRD-2-52 detected a planar indication. Reference attached UT report.

Signature of Examiner/Certification Level: [signature] /Date: 3/3/07
Signature of ISO Coordinator (Field Supervisor): [signature] /Date: 03/03/07
Signature of ISI Program Owner: [signature] /Date: 3/3/07

PART II - DISPOSITION

See attached.

Corrective Action Program or Administrative Control document number (PER, WO) if applicable: 121003

ASME XI Subsection IWE ☐ Yes ☑ No — If Yes, complete the supplemental information Parts II and III of Page 2 of this form in addition to Parts II, III, and IV, of Page 1. If No, completion of Parts II and III of Page 2 of this form is not required and attachment of Page 2 with Page 1 is not required.

Disposition Prepared/Recorded By: [signature] Org. SE-M/N Date: 05-10-2007

PART III - ADDITIONAL EXAMINATIONS

Additional Sample Required [IW(X)-2430]: ☑ Yes ☒ No (SCW 5/11/07) — Page 2 of 2 additional samples attached? ☒ Yes ☑ No (No SCW 5/11/07)

(Attach list of items in additional sample, if yes.) [signature] 5/11/07
ISI or CISI Program Owner Date

Successive Examination Required: ☐ Yes ☑ No [signature] 5/11/07
ISI or CISI Program Owner Date

PART IV - VERIFICATION OF CLOSURE

Reexamination Report number, if Applicable: N/A
Signature of ISO Coordinator: ______ Date: ______

Finding resulted from performance of the General visual Examination ☐ Yes ☑ No — If Yes, concurrence of the Registered Professional Engineer (RPE) or Individual Responsible for performance is required (N/A otherwise):

N/A
RPE/Responsible Engineer Date

Comments: ______

Verification of Complete Corrective Action Required by Disposition (Including Page 2, if applicable)
Signature of ISI or CISI Program Owner: [signature] Date: 5/11/07

NOTIFICATION OF INDICATION FORM
ATTACHMENT

NOI No. U2C14-017 Plant/Unit BFN Unit 2

Examination Report No. R-074 Component ID RCRD-2-52

Part II - Disposition

This NOI documents a planar indication that was observed during manual ultrasonic examination of dissimilar metal weld RCRD-2-52 (4-inch Carbon Steel, Schedule 80 pipe to stainless steel check valve 2-CKV-085-0576) during the Unit 2 Cycle 14 Refueling Outage. This examination was performed in accordance with ASME Section XI, Appendix VIII qualified techniques for examination of dissimilar metal welds (Report Number R-074). The procedure utilized was TVA/ISO NDE Procedure N-UT-82 that implements the PDI Generic Procedure PDI-UT-10. The indication presented signal characteristics indicative of a planar reflector located in the weld. The available data indicated that the planar reflector would not meet the ASME Section XI, Table IWB-3514-2, criteria for allowable planar flaws.

The planar indication was removed when check valve 2-CKV-085-0576 was cut out and replaced under Work Order Number 07-713160-000. The indication was removed in such a manner to allow subsequent metallurgical evaluation. Westinghouse, LLC has been contracted to determine the cause of the planar indication, and is expected to have preliminary results of their evaluation by June 2007.

Prepared By: Victor D. Schiavone Org. SE-M/N Date 05-10-2007

NOI U2C14-017
List of Items in Additional Sample

Weld ID	ISI Exam	Report Nunber	Exam Results
RCRD-2-33	manual UT	R-116	No Recordable Indications
RCRD-2-50	manual UT	R-118	No Recordable Indications
DRHR-2-11	manual UT	R-119	No Recordable Indications
DRHR-2-03	manual UT	R-121	No Recordable Indications

NOTIFICATION OF INDICATION FORM
SUBSECTION IWE

Complete this page in addition to Page 1 for findings affecting Class MC/Subsection IWE.

NOI No. 42C14-017 Plant/Unit BFN/2

Examination Report No. R-074 Component ID RCRD-2-52

PART II - DISPOSITION (Supplemental Information)

Evaluation of inaccessible areas as required by 10CFR50.55a(b)(2)(ix)(A)
(Include (1) A description of the type and estimated extent of degradation, and the conditions that led to the degradation; (2) An evaluation of each area, and the result of the evaluation; and (3) A description of necessary *corrective actions) [additional separate continuation sheets may be attached, as necessary].*

____

____

____

____

____

____

Corrective Action Program or Administrative Control document number (PER, WO) if applicable: ______________

Disposition Prepared By: ______________ Org. ______________ Date ______________

PART III - ADDITIONAL EXAMINATIONS (Supplemental Information)

Additional examinations required per 10CFR50.55a(b)(2)(ix)(D) ☐ Yes ☐ No
If Yes, provide (1) A description of each flaw or area, including the extent of degradation, and the conditions that led to the degradation; (2) The acceptability of each flaw or area, and the need for additional examinations to verity that similar degradation does not exist in similar components; (3) A description of the necessary corrective actions; and (4) The number and type of additional examinations to ensure detection of similar degradation in similar components [additional separate continuation sheets may be attached, as necessary].

____

____

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____

Specified By: ______________ Org. ______________ Date: ______________

TENNESSEE VALLEY AUTHORITY	EXAMINATION SUMMARY AND RESOLUTION DATA SHEET	REPORT NUMBER: R074

PROJECT: BFN	UNIT: 2	CYCLE: 14	COMPONENT ID: RCRD-2-52		
EXAMINATION METHOD			SYSTEM: RWCUS	ISI DWG. NO. 2-ISI-0272-C-01	
MT ☐	PT ☐	UT ☒	VT ☐	CODE CLASS:	CATEGORY: R-A
PROCEDURE: N-UT-82	REV: 2	TC: N/A	CONFIG.: VALVE TO PIPE		

EXAMINER: WADE HOLLOWAY	EXAMINER:	EXAMINER:	EXAMINER:
LEVEL: II	LEVEL:	LEVEL:	LEVEL:

This report contains the data associated with the manual ultrasonic examination of RCRD-2-52 to meet the requirements of ASME Section XI, category R-A, item number R1.16D, and BWRVIP-75.

This exam was performed using equipment, procedures and personnel qualified in accordance with ASME Section XI, Appendix VIII as amended by 10CFR50.55a final rule.

The component configuration is a 4" diameter, Sch 80 carbon steel pipe, welded to a forged stainless steel valve.

Both refracted longitudinal (RL) and shear wave search units were used as defined in procedure PDI-UT-10. The ultrasonic examination is limited due to the taper configuration of the dissimilar metal weld.

During the examination, a planar indication was detected that was oriented in the circumferential direction with a recorded length of 1.10 inches. The indication was detected using a 60° shear wave and a 60° RL wave search units. The indication was sub sequentially confirmed using a 70° shear wave and a 70° RL wave search units.

Due the inherent component geometry, it is not possible to obtain depth measurements of this indication using PDI ultrasonic qualified techniques. However, a best effort through wall sizing technique was applied and indicated as estimated remaining ligament of 0.20" in depth.

ASME Section XI Coverage:
Circumferential scan coverage was 100%. Axial scan coverage was 74%
Combined ASME Section XI Code coverage was 87%

Preliminary report for notification. Report will be finalized when all data is complete.
PER U2C14-017 generated.
[signature]

RESOLUTION BY: [signature]	REVIEWED BY: [signature]	ANII:
LEVEL: II DATE: 3/3/07	LEVEL: III DATE: 3/3/07	DATE:
		PG. 1 OF

ISI report no. R-017

NOI no. U2C14-017

Component I.D. RCRD-2-52

Additional resolution details:

Weld configuration:

4" Carbon Steel, sch. 80 pipe to a forged stainless steel check valve. The joint configuration exhibits a dissimilar metal weld with a pipe wall thickness at the weld joint of .36" connected to a SS check valve body. The weld crown is tapered from the pipe to the valve at an angle of 18°. This configuration limits the ability to scan across the weld crown in the axial direction.

Examination technique:

The examination was performed in accordance with ASME Section XI, Appendix VIII qualified techniques for examination of dissimilar metal welds. The procedure utilized was TVA/ISO NDE Procedure N-UT-82 that implements the PDI Generic procedure PDI-UT-10.

Indication discrimination:

The joint configuration limited the ultrasonic examination angles to 60 and 70 degrees. The weld taper and width prevented the use of a 45° inspection angle.

The indication presented signal characteristics indicative of a planer reflector located in the weld. The reflector continued to return energy until the transducer contacted the weld taper. The higher examination angle returned more reflected energy than the lower examination angle. The reflector maintained echo dynamic motion during the axial raster scan and during skewing of the search unit.

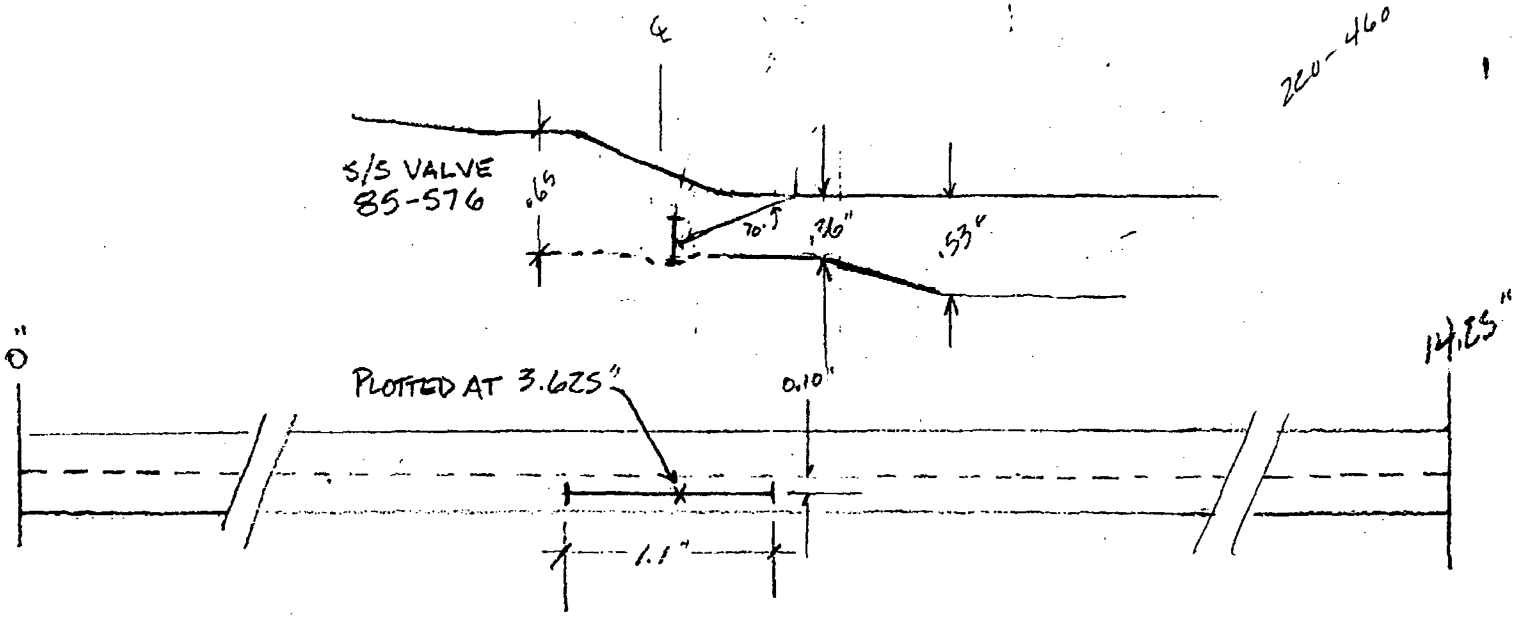
The PDI dissimilar metal examination does not contain qualified through wall sizing techniques. However, a best effort through wall sizing technique was applied and indicated an estimated remaining ligament of 0.20" in depth.

Conclusion:

The weld configuration does not allow for all of the indication discrimination tools defined in the PDI generic procedure. The discrimination tools utilized indicate the presence of a planer flaw located in the weld metal. The available data indicates the presence of a planer reflector that would not meet the ASME Section XI, Table IWB-3514-2, for allowable planer flaws.

[signature] III 3/3/07

TVA Office of Nuclear Power	PROJECT: BFN SYSTEM: RWCU Unit: 2 WELD NO.: RCRD-2-50	REPORT NO.: R074



- Through wall size not available due to configuration and PDI technique
- Best effort through wall dimension provided

BY: [signature] LEVEL: III DATE: 3/3/07 PAGE ____ OF ____

TVA 19669 (ONP-6-88)

ACTUAL WORK PERFORMED
(Continuation Sheet)

UNID: BFN-2-CKV -085-0576

WO NO: 07-713160-000

DESCRIBE ACTUAL WORK PERFORMED (cont):

3/27/07 Located argon bottles in Breeze way and Transported to the steam tunnel. And performed ISI prep on the 4" weld too the spool ~~piece~~ JG 3-27-07 piece of pipe to the valve "576". and transported Gold Track machine from mods-SHOP to new Fab-SHOP. and Requisted ~~ISI~~ JG 3-27-07 Q.C. and waiting on Q.C. for Finial By-off. called Q.C. at 3:50. JG. 3/27/07

3/27/07 Contacted OPs to find out status on clearance. Attended Pre-Job and RP briefs.

3/28/07 got cleaves clearance signed-off of 576 valve. started to get Pre-Job briefing from RP too start gcutting old 576 valve out. war-Room called and stopped work on our valve because weary valve started working on the MSIV valve which is critical Path. we was shutdown from 9:00 A.M to 6:00 P.M. got purge paper and clue and made purge Dam's. They in Dave Russ cubical. J.G. 3/28/07

3/29/07 Rigged old valve out and new valve into steam tunnel. Old valve went to turbine decon. New valve is staged and rigged on Scaffold. New valve and pipe ends are prepped and clean. Purge dams and paper is staged on beam. TS 3/29/07

020

ACTUAL WORK PERFORMED
(Continuation Sheet)

UNID: BFN-2-CKV -085-0576

WO NO: 07-713160-000

DESCRIBE ACTUAL WORK PERFORMED (cont):

3/30/07 Day shift put root and hot passes in both field welds. Root passes were bought on days. Night shift completed bi-metal weld and welded on pipe-to-pipe carbon weld. Bi-metal weld was PSI prepped. 3/31/07 [illegible]

04-01-07: Sample piece with indication was removed from valve 2-85-0576 and submitted to Site Engineering for analysis. [illegible] 04-01-07