WCAP-10453

WESTINGHOUSE CLASS 3

METALLURGICAL INVESTIGATION OF THE RECORDED UT INDICATIONS IN THE STEAM GENERATOR STUB BARREL TO LOWER SHELL WELD AT BYRON 1 STATION

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PREFACE

This report has been technically reviewed and verified.

Reviewer	*Signature*
M. K. Kunka	M.K. Kunka
R. D. Rishel	R.D. Rishel

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

(Continued)

LIST OF TABLES

SECTION 1
INTRODUCTION

This report summarizes the findings of the metallurgical investigation of the UT indications recorded in the steam generator stub barrel-to-lower shell circumferential weld of the Commonwealth Edison Company's Byron 1 nuclear power generating station.

Commonwealth Edison Company's Byron 1 station is a four loop 1120 MWe plant which is expected to resume commercial operation during 1984. During the preservice inspection conducted by EBASCO Services Inc. for Commonwealth Edison, several indications requiring evaluation were recorded. Westinghouse, at the request of Commonwealth Edison, provided assistance in the evaluation of the preservice test results. As a result of these evaluations, two plugs from 113" CCW and 93" CCW positions, respectively, of the stub barrel-to-lower shell circumferential weld that had produced the worst case indications were removed for metallurgical investigation. The steam generator shell was made of A533 Grade B Class 2 material and the circumferential welds employed submerged arc with SFA 5.17 Type EH14 wire and Modified Flux Linde 0091. The current report summarizes the results of these metallurgical evaluations.

The investigation consisted of surface examinations, metallographic and fractographic examinations and chemistry evaluations. The purpose of the investigation is to establish the size, shape, orientation and location of the discontinuities or voids that gave rise to the reported UT indications and further to establish the cause of their occurrence.

SECTION 2
TESTS AND EVALUATIONS

2-1. SURFACE EXAMINATIONS

The as-received condition of the two plugs, namely Plug No. 93 CCW and Plug No. 113 CCW were carefully examined visually and by low power light microscopy for evidence of surface defects, cracks or other deposits. The examinations were also carried out in lightly polished condition. The results of these surface examinations are illustrated in Figures 2-1 through 2-4. The results are discussed in Section 3.

2-2. METALLOGRAPHIC EXAMINATIONS

Based on the locations of the recorded UT indications and the results of the surface examinations of the plugs, series of sections through each of the plugs were taken (dry) to obtain maximum possible information on the cause of reported indications. The sections were taken transverse to the longitudinal direction of the reported indications, and were oriented axial to the plugs and transverse to the steam generator circumferential welds.

The sections were examined both in the as-polished and in the polished and etched conditions. The overall purpose of the metallographic examination was to establish the morphology and physical dimensions of the voids or discontinuities associated with the reported indications and further to establish their relationship to the local microstructure. The results of the metallographic examination are illustrated in Figures 2-5 through 2-12. The results are discussed in Section 3 of the report.

2-3. FRACTOGRAPHIC EXAMINATIONS

Dry cut samples from the plugs containing the voids or discontinuities were opened fresh in the laboratory and were examined for surface morphology by light optical and scanning electron fractography techniques. The examinations were conducted both in the as-opened as well as in the endoxed (oxide removed) condition. The

results are illustrated in Figures 2-13 through 2-17. The results are discussed in Section 3.

2-4. CHEMISTRY EVALUATIONS

Chemistry analysis of the weld deposit associated with the discontinuities was conducted by wet analysis to examine its conformance to the specification requirements. The results are listed in Table 1. The chemistry of the deposits present in the discontinuities was examined by energy dispersive x-ray (EDAX) analysis. The results are illustrated in Figure 2-18. The results of the chemistry evaluations are discussed in Section 3.

SECTION 3
RESULTS AND DISCUSSION

The results of the surface examinations on the two plugs (Plug Nos. 93 CCW and 113 CCW) are illustrated in Figures 2-1 through 2-4. Examination of the Plug 93 CCW in the as-received and slightly polished condition showed no evidence of cracks, voids or discontinuities on the outside diameter surface. Examination of the surface condition of the end face of the plug (which corresponded to the inside diameter surface of the steam generator outer shell), however, showed some evidence of what appeared to be isolated inclusion sites along the weld line (Figure 2-3). Similar examinations on Plug 113 CCW showed evidence of a deep void on the outside diameter surface of the plug, at a location approximately 0.37 inches below the end face (shell ID surface). The appearance of the void is illustrated by the light optical macrograph in Figure 2-4. No evidence of any abnormal surface condition was seen on the end face of Plug 113 CCW. The end faces of both the plugs corresponding to the ID surface of the steam generator outer shell, showed presence of grinding marks, presumably introduced during surface cleaning subsequent to welding.

The results of the metallographic examination of the two plugs are illustrated in Figures 2-5 through 2-12. Figures 2-5 through 2-7 illustrate the examination results of the as-polished sections, taken axial to the plug and transverse to the circumferential weld in Plug 93 CCW. Figure 2-5 illustrates in a roughly polished condition, the appearance of a section taken at mid-length of the reported indication. Evidence of a void or discontinuity close to the surface can be seen here. The discontinuity is shown at a higher magnification in Figure 2-6(a). Figures 2-6 and 2-7 illustrate the appearance of the discontinuity on sections taken progressively at increasing distances along its length. The discontinuity which appeared close to the surface on a section at its mid-length, is seen at deeper locations at its terminations. For example, the discontinuity is seen at a depth of approximately 0.03 inches below the surface (Figure 2-8) at its mid-length while it is seen at a depth of approximately 0.143 inches

below the surface at one of its termination, 0.5" away from the mid-section. The depth and width of the discontinuity itself, however, appeared maximum at its mid-section (Figure 2-6a) measuring approximately 0.09 inches deep and 0.01 inches wide. Metallographic examination results of the polished and etched sections of Plug 93 CCW are illustrated in Figure 2-8 through 2-10. The morphology of the discontinuity and its relationship to the local microstructure are clearly illustrated here in the micrographs. The morphology of the discontinuity varied from approximately a tear drop shape at its mid-length to a planar shape, which then turned into two isolated voids as it approached its termination. The discontinuity is located at the weld metal to base metal interface at the root gap of the weld. Figure 2-10 clearly illustrates that the two voids connected to the discontinuity are located at the weld metal-to-base metal interface. Evidence of trapped slag inclusion in one of the voids can also be seen here. Examination of a number of sections taken along the weld line confirmed that the total length of the discontinuity in Plug 93 CCW is approximately 1.15 inches. Figure 2-11 illustrates the morphology of the discontinuity in Plug 113 CCW on an axial section transverse to the weld and at 0.325 inches from the outside diameter surface of the plug. The morphology here consists of three isolated voids connected with a thin crack-like opening. Light optical metallographic examination results of the polished and etched section 0.125 inches from the OD surface of the plug are illustrated in Figure 2-12. As can be seen here the discontinuity is located at the weld bead interface and evidence of slag inclusion associated with the discontinuity can be seen here (Figure 2-12b). The discontinuity measured a maximum of 0.02 inches in width and 0.07 inches in depth. Examinations on sections taken progressively along the weld confirmed that the discontinuity is approximately 0.45 inches long. The overall results of the metallographic examinations on the two plugs showed that the observed discontinuities are located at the weld metal-to-base metal interface and that they are often associated with slag inclusions.

The results of the fractographic examinations are illustrated in Figures 2-13 through 2-17. Figure 2-13 illustrates light optical fractographs of a freshly opened (dry) discontinuity from Plug 93 CCW. The fractographs show evidence of dark colored oxide or slag deposits on the inside surface of the discontinuity. Higher magnification scanning electron fractographs of both freshly opened and endoxed discontinuity faces are illustrated in Figures 2-14 through 2-17. Figure 2-14 is a lower magnification scanning electron fractograph of a freshly opened discontinuity showing an overview of the discontinuity face and laboratory induced fracture. Figure 2-15 illustrates higher magnification fractographs of the discontinuity face and the laboratory frac-

ture. As can be seen here, the discontinuity face showed presence of oxide or other slag deposits while the laboratory fracture is made of dimpled morphology. Figure 2-16 shows fractographs of the laboratory opened discontinuity in the freshly opened and endoxed conditions respectively.

Figure 2-17 is a higher magnification scanning electron fractograph of endoxed discontinuity face showing evidence of surface crazing presumably caused by the inclusion-base metal interactions at the interface. The crazing appearance was seen occasionally on the endoxed discontinuity faces at isolated local regions.

The results of the wet chemistry analysis of the weld metal are listed in Table 1. The results show that the weld metal contained significantly higher amounts of silicon and "sum of other elements" as compared to the specification requirements for SFA 5.17 Type EH14, Modified Flux Linde 0091. Chemistry evaluation results of the discontinuity deposits by energy dispersive x-ray analysis, illustrated in Figure 2-18 showed evidence of a number of elements such as magnesium, aluminum, silicon, calcium, titanium, that can be normally found in slag inclusion.

In summary, the results of the surface examination of the plugs suggested presence of isolated inclusion sites along the weld line as seen on the inside diameter (ID) surface of the shell in the case of Plug No. 93 CCW. In the case of Plug No. 113 CCW a deep void-like discontinuity was observed on the cylindrical surface at a location approximately 0.37 inches below the ID surface. Light optical metallography on a series of sections taken across the recorded indication and transverse to the weld and examined in the as-polished condition (dry) showed that the discontinuities are void-like in nature and are oriented parallel to the circumferential welds of the steam generator shell. These examinations also showed that the discontinuity morphology varied from a tear drop shape to that of an oval, or linear shape depending on the location of the section taken along the discontinuity length. The discontinuity was located at approximately 0.33 inches below the shell ID surface in the case of Plug No. 93 CCW and 0.37 inches below the shell ID surface in the case of Plug No. 113 CCW. The discontinuity measured a maximum of approximately 0.09 inches deep along the shell radial direction (axial to the plug), 1.15 inches long along the circumferential weld direction and 0.01 inches wide along the shell axial direction in the case of Plug No. 93 CCW. The discontinuity in Plug No. 113 CCW measred a maximum of approximately 0.45 inches in length, 0.07 inches in depth and 0.02 inches at its widest location. Metallographic examination of the sections in polished and etched

condition showed that the discontinuities are located at the weld metal to base metal interface and are often associated with slag inclusions. Light optical and scanning electron fractographic examination of the discontinuity surfaces in the freshly opened condition suggested the appearance of freshly fused surface covered with oxide (or slag) phase. Surface crazing, indicative of some form of base metal-slag interaction at the interface, was seen occasionally at some localized regions on the inside surface of the discontinuity. Chemistry evaluation of the surface deposits of the freshly opened discontinuities (voids) by EDAX analysis confirmed the presence of calcium, silicon, titanium, aluminum, and magnesium. Wet chemistry analysis results of the weld metal showed that it contained appreciably higher amounts of silicon and "total of other elements" as compared to the specification requirements of SFA 5.17 Type EH14, Modified Flux Linde 0.0091.

The overall results of the investigation confirmed that the suspected regions in both the plugs did, in fact, contain void-like discontinuities near the shell ID surface, oriented parallel to the circumferential welds. The results also showed that the discontinuities are located at the weld metal to base metal interface and are caused by the presence of trapped slag inclusions.

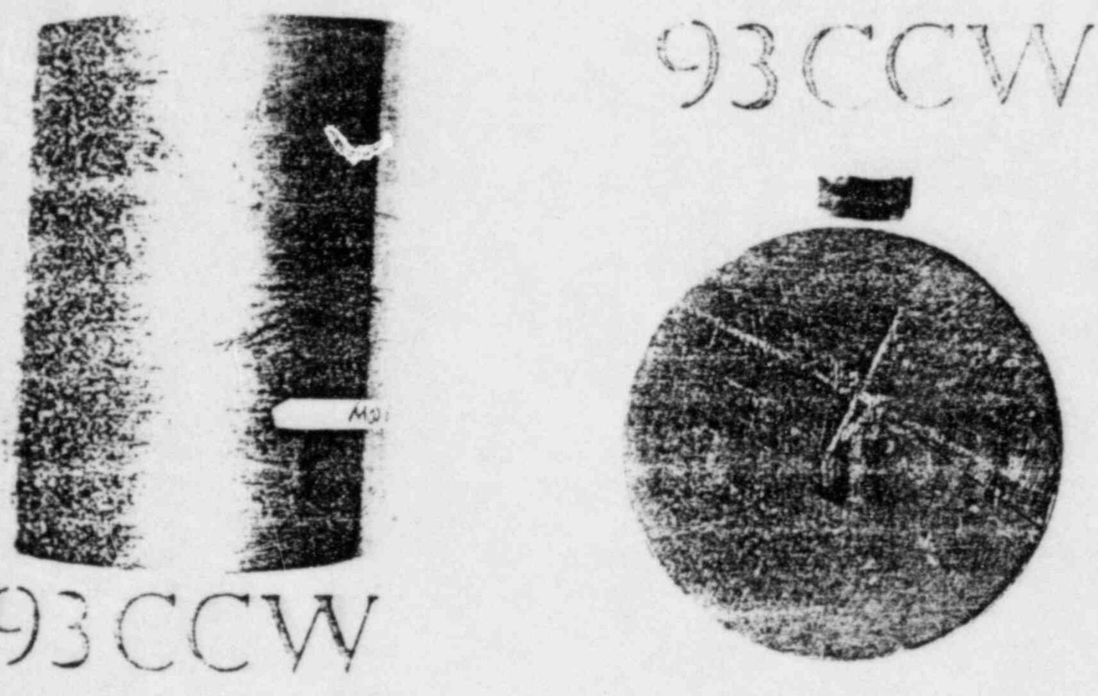
SECTION 4
CONCLUSIONS

Based on the overall results of the investigation, it is concluded that the recorded indications in the Byron 1 Loop 1 steam generator outer shell circumferential welds are caused by the presence of void-like discontinuities near the shell ID surface, oriented parallel to the circumferential welds. Based on the results, it is further concluded that the observed discontinuities are located at the weld metal-to-base metal interface and are caused by the presence of trapped slag inclusions.

TABLE 1

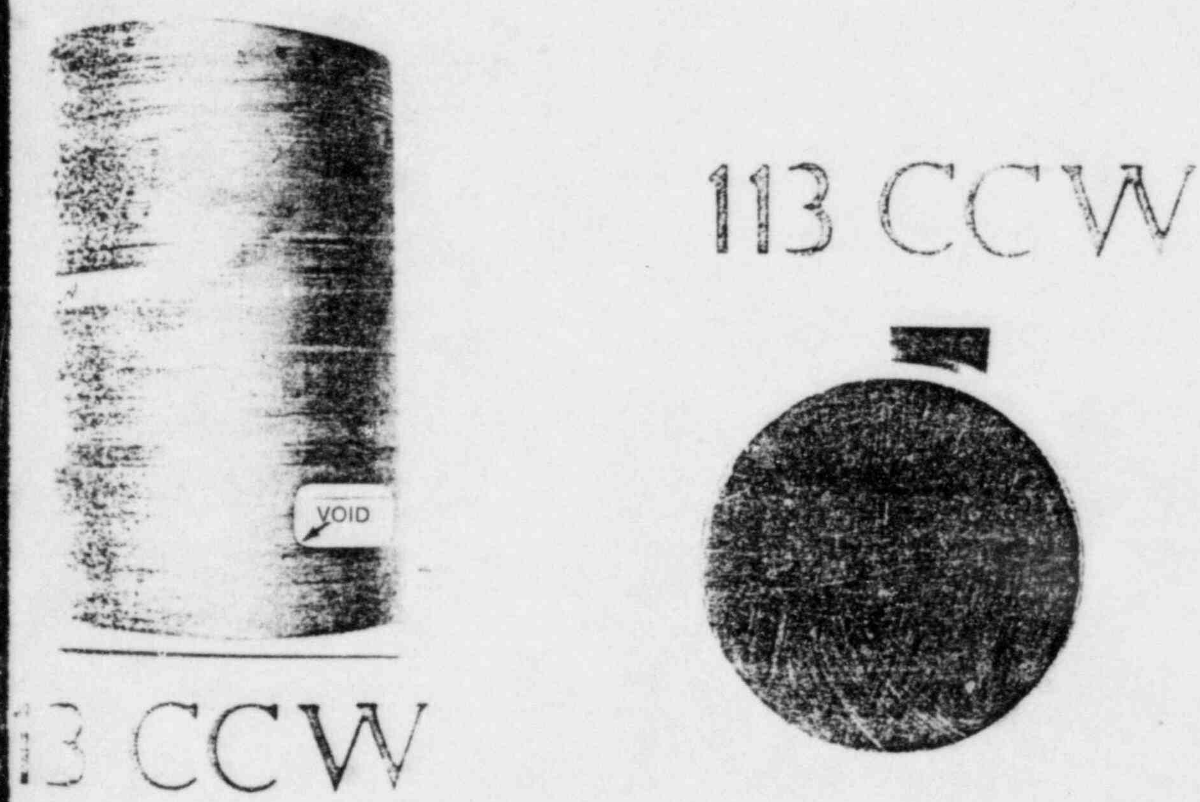
WET CHEMISTRY ANALYSIS RESULTS OF THE WELD METAL

Element	C	Mn	Si	S	P	Cu	Total Other Elements
Wet Analysis Results (Wt %)	0.10	1.24	0.28	0.007	0.016	0.10	1.24 (Mo + Ni + Cr + V)
SFA 5.17 Type EH14, Modified Flux Linde 0091	0.10 to 0.18	1.75 to 2.25	0.05	.035	.03	.30	0.50



(a) (0.85X) (b) (0.85X)

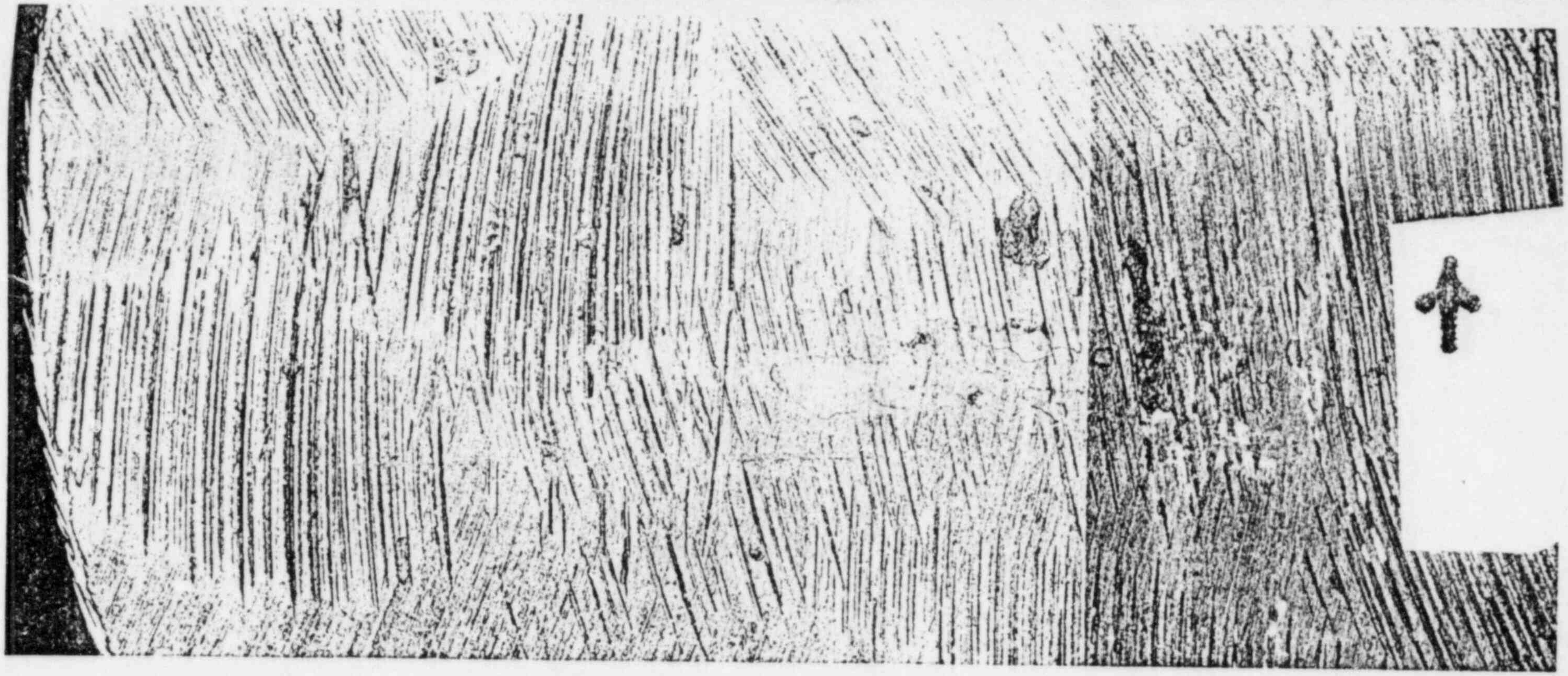
GURE 2-1. AS-RECEIVED SURFACE APPEARANCE OF PLUG NO. 93 CCW
(a) CYLINDRICAL SURFACE APPEARANCE.
(b) END VIEW SHOWING SG SHELL ID SURFACE. THE WHITE LONGER CHALK MARK INDICATES THE ORIENTATION AND LOCATION OF REPORTED INDICATION.



(0.9X) (a)

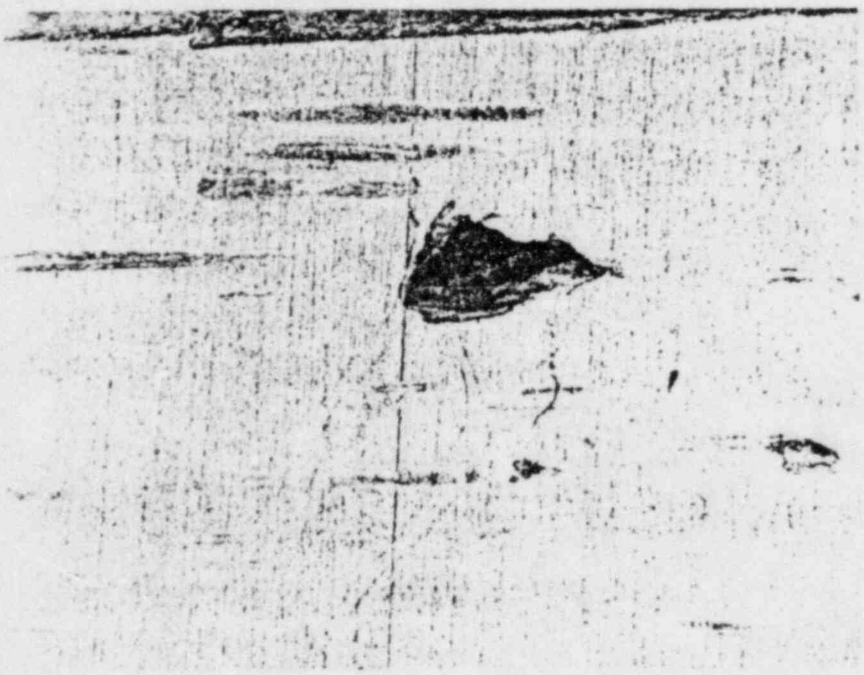
(0.9X) (b)

URE 2-2. AS-RECEIVED SURFACE APPEARANCE OF PLUG NO. 113 CCW
(a) CYLINDRICAL SURFACE SHOWING THE LOCATION OF VOID.
(b) END VIEW OF THE PLUG SHOWING THE STEAM GENERATOR SHELL ID SURFACE.



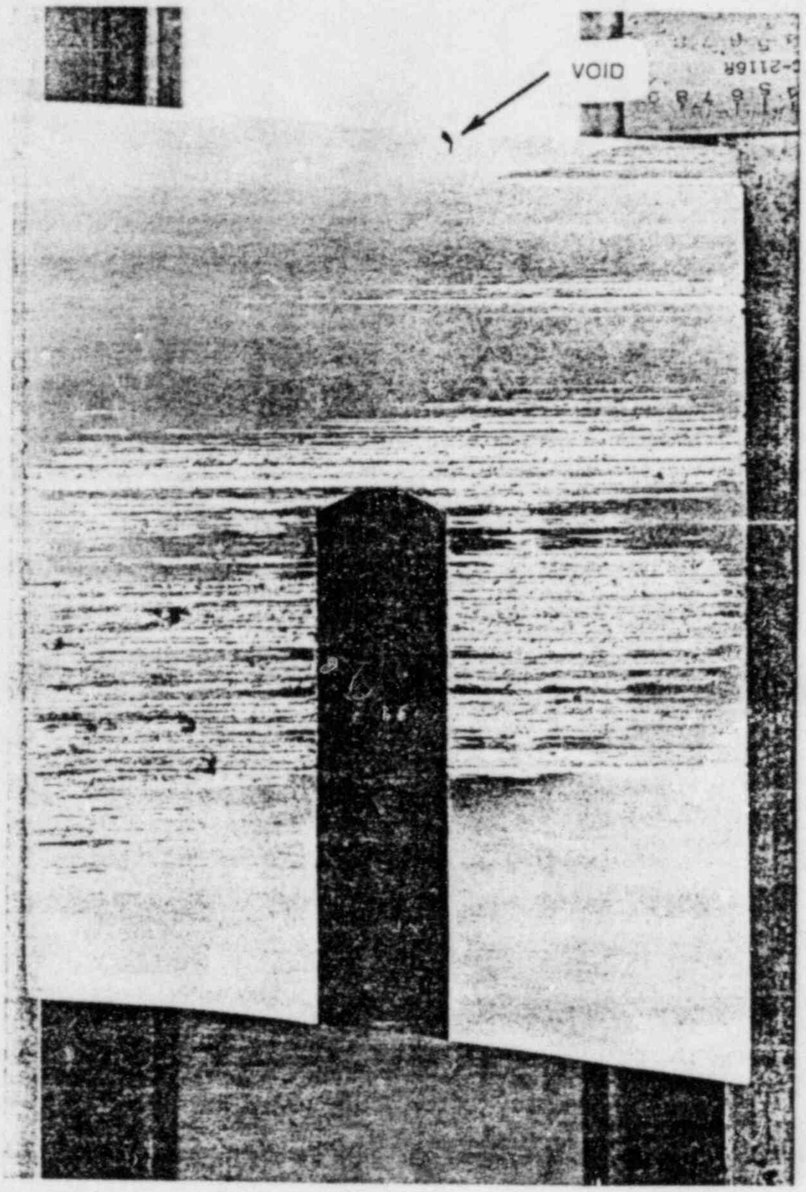
(6.3X)

FIGURE 2-3. LIGHTLY POLISHED APPEARANCE OF THE ID SURFACE OF THE STEAM GENERATOR SHELL (PLUG NO. 93 CCW). (ARROW INDICATES SG TOP DIRECTION, AND THE LONG CHALK MARK CORRESPONDS TO THE ORIENTATION OF REPORTED INDICATION AND CIRCUMFERENTIAL WELD.)



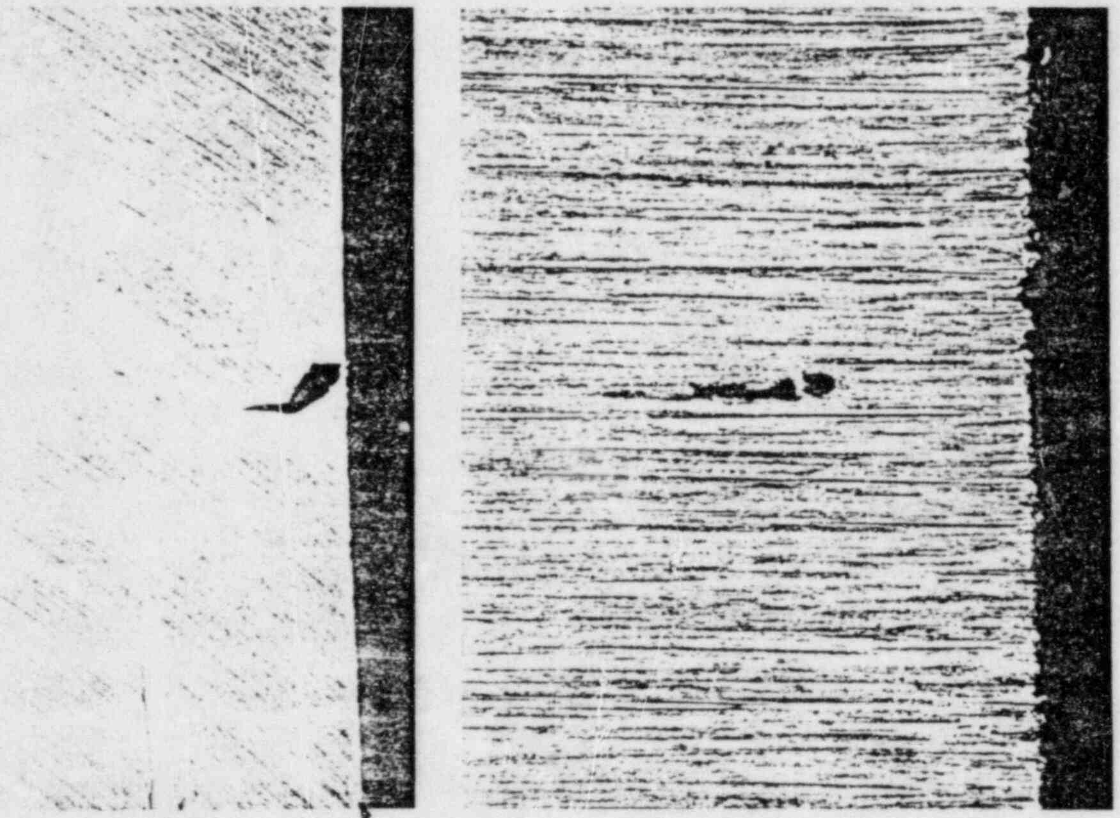
(20X)

IGURE 2-4. APPEARANCE OF VOID ON THE CYLINDRICAL SURFACE OF THE PLUG NO. 113 CCW, IN THE AS-RECEIVED CONDITION.



(1.5X)

GURE 2-5. APPEARANCE OF THE AS-POLISHED SECTION TAKEN DIAMETRICALLY THROUGH THE PLUG NO. 93 CCW. THE SECTION IS TAKEN TRANSVERSE TO THE INDICATION (AS MARKED ON THE PLUG) AT ITS MID-LENGTH LOCATION.



(a) DIAMETRIC SECTION THROUGH THE PLUG. (b) 0.25" FROM CENTER (20X)

GURE 2-6. **APPEARANCE OF AS-POLISHED SECTIONS TAKEN AXIAL TO THE PLUG NO. 93 CCW ILLUSTRATING THE MORPHOLOGY OF VOIDS AT VARIOUS LOCATIONS.**

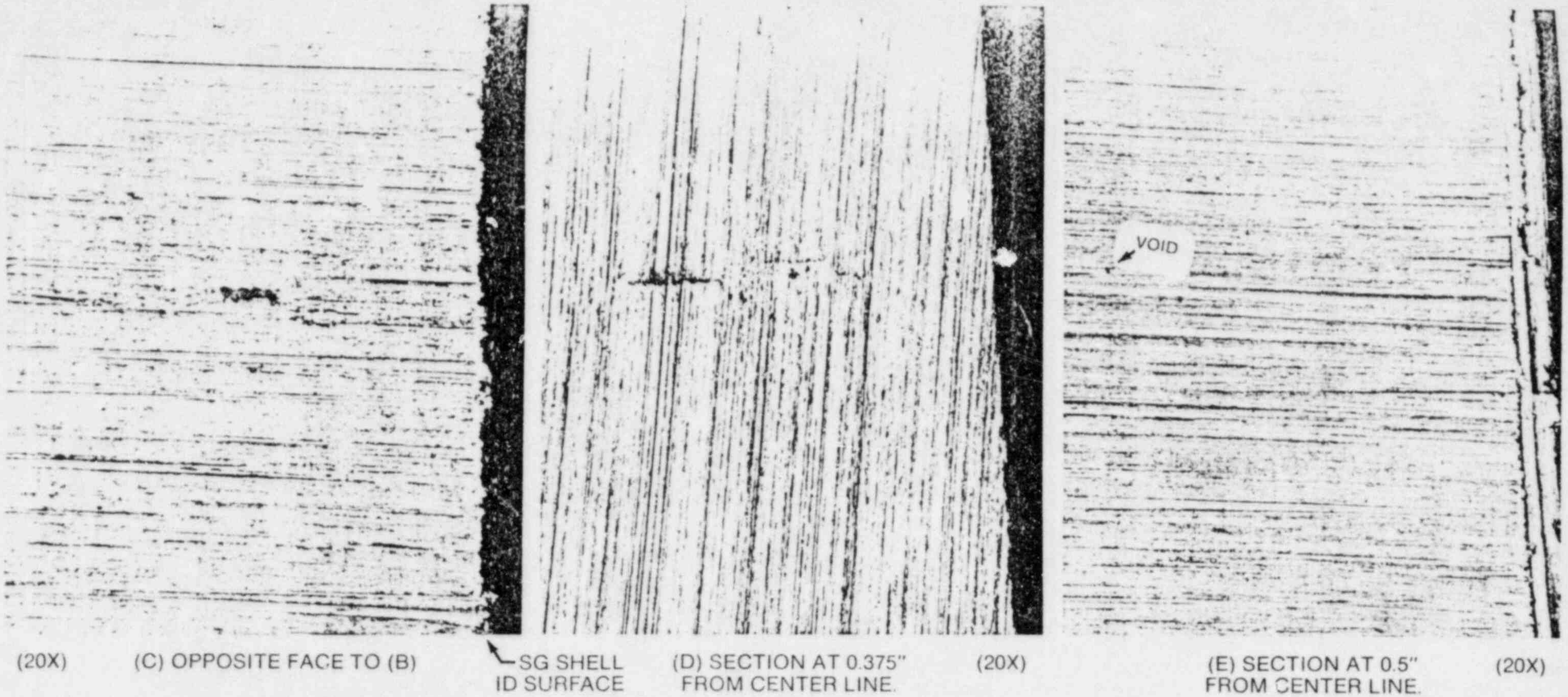


FIGURE 2-7. APPEARANCE OF AS-POLISHED SECTIONS TAKEN AXIAL TO THE PLUG NO. 93 CCW ILLUSTRATING THE MORPHOLOGY OF VOID AT VARIOUS LOCATIONS.

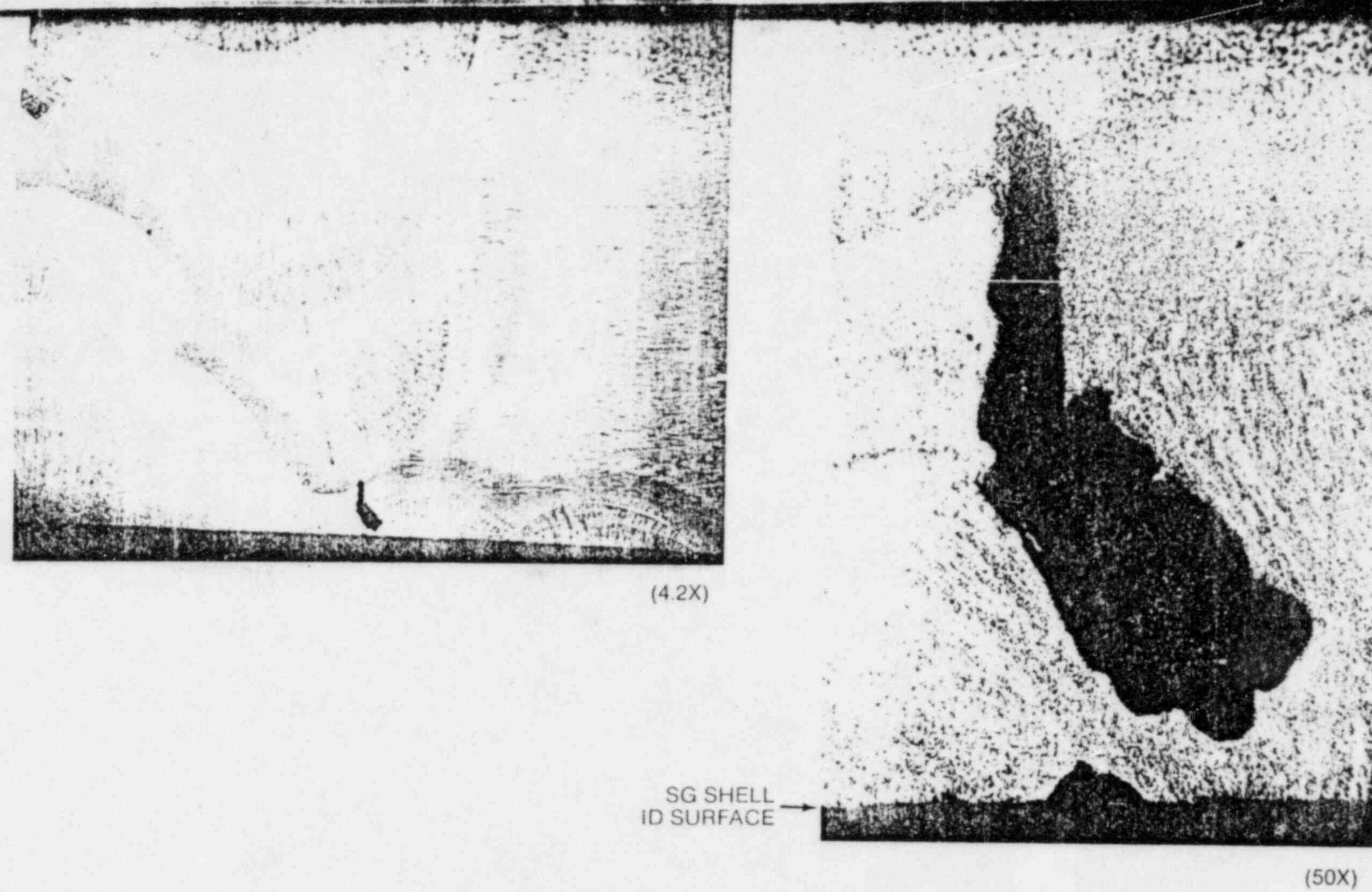
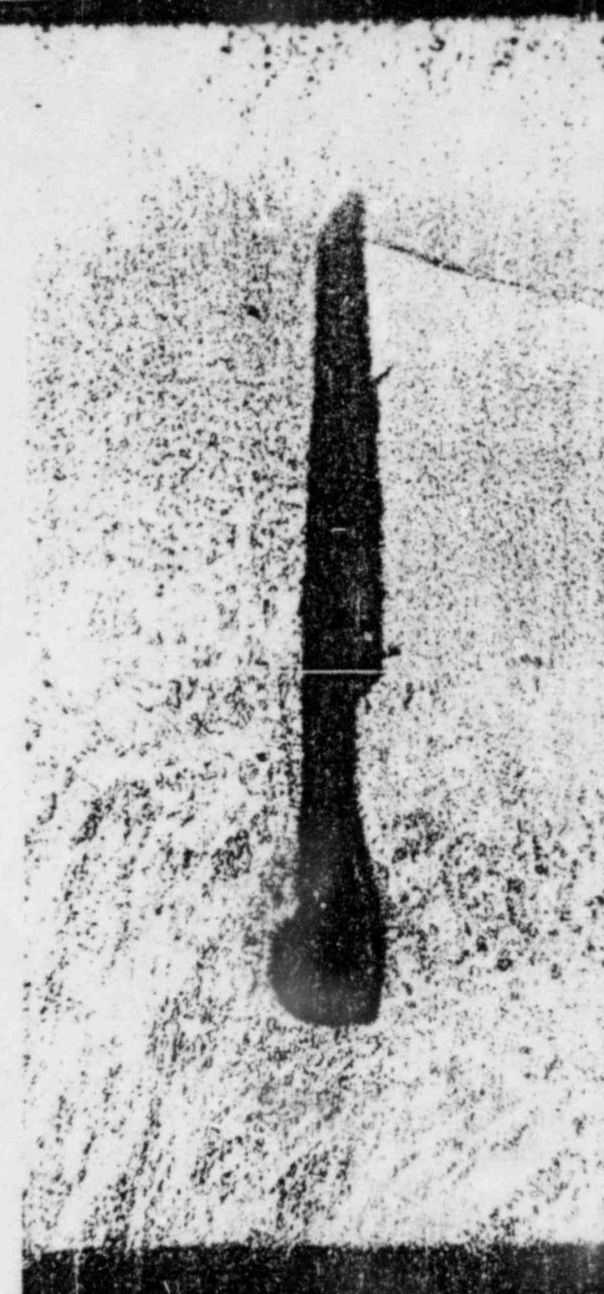


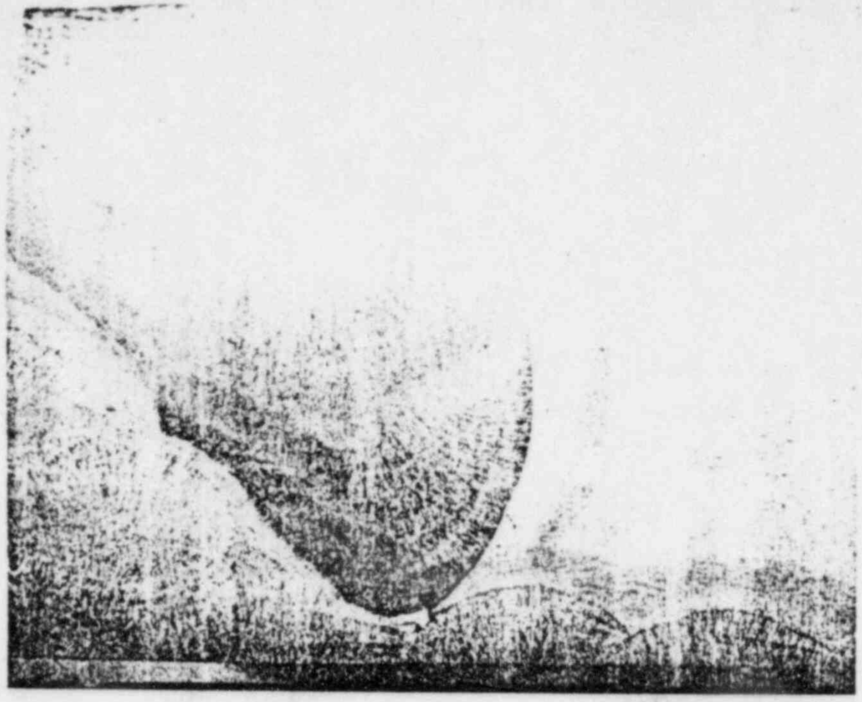
FIGURE 2-8. LIGHT OPTICAL METALLOGRAPHY RESULTS, ILLUSTRATING THE VOID MORPHOLOGY AND ITS RELATION TO THE LOCAL WELD MICROSTRUCTURE. PLUG NO. 93 CCW, SECTION AT THE MID-LENGTH LOCATION OF REPORTED INDICATION.

(4.2X)

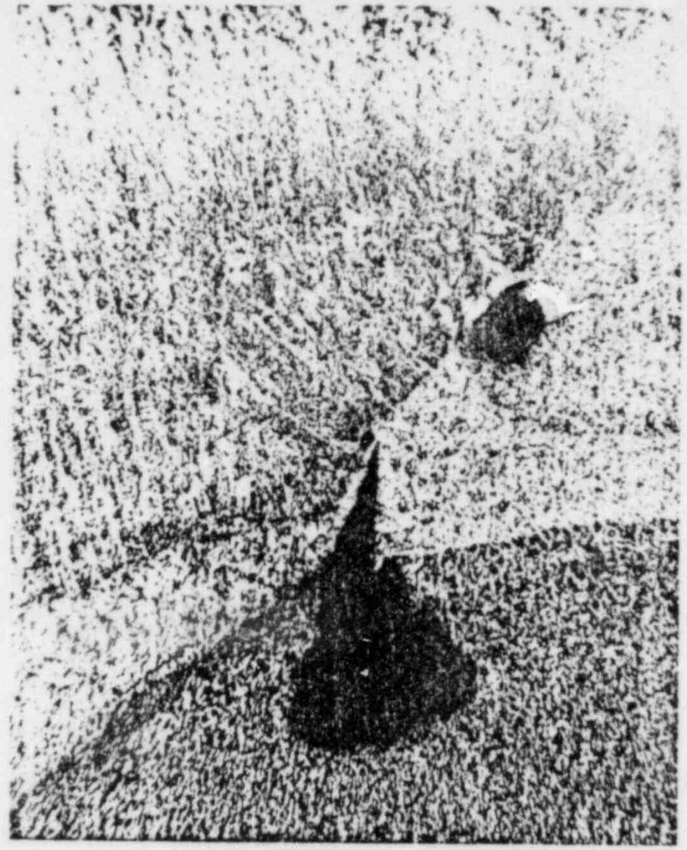


(50X)

FIGURE 2-9. LIGHT OPTICAL METALLOGRAPHY RESULTS ILLUSTRATING THE VOID MORPHOLOGY AND ITS RELATION TO THE LOCAL (WELD) MICROSTRUCTURE. PLUG NO. 93 CCW, SECTION AT 0.25" FROM THE MID-LENGTH OF REPORTED INDICATION.

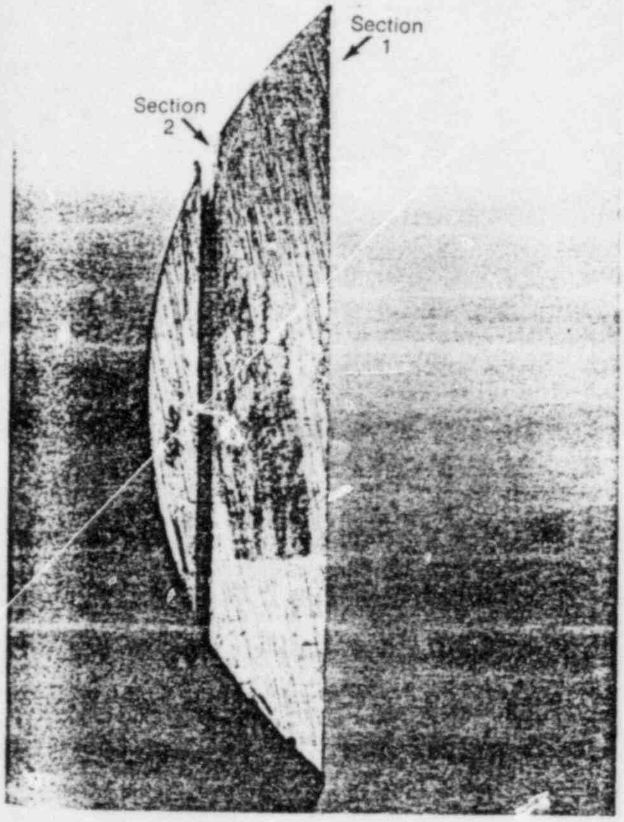


(4.2X)

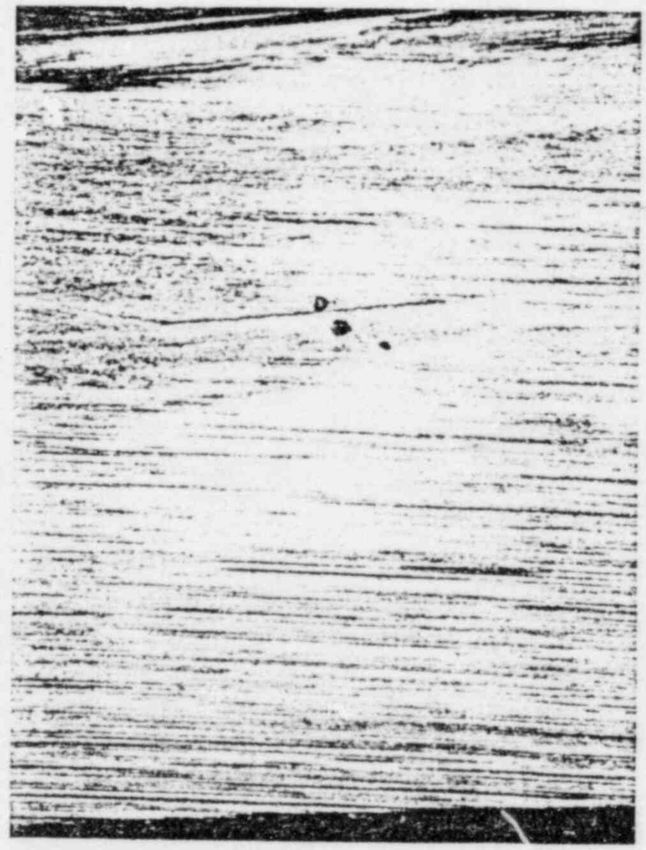


(50X)

FIGURE 2-10. LIGHT OPTICAL METALLOGRAPHY RESULTS, ILLUSTRATING THE MORPHOLOGY OF THE VOID AND ITS RELATION TO THE LOCAL (WELD) MICROSTRUCTURE. PLUG NO. 93 CCW, SECTION AT 0.375" FROM THE MID-LENGTH LOCATION OF REPORTED INDICATION.

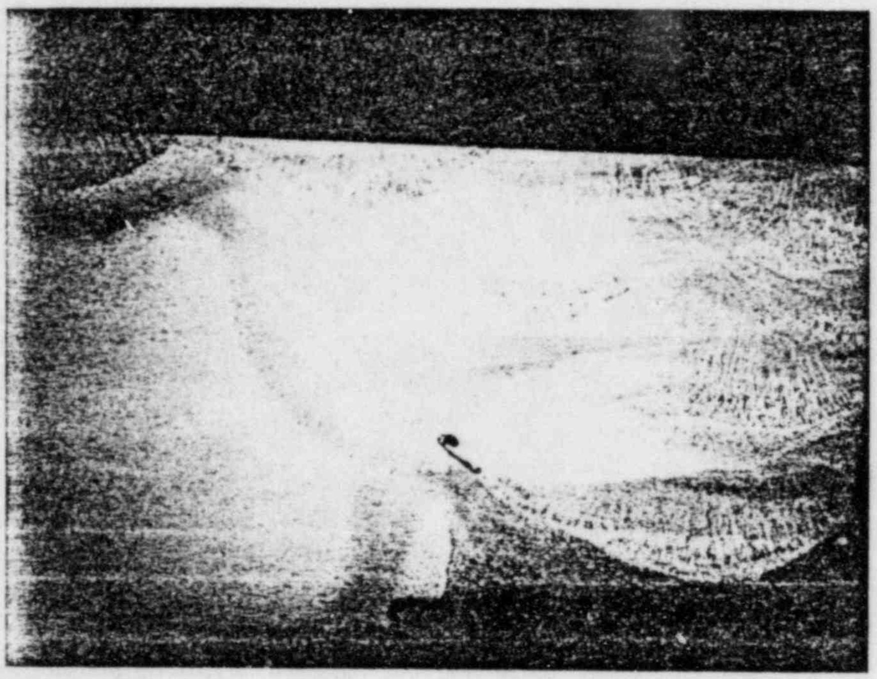


(2.7X)

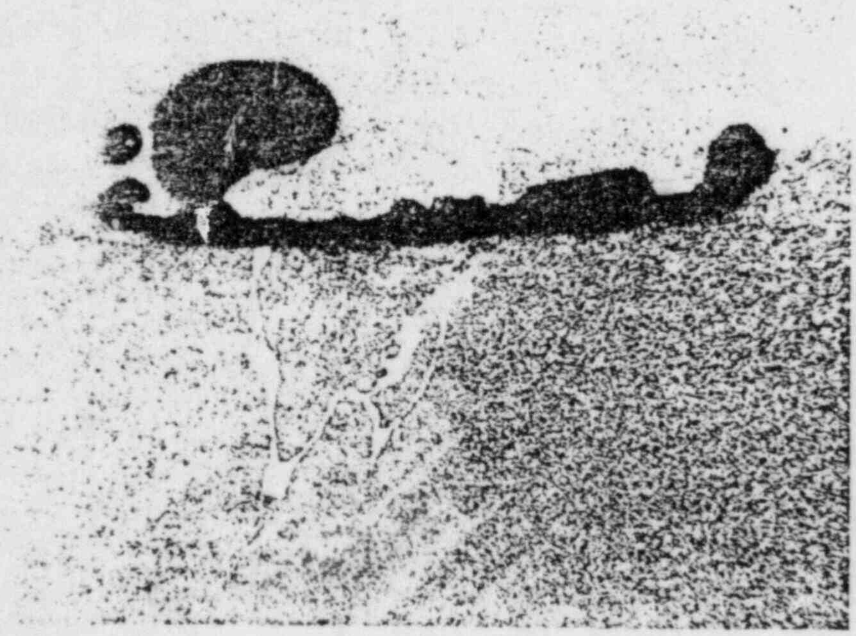


(6.3X)

FIGURE 2-11. APPEARANCE OF THE VOID ON A SECTION TAKEN AT 0.325" FROM THE OD SURFACE ON PLUG NO. 113 CCW.

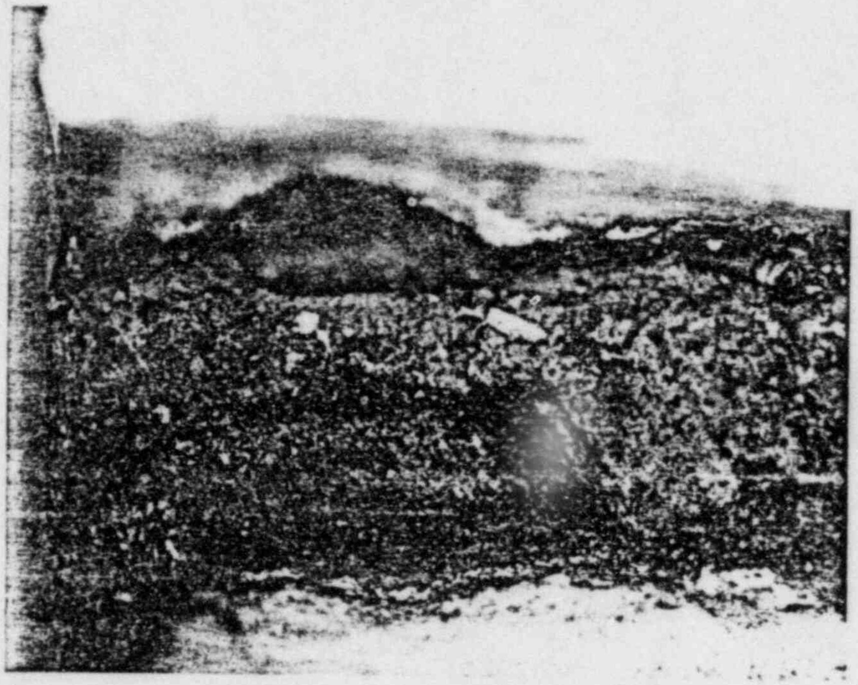


(4X)

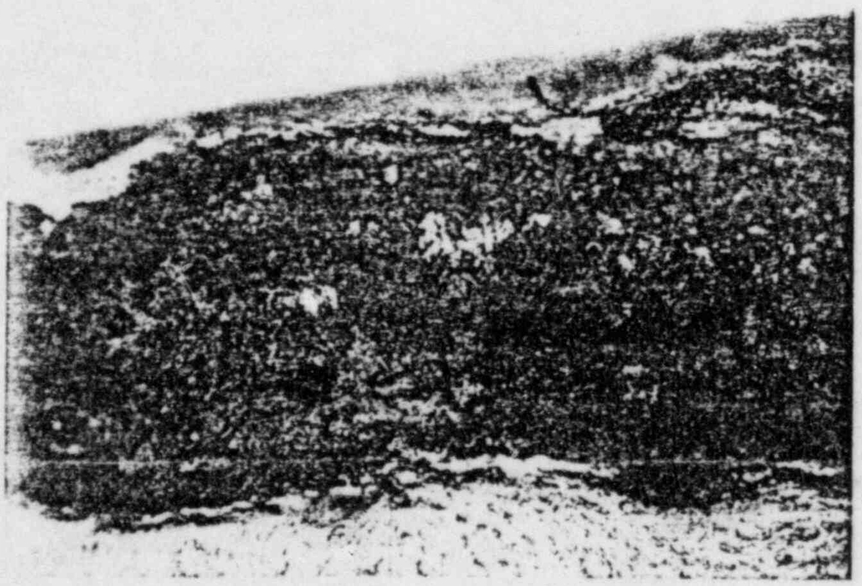


(50X)

FIGURE 2-12. LIGHT OPTICAL METALLOGRAPHY RESULTS ILLUSTRATING THE MORPHOLOGY OF VOID AND SLAG INCLUSION AT THE WELD INTERFACE. (SECTION AT 0.125" FROM OD SURFACE OF PLUG NO. 113 CCW)



(32X)

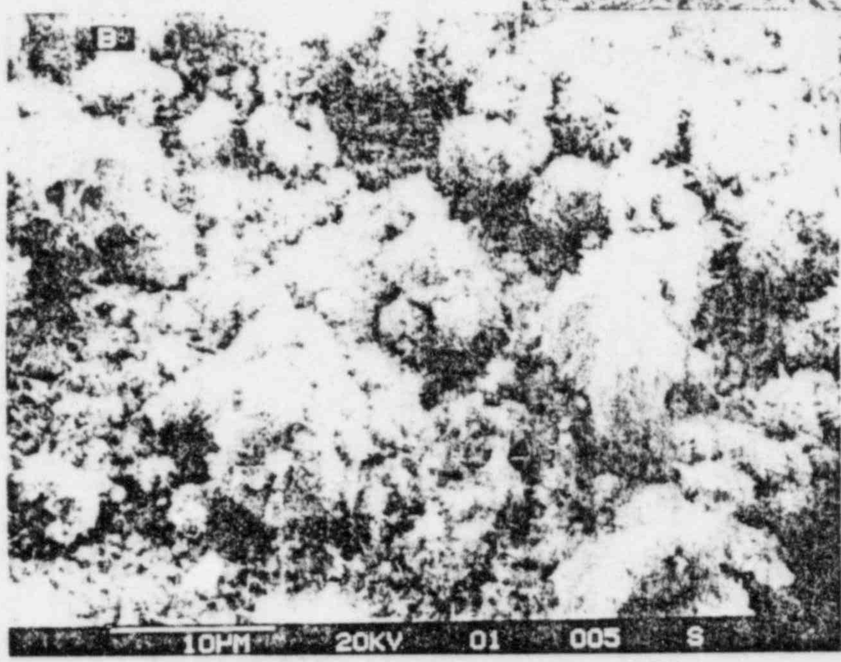


(32X)

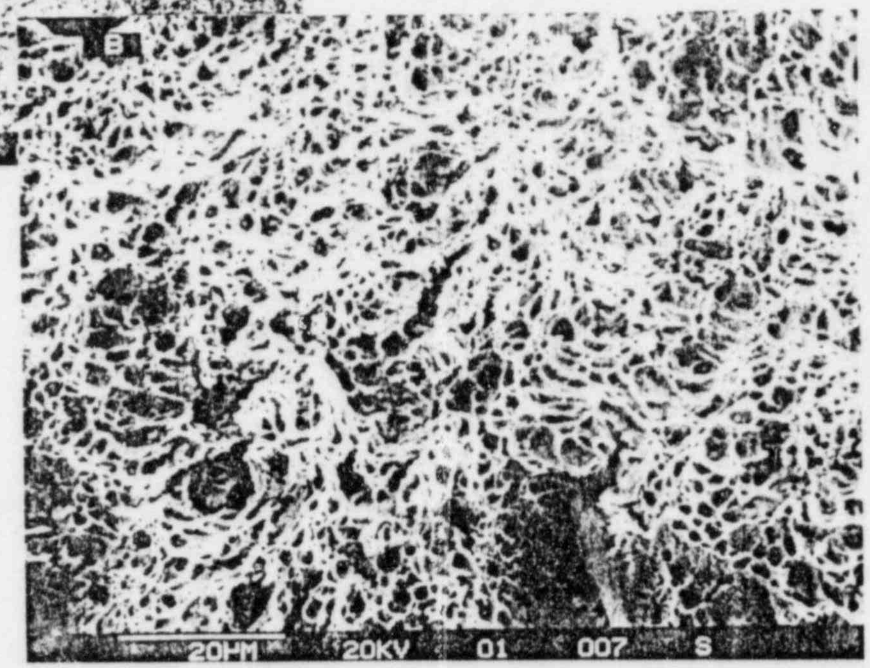
FIGURE 2-13. LIGHT OPTICAL FRACTOGRAPHS OF FRESHLY OPENED INCLUSION VOID IN PLUG NO. 93 CCW SHOWING THE DARK DEPOSITS ON THE VOID ID SURFACE.

FIGURE 2-14. SCANNING ELECTRON FRACTOGRAPH OF FRESHLY OPENED VOID SURFACE FROM SAMPLE 93 CCW.

(a) OVERALL VIEW OF FRACTURE SURFACE



(b) DEPOSITS AT THE INCLUSION SITE.



(c) LABORATORY INDUCED DIMPLED FRACTURE.

FIGURE 2-15. SCANNING ELECTRON FRACTOGRAPHS OF THE FRESHLY OPENED VOID IN PLUG NO. 93 CCW.

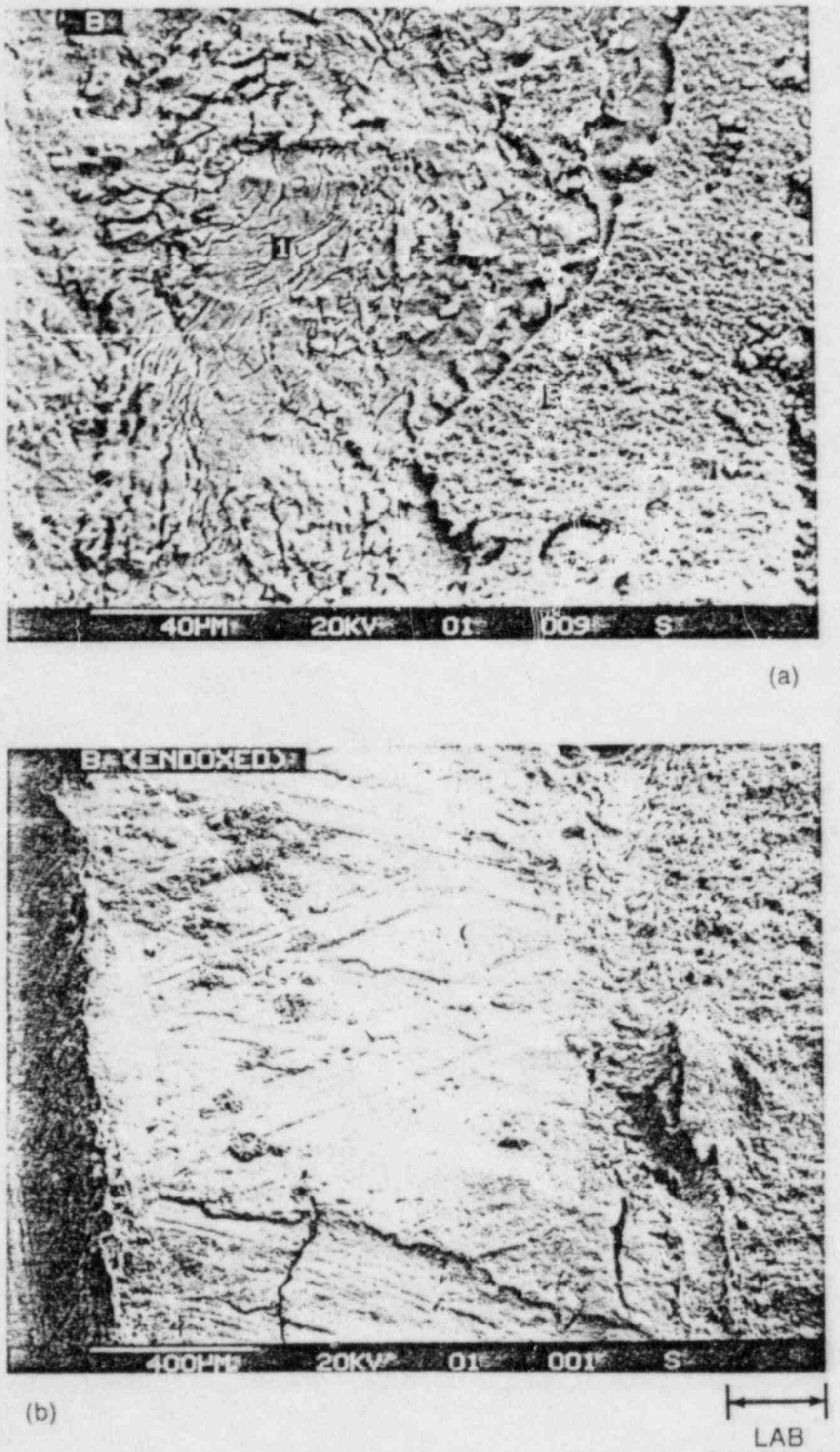


FIGURE 2-16. SCANNING ELECTRON FRACTOGRAPHS OF (a) AS-OPENED, AND (b) ENDOXED FRACTURE FACES. (PLUG NO. 93 CCW)

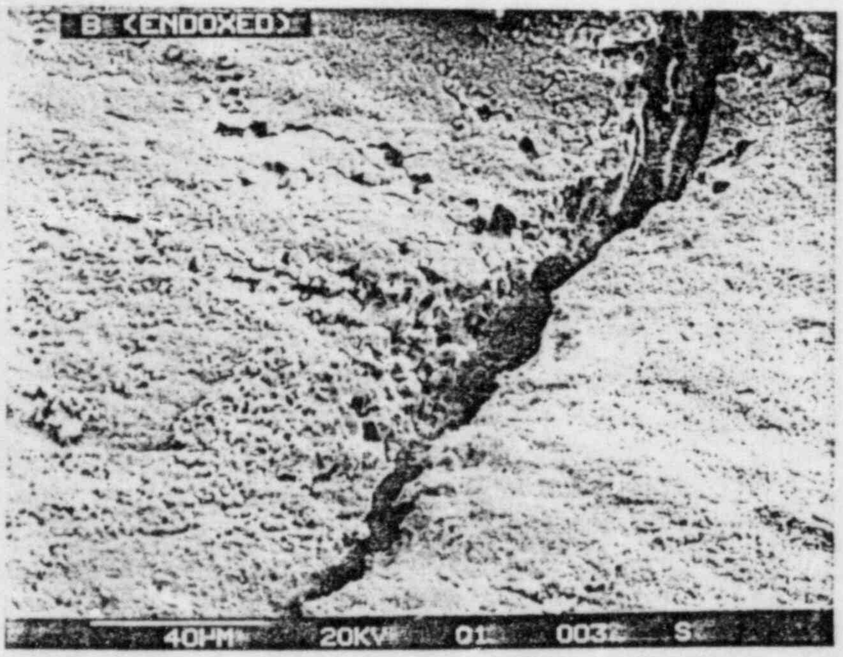
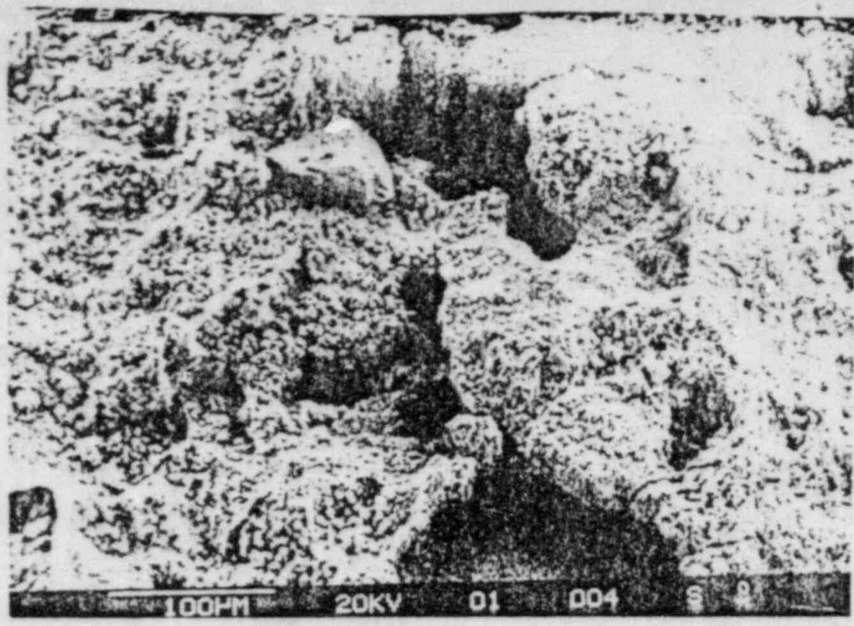
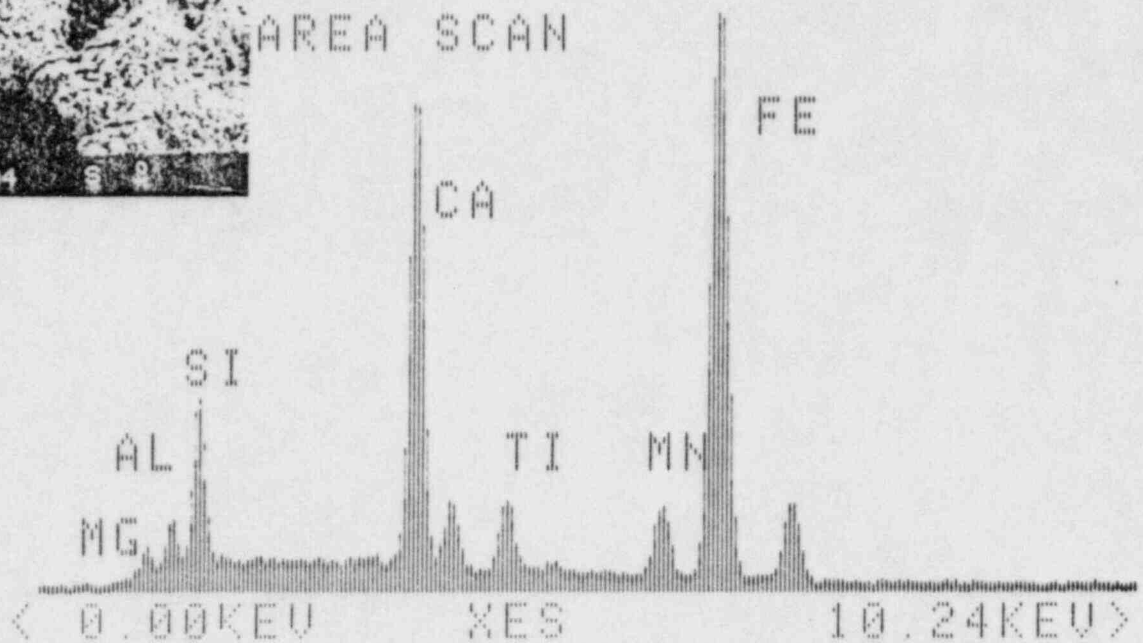


FIGURE 2-17. SCANNING ELECTRON FRACTOGRAPH SHOWING THE CRAZING APPEARANCE AT THE INCLUSION SITE. (ENDOXED, PLUG NO. 93 CCW)



(A)



(B)

FIGURE 2-18. ENERGY DISPERSIVE X-RAY (EDAX) ANALYSIS RESULTS OF THE FRESHLY OPENED VOIDS IN PLUG NO. 93 CCW (AREA SCAN) (A) SCANNING ELECTRON FRACTOGRAPH. (B) EDAX SPECTRUM.

ATTACHMENT IV

ATTACHMENT IV

Byron Steam Generator Fabrication

Byron Unit 2 steam generator shell courses are made from SA 533 Grade A, Class II Mn-Mo type steel plate. The forgings such as the tube sheet, trunnions, manways, etc. are made of SA 508 Class II as modified by Code Case 1528. The longitudinal seams were flame cut to a 7°/5° level and closed in the forming roll on a 3/4 inch square bar that became the backup bar. Shielded Metal Arc Welding (SMAW) was utilized to seal the backup bar in preparation for Sub Arc Welding (SAW) of the longitudinal seams. Upon completion of the SAW, the backup bar was removed by automatic arc air. The I.D. area was then ground, inspected and back-welded using SAW. The circumferential welds were made in the same way except in some cases, the I.D. weld was not accessible for SAW. In these cases SMAW was used to back-fill the weld after back chip. Seam SGC06 is one case where the back weld was manual.

All procedure qualifications were performed with a post weld heat treatment (PWHT) at 1125 ± 25°F for 24 hours which qualifies for 30 hours of total PWHT time. As shown in the attached tables, in general the PWHT time for the majority of these welds has been less than 10 hours and only a few welds have seen times ranging from 10 to 14 hours. An additional 2.5 to 3 hours of PWHT at 1125°F following field repairs will have no affect on the material properties since the procedures were qualified to 30 hours of PWHT time.

Attached is a general arrangement drawing for the Byron Unit 2 steam generators. This drawing provides weld details and lists the material specifications for various parts of the component. These material specifications are also enclosed.

CCGT 2095

Part	Time		Chart Numbers
Chamber	5 hr. 11 min.		2457,3107
Tube Plate	13 hr. 30 min.		2209,2292,2329,2365,2917,3107
Z Girth Seam	3 hr. 04 min.		3107
Stub Barrel	9 hr. 24 min.		2130,2329,2365,2917
Y Girth Seam (SGC02)	8	12	2329,2365,2917
A Barrel	7	57	2238,2365,2917
W Girth Seam (SGC03)	6	48	2365,2917
B Barrel	8	01	2195,2365,2917
C Girth Seam (SGC04)	6	48	2365,2917
Transition Cone	[illegible]	31	2232,3130,2917
G Girth Seam (SGC05	2	52	2917
H Barrel	11	51	2466,2503,2558,3068,3130
CL Girth Seam (SGC06)	2	34	3130
J Barrel	7	55	2459,2558,3068
K Girth Seam (SGC07)	5	29	2558,3068
Elliptical Head	5	29	2558,3068
P Girth Seam (SGC08)	5	29	2558,3068
Steam Outlet Noz.	5	29	2558,3068
T Girth Seam	5	29	2558,3068
Feedwater Nozzle	8	12	2329,2365,2917
Aux. Feedwater Noz.	10	29	2459,2503,2558,3068
AT & BT Trunnions	6	44	2365,2917
CT & DT Trunnions	7	32	2503,2558,3068
S Manway	5	29	2558,3068
SO Manway	5	29	2558,3068

[illegible]GT 2097

Part	Time	Chart Numbers
Chamber	7hr.26min.	2422,2904,3150
TubeuPlate	12 32	2212,2322,2374,2904,3150
Z Girth Seam	6 06	2904,3150
Stub Barrel	9 17	2226,2278,2327,2374,2904
Y Girth Seam (SGC02)	5 49	2374,2904
A Barrel	8 12	2260,2374,2904
N Girth Seam (SGC03)	5 49	2374,2904
B Barrel	8 12	2260,2374,2904
C Girth Seam (SGC04)	8 12	2260,2374,2904
Transition Cone	10 48	2260,2374,2904,3151
G Girth Seam (SGC05)	8 12	2260,2374,2904
H Barrel	11 30	2481,2525,2581,3085,3151
CL Girth Seam (SGC06)	2 36	3151
J Barrel	6 55	2469,2581,3085
K Girth Seam (SGC07)	5 57	2581,3085
Elliptical Head	5 57	2581,3085
P Girth Seam (SGC08)	5 57	2581,3085
Steam Outlet Nozzle	5 57	2581,3085
T Girth Seam	5 57	2581,3085
Feedwater Nozzle	7 02	2327,2374,2904
AT & BT Trunnions	5 49	2374,2904
CT & DT Trunnions	10 26	2525,2581,3085,3151
Aux. Feedwater Noz.	7 57	2524,2581,3085
S Manway	5 57	2581,3085
SO Manway	5 57	2581,3085

CCGT 2096

Part	Time		Chart Numbers
Chamber	4hr. 26min.		2699, 3146
Tube Plate	16	48	2212, 2299, 2333, 2389, 2937, 3146
Z Girth Seam	3	15	3146
Stub Barrel	13	16	2130, 2267, 2333, 2389, 2937
Y Girth Seam (SGC02)	7	06	2333, 2389, 2937
A Barrel	6	56	2249, 2389, 2937
W Girth Seam (SGC03)	5	45	2389, 2937
B Barrel	6	48	2827, 2389, 2937
C Girth Seam (SGC04)	5	45	2389, 2937
Transition Cone	9	38	2247, 2389, 2937, 3147
G Girth Seam (SGC05)	5	45	2389, 2937
H Barrel	11	11	2464, 2524, 2581, 3068, 3147
CL Girth Seam (SGC06)	2	33	3147
J Barrel	8	13	2466, 2581, 3068
K Girth Seam (SGC07)	5	48	2581, 3068
Ellipsical Head	5	48	2581, 3068
P Girth Seam (SGC08)	5	48	2581, 3068
Steam Outlet Noz.	5	48	2581, 3068
T Girth Seam	5	48	2581, 3068
Feedwater Nozzle	12	04	2267, 2333, 2389, 2937
Aux. Feedwater Noz.	10	16	2459, 2524, 2581, 3068
AT & BT Trunnions	3	01	2937
CT & DT Trunnions	9	54	2524, 2581, 3068, 3147
S Manway	5	48	2581, 3068
SO Manway	5	48	2581, 3068

FORM TA00142

S.O.	DFTM.	CHKD.	Q.C.	DSGN.	M.&W.	ENGR.	MFG.	REF. SIM. PARTS	IT.	CHANGE	NUMBER LAST USED

WESTINGHOUSE ELECTRIC CORPORATION TAMPA DIVISION TAMPA, FLA.

TITLE: MATERIAL, SA-508 CLASS 2 (Mn-Mo ALLOY STEEL FORGINGS)

Material: Manganese Molybdenum Steel Forging SA-508 Class 2 as modified by Code Case 1528 and in accordance with ASME Boiler and Pressure Vessel Code, Nuclear Vessels, Section III for Class 1 Vessels.

Note 1: The minimum tempering temperature shall be 1175°F.

Note 2: Supplementary Requirements: S-1 simulated post-weld heat treatment as follows:

All test specimens must meet the necessary specifications after the following heat treatment: Place in furnace at not over 600°F, then heat at 100°F/hr. to 1125°F ± 25°F and hold at this temperature for 24 hrs. Cool at 100°F/hr. to 600°F.

Note 3: The reference temperature, RT_{NDT}, shall be established in accordance with NB-2300, Fracture Toughness Requirements for Material, Section III of the ASME Code. RT_{NDT} shall be + 60°F maximum.

Note 4: Supplier shall submit test specimen location for W Metallurgical approval.

Note 5: Nondestructive Testing:

a. Magnetic particle inspection is required on all surfaces after final heat treatment to Westinghouse P.S. 84350 NM or supplier's specification approved by Westinghouse Tampa Division (see Para. NB-2545 of ASME Code, Section III).

b. Ultrasonic inspection must be in accordance with Westinghouse P.S. 84350 LR or by supplier's specification approved by Westinghouse Tampa Division and must be witnessed by Westinghouse representative. (See Para. NB-2542 of ASME Code, Section III).

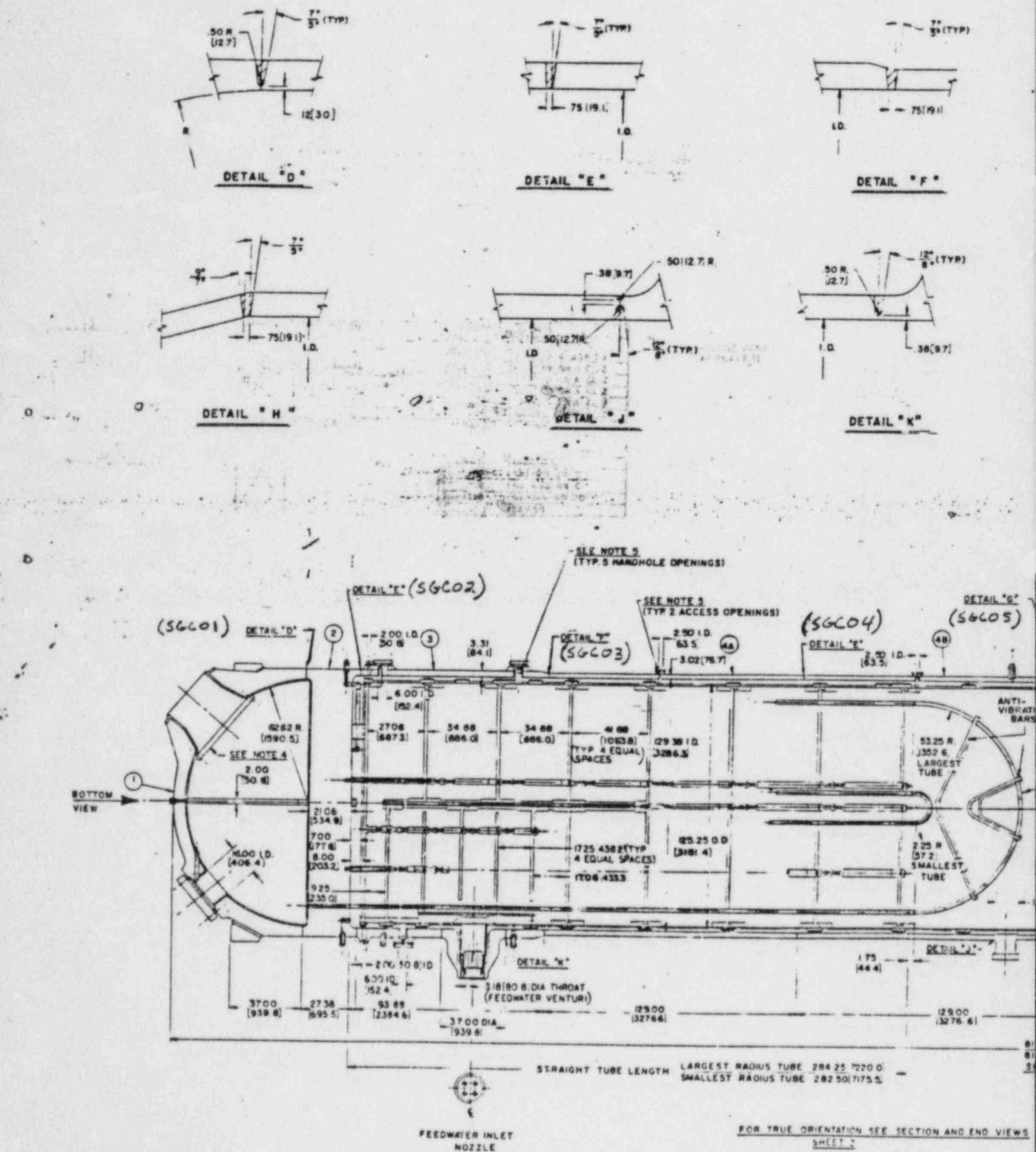
Note 6: Forging defects may be repair welded by the supplier provided the requirements for repair welding in Para. NB-2549 of Section III Nuclear Vessel Code are met and the supplier's repair procedure is approved by Westinghouse Tampa Division.

Note 7: Westinghouse reserves the right to witness the heat treatment of forgings. Mill reports and heat treatment records shall be submitted to Westinghouse prior to shipment of the forgings. Mill reports shall show all chemical and mechanical properties required by the specifications.

Note 8: Do not stamp forging - identification shall be maintained by paint or vibro tool marking.

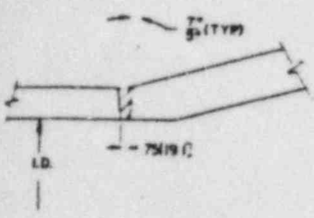
ISSUED

393A708

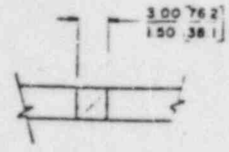

DETAIL "D"
.50 R [12.7]
12[30]
DETAIL "E"
.75 [19.1]
I.D.
DETAIL "F"
.75[19.1]
I.D.
DETAIL "H"
.75[19.1]
I.D.
DETAIL "J"
.38[9.7]
.50[12.7] R.
.50[12.7]R
DETAIL "K"
.50 R. [12.7]
.38[9.7]
I.D.
SEE NOTE 5 (TYP. 5 HANDHOLE OPENINGS)
DETAIL "E" (SGC02)
SEE NOTE 5 (TYP. 2 ACCESS OPENINGS)
(SGC01)
DETAIL "D"
(SGC04)
DETAIL "G"
(SGC05)
DETAIL "F" (SGC03)
DETAIL "E"
2.00 I.D. [50.8]
3.31 [84.1]
2.50 I.D. 63.5
3.02[76.7]
6.00 I.D. [152.4]
62.62 R [1590.5]
SEE NOTE 4
27.06 [687.3]
34.88 [886.0]
34.88 [886.0]
41.88 [1063.8] (TYP. 4 EQUAL SPACES)
129.38 I.D. [3286.3]
53.25 R. [1352.6] LARGEST TUBE
ANTI-VIBRATION BARS
BOTTOM VIEW
2.00 [50.8]
21.06 [534.9]
7.00 [177.8]
8.00 [203.2]
9.25 [235.0]
16.00 I.D. [406.4]
17.25 438.2 (TYP 4 EQUAL SPACES)
125.25 O.D. [3181.4]
2.25 R [57.2] SMALLEST TUBE
DETAIL "K"
DETAIL "J"
1.75 [44.4]
2.00 50.8 I.D.
6.00 I.D. 152.4
3.18 [80.8] DIA THROAT (FEEDWATER VENTURI)
37.00 [939.8]
27.38 [695.5]
93.89 [2384.6]
37.00 DIA. [939.8]
129.00 [3276.6]
129.00 [3276.6]
STRAIGHT TUBE LENGTH LARGEST RADIUS TUBE 284.25 7220.0 SMALLEST RADIUS TUBE 282.50 [7175.5]
FEEDWATER INLET NOZZLE
FOR TRUE ORIENTATION SEE SECTION AND END VIEWS SHEET 2

NOTES

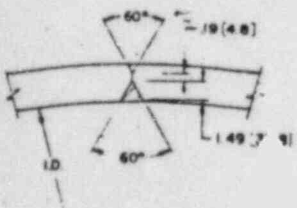
1. THIS DRAWING IS TO BE USED IN CONJUNCTION WITH "OUTLINE" DRAWING 1106 J25.
2. ALL WELD JOINT DIMENSIONS AND ANGLES SHOWN ARE INITIAL WELD JOINT PREP DETAILS AND ARE SUBSEQUENTLY BACK-CHIPPED AND BACK-WELDED FOR FULL PENETRATION WELDS.
3. VESSEL EXTERIOR SURFACE PREPARATION FOR ISI IS TO BE PER PROCESS SPECIFICATION NPT-67.
4. REFER TO TECHNICAL MANUAL FOR CLOSURE RING DETAILS.
5. REFER TO TECHNICAL MANUAL FOR ASSEMBLY AND DISASSEMBLY PROCEDURE OF INTERNAL WRAPPER OPENING CLOSURE ASSEMBLIES, IMMEDIATELY, INSIDE THE SHELL SECONDARY HANDHOLE AND ACCESS OPENINGS. REFER TO OUTLINE DRAWING FOR SHELL OPENING LOCATIONS.



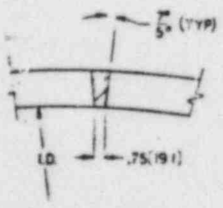
DETAIL "G"



DETAIL "M"
SEE SHT 2 ZONE A,B-1,2



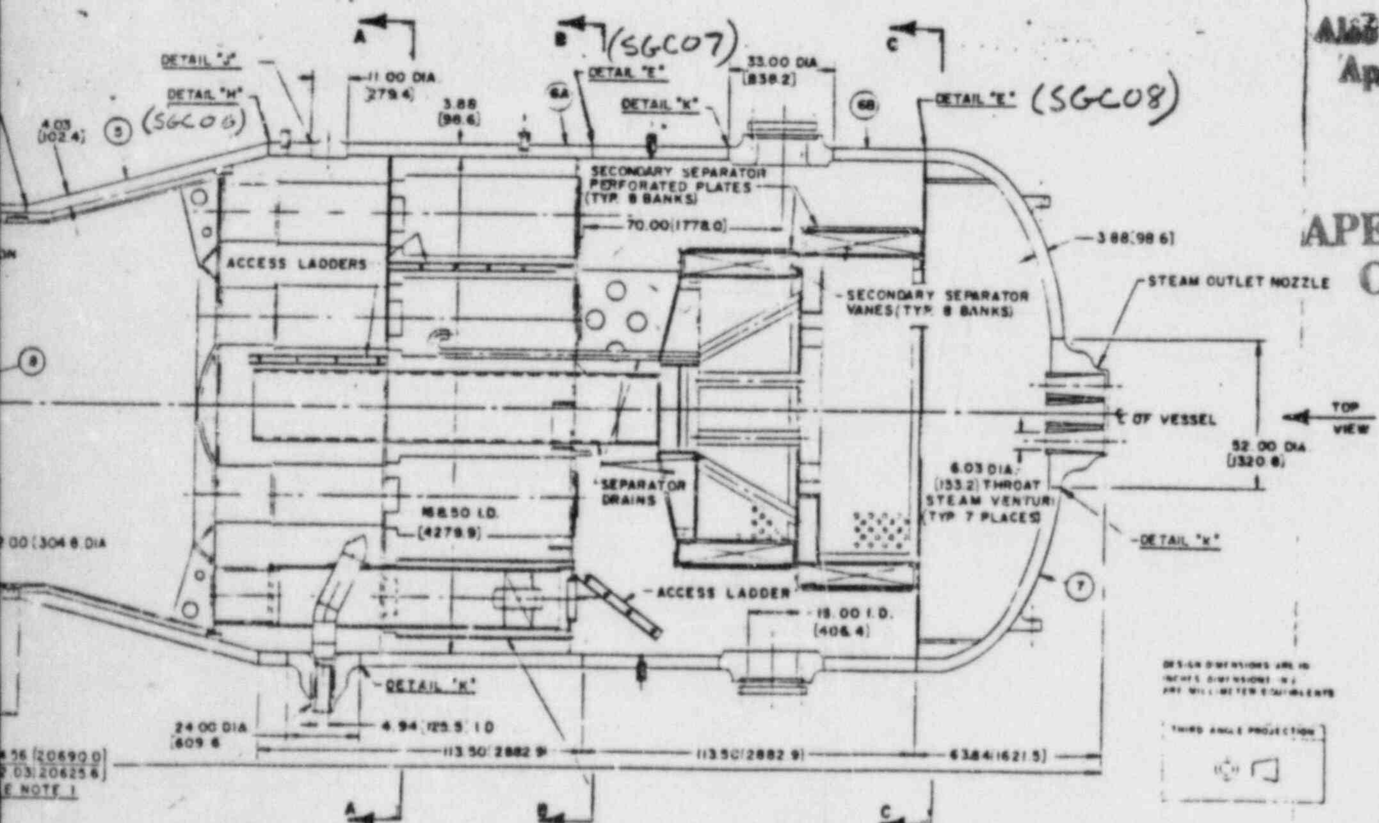
DETAIL "L"
SEE SHT 2 ZONE AB-3



DETAIL "N"
SEE SHT 2 ZONE A,B-1,2,3

ITEM Nº	DESCRIPTION	MATERIAL SPEC'S	
1	CHANNEL HEAD	398A006	SA-216 GR WCC
2	TUBE PLATE	393A708	SA-508 CLASS 2a
3	STUB BARREL	2656A90	SA-533 GR A CL 2
4A & 4B	LOWER SHELL BARRELS	2656A90	SA-533 GR A CL 2
5	TRANSITION CONE	2656A90	SA-533 GR A CL 2
6A & 6B	UPPER SHELL BARRELS	2656A90	SA-533 GR A CL 2
7	UPPER HEAD	2656A90	SA-533 GR A CL 2
8	U-TUBES	2655A65	SB-163
	MISCELLANEOUS INTERNAL NON PRESSURE PARTS	1010AD	ASTM A 285 GR C
		2655A64	SA-240-TYPE-405
		1910BCT	INCONEL
		2655A98	SA-106 GR B
		2656A92	SA-696 GR C
		389A710	SA-516 GR 70
		2655A97	SA-36

ACCESS PANEL (2 PLACES)



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8506050403-01

BRUNING

JUN 15 1973

S.O. 1	DFTM.	CHKD.	Q.C.	DSGN.	M.&W.	ENGR.	MFG.	REF. SIM. PARTS	IT.	CHANGE			NUMBER LAST USED
										9	10		

WESTINGHOUSE ELECTRIC CORPORATION

TAMPA DIVISION TAMPA, FLA.

TITLE: Material, SA-508 Class 2 (Mn-Mo Alloy Steel Forgings)

Material: Manganese Molybdenum Steel Forging SA-508 Class 2 to be in accordance with ASME Boiler and Pressure Vessel Code Section III and as modified by code case 1528 and the following:

Note 1 - The minimum tempering temperature shall be 1175°F.

Note 2 - Supplementary Requirements: S-1 Simulated post-weld heat treatment as follows:

All test specimens must meet the necessary specifications after the following heat treatment: Place in furnace at not over 600°F, then heat at 100°F/hr. to 1125°F ± 25°F and hold at this temperature for 24 hrs. Cool at 100°F/hr. to 600°F.

Note 3 - The reference temperature, RT_{NDT}, shall be established in accordance with NB-2300, Fracture Toughness Requirements for Material, Section III of the ASME Code. RT_{NDT} shall be + 60°F maximum.

Note 4 - Supplier shall submit test specimen location for W Metallurgical approval.

Note 5 - Nondestructive Testing:

a) Magnetic particle inspection is required on all surfaces after final heat treatment to Westinghouse Proc. Spec. 84350 NM or supplier's specification approved by Westinghouse Tampa Division (See Para. NB-2545 of ASME Code Section III).

b) Ultrasonic inspection must be in accordance with Westinghouse Proc. Spec. 84350 LR or by supplier's specification approved by Westinghouse Tampa Division and must be witnessed by Westinghouse representative. (See para. NB-2542 of ASME Code, Sect. III).

Note 6 - Forging defects may be repair welded by the supplier provided the requirements for repair welding in para. NB-2549 of Section III Nuclear Vessel Code are met and the suppliers' repair procedure is approved by Westinghouse Tampa Division.

Note 7 - Westinghouse reserves the right to witness the heat treatment of forgings. Mill reports and heat treatment records shall be submitted to Westinghouse prior to shipment of the forgings. Mill reports shall show all chemical and mechanical properties required by the specifications.

Note 8 - Do not stamp forging - identification shall be maintained by paint or vibro tool marking.

ISSUED

393A708

FOR INFO

FORM TA00142

S.O.	DFTM. T. m. Brow 1/3/	CHKD.	Q.C.	DSGN.	M.&W.	ENGR.	MFG.	REF. SIM. PARTS	IT.	CHANGE CH. 1702 REDRAWN FROM 2656A90 EXTENSIVE CHANGES TAB 4/13/73	A 9

INFORMATION COPY
FOR PLANNING PURPOSES ONLY
NOT FOR SHOP USE

NUMBER LAST USED

WESTINGHOUSE ELECTRIC CORPORATION TAMPA DIVISION TAMPA, FLA.

TITLE: Material, Mn-Mo Stl. Plate - SA-533, Gr. A, Class 2

NOTES:

1. MATERIAL: Manganese Molybdenum Steel Plate; ASME SA-533, Grade A, Class 2. The material shall satisfy all requirements of the ASME Boiler & Pressure Vessel Code, Nuclear Vessels, Section III.

2. The material test coupons (See Para. NB-2200 of Section III) shall be heated and cooled at 100°F an hour with a holding time of twenty-four (24) hours at 1125° ± 25°F and with furnace charge and discharge temperature of 600°F maximum.

3. HEAT TREATMENT: In order to obtain the required properties the plate shall be heated to a temperature which produces an austenitic structure and then quenched in a suitable medium by spray or immersion. The minimum tempering temperature is 1175°F.

4. FRACTURE TOUGHNESS TESTING: The reference temperature, RT_{NDT}, shall be established in accordance with NB-2300, Fracture Toughness Requirements for Materials, Section III of the ASME Code. RT_{NDT} shall be + 60°F maximum.

5. TESTING: All testing shall be conducted on the plate in the flat prior to forming. Any subsequent fabrication operations conducted below 1100°F will not require retesting of the material. If hot forming above 1100°F is utilized in fabrication the mill heat treatment and impact testing as above shall follow this forming.

6. INSPECTION:

   a) WTD reserves the right to witness the heat treatment and inspection of plates or formed parts. The mill reports and heat treatment records shall be submitted to WTD as they become available. The mill test reports shall show all chemical and physical properties required by the specification.

   b) Ultrasonic inspection shall be performed on the plate after final heat treatment in accordance with WTD Specification 84350 LF.

7. SURFACE PREPARATION: Material shall be sand-blasted for inspection before forming. Excessive pits must be repaired by grinding and/or welding but minimum thickness must be maintained. Repair welding must be done in accordance with para. NB-2539 of Sec. III. A repair welding procedure shall be submitted to Westinghouse Tampa Division for approval, prior to its use.

8. Supplementary requirement S2 product analysis covering check analysis shall be required. This check analysis shall conform to the required chemistry of the specification and the results shall be reported on the supplier's test report.

Caution NO STAMPING is permitted on this material.

ISSUED JUN 15 1973

2656A90

CCGT 2098

Part	Time		Chart Numbers
Chamber	4hr.27min.		2479,[illegible]
Tube Plate	[illegible]	07	[illegible],[illegible],2342,2397,2942,2950
Z Girth Seam	[illegible]	20	3140
Stub Barrel	11	01	2226,2297,2342,2397,2942,2950
Y Girth Seam (SGC02)	8	11	2342,2397,2942,2950
A Barrel	10	11	2270,2343,2397,2942,2950
N Girth Seam (SGC03)	6	54	2397,2942,2950
B Barrel	9	19	2268,2343,2397,2942,2950
C Girth Seam (SGC04)	8	15	2343,2397,2942,2950
Transition Cone	13	02	2278,2343,2397,2942,2950,3141
G Girth Seam (SGC05)	8	15	2343,2397,2942,2950
H Barrel	12	19	2478,2525,2686,3085,3142
CL Girth Seam (SGC06)	2	33	3141
J Barrel	7	47	2489,2686,3085
K Girth Seam (SGC07)	5	43	2686,3085
Elliptical Headr	5	43	2686,3085
P Girth Seam (SGC08)	5	43	2686,3085
Steam Outlet Nozzle	5	43	2686,3085
T Girth Seam	5	43	2686,3085
Feedwater Nozzle	8	11	2342,2397,2942,2950
Aux. Feedwater Noz.	7	43	2524,2686,3085
AT & BT Trunnions	8	15	2343,2397,2942,2950
CT & DT Trunnions	10	34	2525,2686,3085,3141
S Manway	5	43	2686,3085
SO Manway	5	43	2686,3085