

D. Ashley - Firebar-D material

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Donnie:

Attached is part 2 of the GE report on Firebar-D.

<<GE Report on corrosion analysis- Part 2.pdf>>

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TABLE 1

DRYWELL STEEL

SPECIFICATION: ASTM: A-212-61T Gr B
FIREBOX FINE GRAIN - NORMALIZED

CHEMISTRY: C - .23
(TYPICAL) Mn - 1.06
P - .010
S - .023
Si - .21

STRENGTH: TENSILE - 75,000 PSI
(TYPICAL) YIELD - 50,000 PSI
ELONG - 35%

NOTE: MATERIAL WAS IMPACT TESTED

TABLE 2. GPUN Sand and Firebar-D Leachate Analysis

Analytical Parameters	Moist					Dry	
	Firebar-D* Leachate 1 Hr, 60° C (ug/g)	Sand Leachate Bay 11 Drain 24 Hrs, Room Temp (ug/g)	Sand Leachate Bay 11 Drain 1 Hr, 90° C (ug/g)	Sand Leachate Plug #1 (19C) 1 Hr, 60° C (ug/g)	Sand Leachate Plug #2 (15A) 1 Hr, 60° C (ug/g)		
Na	777	25	25	37	47		
K	784	25	20	37	23		
Ca	176	30	25	47	< 23		
Mg	1936	30	10	10	< 23		
Al	< 0.3	< 0.5	1.5	39	2.3		
Ni	< 0.3	< 0.5	0.5	< .33	< 2.3		
Fe	< 0.3	5.0	1.0	82	8.4		
Cr	< 0.3	< 0.5	< 0.5	< .33	< 2.3		
Mn	< 0.3	0.5	< 0.5	3.7	< 2.3		
Pb	0.6	1.5	< 0.5	< .33	< 2.3		
NH ₃ (N)	-	-	-	-	-		
Cl	573	10.5	6.5	45	93		
NO ₃	132	2.5	1.5	< 17	6		
SO ₄	2850	< 25	32	28	79		
PO ₄	N.D.	N.D.	N.D.	N.D.	N.D.		
F	14	N.D.	N.D.	N.D.	N.D.		
TOC	1056	39	37	46.6	N.D.		
Organic Acids	< 20	< 5	< 5	-	-		
Total Sulfur	~ 50	-	-	-	-		
B	-	-	-	-	-		
Conductivity	588	-	-	-	-		
pH	8.46	7.43	7.58	7.02	5.99		

Table 3. Test Data Expressed Relative to the Water or Leachate - GE

		Insulation Leachate	Bay #7 Scrapings Leachate	Torus Sand Leachate	Moist Sand Core Sample #3 Leachate	Moist Plug#4 Sand Core Sample Leachate	Dry Area 6 Sand Sample Leachate	Drywell Pipe Leak Water Sample
		WS#6152-86	WS#6153-86	WS#6154-86	WS#6260-86 120	WS#6261-86 19A	WS#6262-86 11A-14	WS#6221-86
Leached Material	(g)	13.647	8.6	260.5	247.6	151.2	339.5	--
Volume of Leachate	(mL)	36	283	548	645	539	87	--
Co-60	(mCi/L)	--	--	--	--	--	--	3.6E-06
Cs-137	(mCi/L)	6.2E-07	7.8E-07	--	1.8E-07	--	1.8E-06	--
Gross Beta	(mCi/L)	<8E-07	9.3E-07	<8E-07	<8E-07	<8E-07	2.4E-06	1.7E-06
Gross Alpha	(mCi/L)	<3E-07	<3E-07	<3E-07	<3E-07	<3E-07	<3E-07	<3E-07
Tritium	(mCi/L)	<4E-06	<4E-06	1.4E-04	<4E-06	6.0E-06	3.5E-06	2.8E-03
pH		8.5	8.9	7.9	7.8	7.1	6.5	8.6
Conductivity	(umhos/cm)	540.	2300.	88.	47.	45.	80.	680.
Alkalinity as CaCO ₃	(mg/L)							
Bicarbonate		170.	110.	44.	23.	24.	9.	260.
Carbonate		8.	18.	<1	<1	<1	<1	21.
Hydroxide		<1	<1	<1	<1	<1	<1	<1
Total		180.	130.	44.	22.	24.	9.0	280.
Total Organic Carbon	(mg/L)	34.	22.	3.0	2.	3.8	12.	19.
Total Sulfur as SO ₄	(mgSO ₄ /L)	80.	880.	7.6	2.4	2.2	16.	56.
Chloride	(mg/L)	23.	240.	2.	0.8	0.5	9.0	20.
Fluoride	(mg/L)	0.5	0.6	0.1	0.1	0.2	0.4	0.2
Nitrogen, Nitrate	(mgN/L)	5.	0.1	0.4	<0.05	<0.05	0.06	6.3
Nitrogen, Nitrite	(mgN/L)	0.66	0.13	<0.04	<0.04	<0.04	<0.04	<0.04
Phosphate, Ortho	(mgP/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	(mgSO ₄ /L)	86.	750.	7.4	1.4	1.0	14.	62.
Potassium	(mg/L)	46.	680.	12.	7.4	4.8	3.	98.
Sodium	(mg/L)	36.	220.	8.3	3.5	2.	1.	110.
Magnesium	(mg/L)	53.	3.	1.7	0.71	1.3	5.7	11.
Iron	(mg/L)	<0.02	<0.03	<0.02	0.14	<0.02	0.27	9.1
Calcium	(mg/L)	5.5	7.8	4.8	1.7	3.5	1.5	6.4
Boron	(mg/L)	0.89	0.93	0.46	0.074	<0.03	0.24	0.92
Strontium	(mg/L)	0.041	0.084	0.13	0.02	0.076	<0.014	0.28
Aluminum	(mg/L)	<0.02	<0.03	<0.02	<0.32	0.16	<0.02	<0.1
Lead	(mg/L)	0.042	0.15	<0.03	<0.03	<0.03	0.1	<0.3
Barium	(mg/L)	0.096	<0.005	0.0037	<0.003	<0.003	0.0042	<0.03
Arsenic	(mg/L)	0.035	0.05	<0.03	<0.03	<0.03	<0.03	<0.3

Table 4. Calculation of Charge Balances - GE
(Ion Concentrations in Milliequivalents per Liter)

	Insulation Leachate	Bay #7 Scrapings Leachate	Torus Sand Leachate	Sand Core Sample #3 Leachate	Plug#4 Sand Core Sample Leachate	Area 6 Sand Sample Leachate	Drywell Pipe Leak Water Sample
	WS#6152-86	WS#6153-86	WS#6154-86	WS#6260-86 17b	WS#6261-86 19A	WS#6262-86 11A-M	WS#6221-86
Bicarbonate	3.4	2.2	0.88	0.46	0.48	0.18	5.2
Carbonate	0.18	0.32					0.42
Chloride	0.63	6.8	0.056	0.023	0.014	0.25	0.56
Fluoride	0.028	0.032	0.0053	0.0053	0.011	0.021	0.011
Nitrate	0.36	0.007	0.029			0.0043	0.45
Nitrite	0.047	0.009					
Sulfate	2.0	16	0.15	0.029	0.021	0.29	1.3
Boron as borate	0.082	0.086	0.043	0.0068		0.022	0.085
Arsenic as arsenate	0.0014	0.0020					
Sum of Anions (me/L)	6.7	25	1.2	0.52	0.53	0.77	8.0
Potassium as K+	1.2	17	0.31	0.19	0.12	0.077	2.5
Sodium as Na+	1.6	9.6	0.36	0.15	0.087	0.043	4.8
Magnesium as Mg++	4.4	0.25	0.14	0.038	0.11	0.47	0.80
Iron as Fe++				0.005		0.0087	0.33
Calcium as Ca++	0.27	0.39	0.24	0.085	0.17	0.075	0.32
Strontium as Sr++	0.0009	0.0021	0.003	0.0005	0.0017		0.0064
Aluminum as Al+++					0.018		
Lead as Pb++	0.0004	0.0014				0.001	
Barium as Ba++	0.0014		0.0001			0.0001	
Sum of Cations (me/L)	7.5	27	1.1	0.49	0.51	0.68	8.9

Table 5. Test Data Expressed Relative to the Sample Weight-GE

	Insulation	Bay #7 Scrapings	Torus Sand	Sand Core Sample #3 17-D	Plug#4 Sand Core Sample 17A	Area 6 Sand Sample 11A-4
	WS#6152-86	WS#6153-86	WS#6154-86	WS#6260-86	WS#6261-86	WS#6262-86
Moisture Content	Dry	Dry	12.6%	1.1%	2.6%	Dry
LEACHABLE CHARACTERISTICS:						
Alkalinity as CaCO ₃ (mg/g)						
Bicarbonate	4.5	4.9	0.093	0.06	0.086	0.026
Carbonate	0.21	0.71	<0.002	<0.003	<0.004	<0.003
Hydroxide	<0.03	<0.05	<0.002	<0.003	<0.004	<0.003
Total	4.7	5.6	0.093	0.057	0.086	0.026
Total Organic Carbon (mg/g)	0.8	0.98	0.0063	0.0052	0.014	0.034
Total Sulfur as SO ₄ (mgSO ₄ /g)	2.1	39.	0.016	0.0063	0.0078	0.046
Chloride (mg/g)	0.61	11.	0.0042	0.0021	0.0018	0.026
Fluoride (mg/g)	0.013	0.027	0.00021	0.00026	0.00071	0.0011
Nitrogen, Nitrate (mgN/g)	0.13	0.0044	0.00084	<0.0002	<0.0002	0.00017
Nitrogen, Nitrite (mgN/g)	0.017	0.0058	<0.0001	<0.0001	<0.0002	<0.0001
Phosphate, Ortho (mgP/g)	<0.003	<0.005	<0.002	<0.0003	<0.0004	<0.0003
Sulfate (mgSO ₄ /g)	2.5	33.	0.016	0.0036	0.0036	0.04
Potassium (mg/g)	1.2	30.	0.025	0.018	0.017	0.0086
Sodium (mg/g)	0.85	9.8	0.017	0.0091	0.0071	0.0029
Magnesium (mg/g)	1.4	0.13	0.0036	0.0016	0.0046	0.016
Iron (mg/g)	<0.0006	<0.002	<0.00004	0.00036	<0.00007	0.00077
Calcium (mg/g)	0.14	0.35	0.01	0.0044	0.012	0.0043
Boron (mg/g)	0.023	0.041	0.00097	0.00019	<0.00011	0.00069
Strontium (mg/g)	0.0011	0.0042	0.00027	0.00005	0.00027	<0.00004
Aluminum (mg/g)	<0.0006	<0.002	<0.00004	<0.0009	0.00057	<0.00006
Lead (mg/g)	0.0011	0.0067	<0.00006	<0.00008	<0.00011	0.00029
Barium (mg/g)	0.0025	<0.00022	0.00001	<0.00001	<0.00001	0.00001
Arsenic (mg/g)	0.00092	0.0022	<0.00006	<0.00008	<0.00011	<0.0009

Table 6. DRYWELL BAY 11 DRAIN WATER (GPUN)

	BAY 11 DRAIN WATER 12/1/86 (ppm)	BAY 11 DRAIN WATER 12/6/86 (ppm)
Sodium	145	96
Potassium	142	85
Calcium	7.5	6.4
Magnesium	30	11
Aluminum	0.33	0.02
Nickel	< 0.01	< 0.02
Iron	< 0.01	0.74
Chromium	< 0.01	< 0.02
Manganese	< 0.01	0.02
Lead	0.06	< 0.02
NH ₃ (N)	3.6	---
Chloride	32.5	25
Nitrate	8.7	6
Sulfate	153	60
Phosphate	5	ND
Fluoride	< 1	---
TOC	51	23.3
Organic Acid	< 0.1	---
Total Sulfur as SO ₄ ⁼	153	---
Conductivity (uS/cm)	1100	814
pH	8.90	8.70
* Alkalinity	---	260

* All Alkalinity Present As HCO₃⁻

Table 7. OYSTER CREEK DEPOSIT SAMPLES (1) (GPUN)

144036	Deposit - Scrapings from Bay No. 7 between torus and drywell (Oyster Creek No. WS-6153-86)
144037	Deposit - Scrapings from in back of No. 11 expansion joint found in Bay No. 11 between torus and drywell (O. C. No. WS-6280-86)
144038	Deposit - Scrapings from under downcomer found in bay No. 11 between torus and drywell (Oyster Creek No. WS-6281-86)

	<u>144036</u>	<u>144037</u>	<u>144038</u>
Aluminum (Al_2O_3)	0.09%	0.23%	0.38%
Boron (B_2O_3)	0.35	0.35	0.32
Calcium (CaO)	0.21	2.07	1.39
Chromium (Cr_2O_3)	0.006	0.004	0.045
Copper (CuO)	0.013	0.038	0.088
Iron (Fe_2O_3)	78.51	69.93	65.35
Lead (PbO)	0.55	0.51	8.72
Magnesium (MgO)	0.27	2.12	4.78
Manganese (MnO)	0.33	0.25	0.48
Nickel (NiO)	0.013	0.025	0.044
Potassium (K_2O)	1.58	0.12	0.16
Sodium (Na_2O)	<u>1.15</u>	<u>0.11</u>	<u>0.19</u>
Total Yields	83.07%	75.76%	81.96%

* The remainder of the deposit was verified by EDAX to be silicon which is not soluble in hydrochloric acid. The chloride detected by EDAX is due to solvent.

(1) Samples taken between 12/1/86 and 12/6/86.

Table 8. EDAX Elemental Analysis of "Deposit" from Bay 7 - GE

<u>Element</u>	<u>Detected Range (Wt.%)</u>	<u>Average (Wt.%)</u>
Na	0.00 - 2.09	0.61
Si	0.00 - 0.66	0.15
S	0.00 - 11.65	4.15
Cl	0.40 - 6.74	2.11
K	0.76 - 21.24	8.00
Ca	0.00 - 1.30	0.20
Mn	0.00 - 0.93	0.25
Fe	41.37 - 96.82	73.49
Br	0.00 - 4.38	0.72
Pb	0.00 - 34.39	10.27

Table 9. UT Characterization of Damage by Bay Number

<u>Bay No.</u>	<u>UT Characterization</u>
1	Minor damage
3	Minor damage
5	Pitting/inclusion
7	Minor damage
9	Pitting/inclusions
11	Wastage
13	Wastage
15	Pitting/inclusions
17	Wastage
19	Wastage

Table 10. Core Sample Locations

<u>Sample No.</u>	<u>Bay/ Location</u>	<u>Type</u>	<u>Elevation</u>	<u>Samples Obtained</u>	<u>Organization</u>
1	19C	Wastage	11'-3 5/8"	Core, sand, bacteriological*	GPUN
2	15A	Pit/Incl	11'-5 1/4"	Core, sand, • bacteriological	GPUN
3	17D	Wastage	11'-3 3/4"	Core, sand	GE
4	19A	Wastage	11'-3 3/8"	Core, sand bacteriological	GE
5	11A	Wastage	11'-3"	Core, sand	GPUN-Archive
6	11A-H	Minor damage	12'-2 3/4"	Core, sand bacteriological	GE
7	19A	Minor damage	12'-1"	Core, sand	GPUN-Archive

*Bacteriological analysis performed at York College

TABLE 11. ENERGY DISPERSION ANALYSES
FROM THE SURFACE OF THE
PLUG SAMPLES (GPUN)

<u>SAMPLE</u>	ELEMENTAL COMPOSITION •		
	<u>MAJOR</u>	<u>MINOR</u>	<u>TRACE</u>
15A	Fe	Pb	Al, Si, Ca, Mn
19C	Fe	Cl	Al, Si, Mn

• MAJOR > 10 wt. %

MINOR > 1 wt. %

TRACE < 1 wt. %

ELEMENTS BELOW ATOMIC NUMBER OF 11
ARE NOT DETECTABLE.

TABLE 12. ENERGY DISPERSION ANALYSIS
OF THE SAND SAMPLE FROM THE
15A SAMPLE LOCATION (GPUN)

ELEMENTAL COMPOSITION •

MAJOR	Si
MINOR	Al, Fe
TRACE	Cl, K, Pb, Ti

• MAJOR	> 10 wt. %
MINOR	> 1 wt. %
TRACE	< 1 wt. %

TABLE 13. ENERGY DISPERSION ANALYSIS
OF THE FLAKE DEPOSIT FROM
THE 19C PLUG SAMPLE (GPUN)

ELEMENTAL COMPOSITION •

MAJOR	Fe
MINOR	--
TRACE	Si, Cl

pH DETERMINED
BY LITMUS PAPER

4

• MAJOR	> 10 wt. %
MINOR	> 1 wt. %
TRACE	< 1 wt. %

Table 14. Oyster Creek Core Plug Corrosion Surfaces - GE

Element Conc. Range	Core Plug 17D	Core Plug 19A	Core Plug 11A-H
Al	---	---	0.00-0.04
Si	---	---	1.42-2.45
S	0.17-0.20	---	9.83-11.31
Cl	3.71-4.92	0.34-1.25	4.39-5.37
K	---	---	0.00-0.16
Ca	---	0.00-0.03	0.14-0.68
Mn	1.36-1.93	1.87-2.48	0.00-0.11
Fe	92.73-94.60	96.07-97.45	21.72-28.87
Pb	---	---	52.61-59.77
Br	0.00-0.35	0.00-0.16	1.17-1.37
Cu	---	---	---
Ti	0.04-0.07	0.03-0.07	---
Cr	0.08-0.09	0.06-0.10	---

Table 15. Oyster Creek Core Plug Cross-Section Analysis - GE

Element	Typical Concentration (Wt.%)		
	Plug 17D*	Plug 19A	Plug 11A-H
Al	---	---	---
Si	0.08	---	0.30
S	0.23	---	16.40
Cl	3.45	0.14	2.57
K	0.02	---	---
Ca	0.02	---	---
Mn	1.63	1.24	0.01
Fe	94.40	98.37	0.66
Pb	---	---	79.56
Br	0.08	---	0.16
Cu	---	---	0.27
Ti	0.04	0.07	0.05
Cr	0.09	0.18	0.02

*Average of (2) values

Table 16. Oyster Creek Plug Crust Samples (Wt.%) - GE

Elemental Conc. Range	Plug 17D	Plug 19A
Al	---	0.00-1.03
Si	0.00-0.63	3.81-30.34
S	---	0.07-1.72
Cl	0.02-0.38	0.33-1.93
K	0.00-0.09	0.00-0.65
Ca	0.00-0.11	0.00-0.66
Mn	1.54-10.92	0.00-1.50
Fe	88.32-98.26	64.69-93.36
Pb	---	---
Br	---	---
Cu	0.00-0.23	0.00-0.52
Ti	---	0.00-2.98

Table 17. Elements Present in Seawater⁹

Anions, ppm		Cations, ppm	
Cl	18980	Na	10561
SO ₄	2652	Mg	1272
Br	65	Ca	400
F	1.4	K	380
I	0.05	Sr	13
Inorg. C	28	SiO ₂	0.01-7.0
Org. C	1.2-3.0	B	4.6
N(NO ₃)	0.001-0.7	H ₃ BO ₃	26
N(NO ₂)	0.001-0.05	Si	0.02-4.0
N(NH ₃)	0.005-0.05	Al	0.6-1.9
Org. N	0.03-0.2	Rb	0.2
P(PO ₄)	0.001-0.10	Li	0.1
Org. P	0-0.016	Ba	0.05
		As	0.003-0.024
		Fe	0.002-0.02
		Zn	0.005-0.014
		Cu	0.001-0.09

Table 18. Summary of Core Plug Thickness Measurements

<u>Sample</u>	<u>Pre-Removal Average Thickness, in</u>	<u>Post-Removal Average Thickness, in</u>	<u>Comments</u>
19C	0.815	0.825	Wastage, thick corrosion product
15A	(0.490 min) 1.17	1.17	Inclusions, superficial corrosion
17D	0.840	0.860	Wastage, thick corrosion product
19A	0.830	0.847	Wastage, thick corrosion product
11A	0.860	0.885	Wastage - Archive specimen
11A-H	1.17	1.19 center	Above wastage, no significant corrosion
19A	1.14	1.18 center	Above wastage, no significant corrosion

TABLE 19. CORROSION RATES OF CARBON STEEL UNDER
STATIC-AIR SATURATED CONDITIONS¹²⁻¹⁵

WATER TYPE	TEMP °C (°F)	PH	EXPOSURE PERIOD, DAYS	CORROSION RATE, MPY	REF
DISTILLED + NAOH/HCL	40(104)	4.5-8	-	23.8	UHLIG/ WHITMAN
	22(72)	4.1-9.5	-	16.6	UHLIG/ WHITMAN
PARTIAL DEMIN (0.1/3.6 μ S/cm)	52(125)	-	62	2.1	BRUSH
		-	145	5.6	BRUSH
NA	40(104)	-	-	12	SPELLER
	60(140)	-	-	14	SPELLER
DISTILLED	25(77)	5.4-6.5	100	1.4	MERCER
	40(104)	5.4-7.0	100	2.9	MERCER
	60(140)	5.4-8.0	100	6.6	MERCER
TAP	40(104)	7.2-7.7	90	53.5	KHOMITCH
	50(122)	7.2-7.7	90	54.0	KHOMITCH
	60(140)	7.2-7.7	90	61.7	KHOMITCH
CONDENSATE	25(77)	-	35	8	BREDEN
FEEDWATER	45(113)	-	-	20	NOE
CONDENSATE	45(113)	7.5-11	365-1095	20	WAGNER
CONDENSATE	45(113)	>6	-	15	OBRECHT
SEAWATER	25(77)	~7	-	3.5	HUDSON
SEAWATER	50(122)	~7	-	>50	NACE
SOIL MIX	15(59)	~7	1456	~18	UHLIG

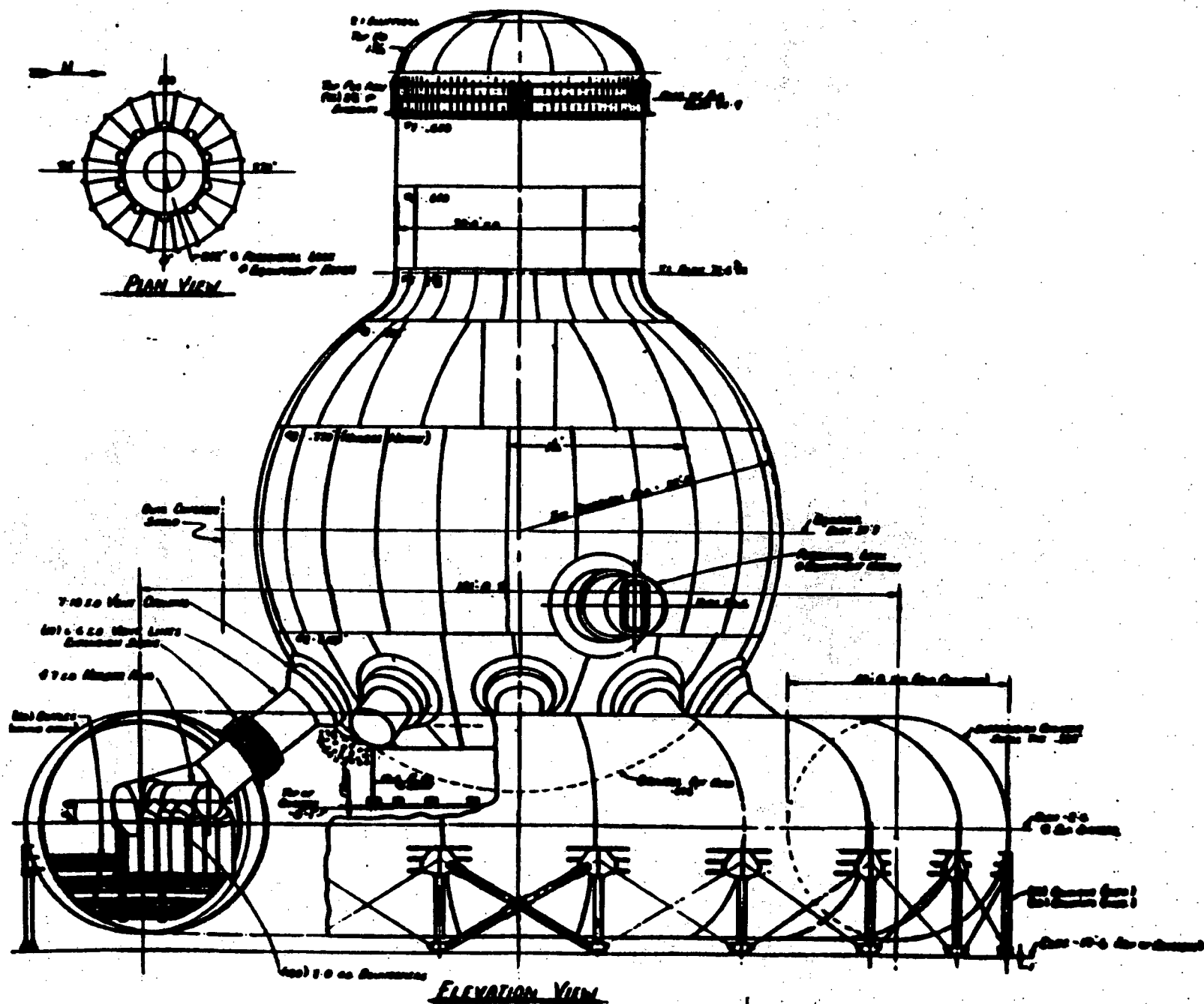
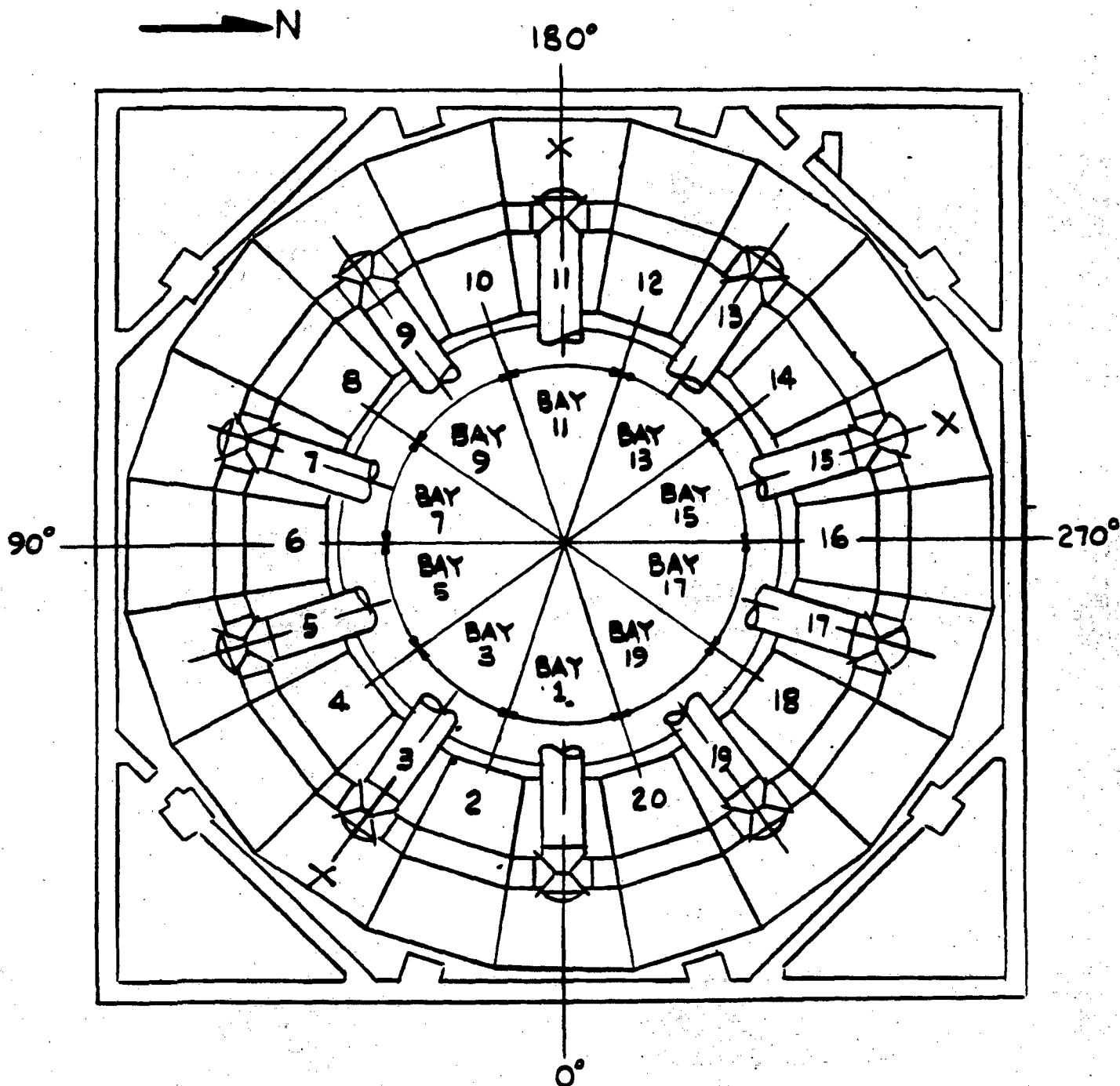


Figure 1. Oyster Creek Mark I Containment



PLAN VIEW
TORUS & DRYWELL

Figure 2. Location of Bays in Oyster Creek Torus and Drywell.
X= Sites of water on Torus floor.

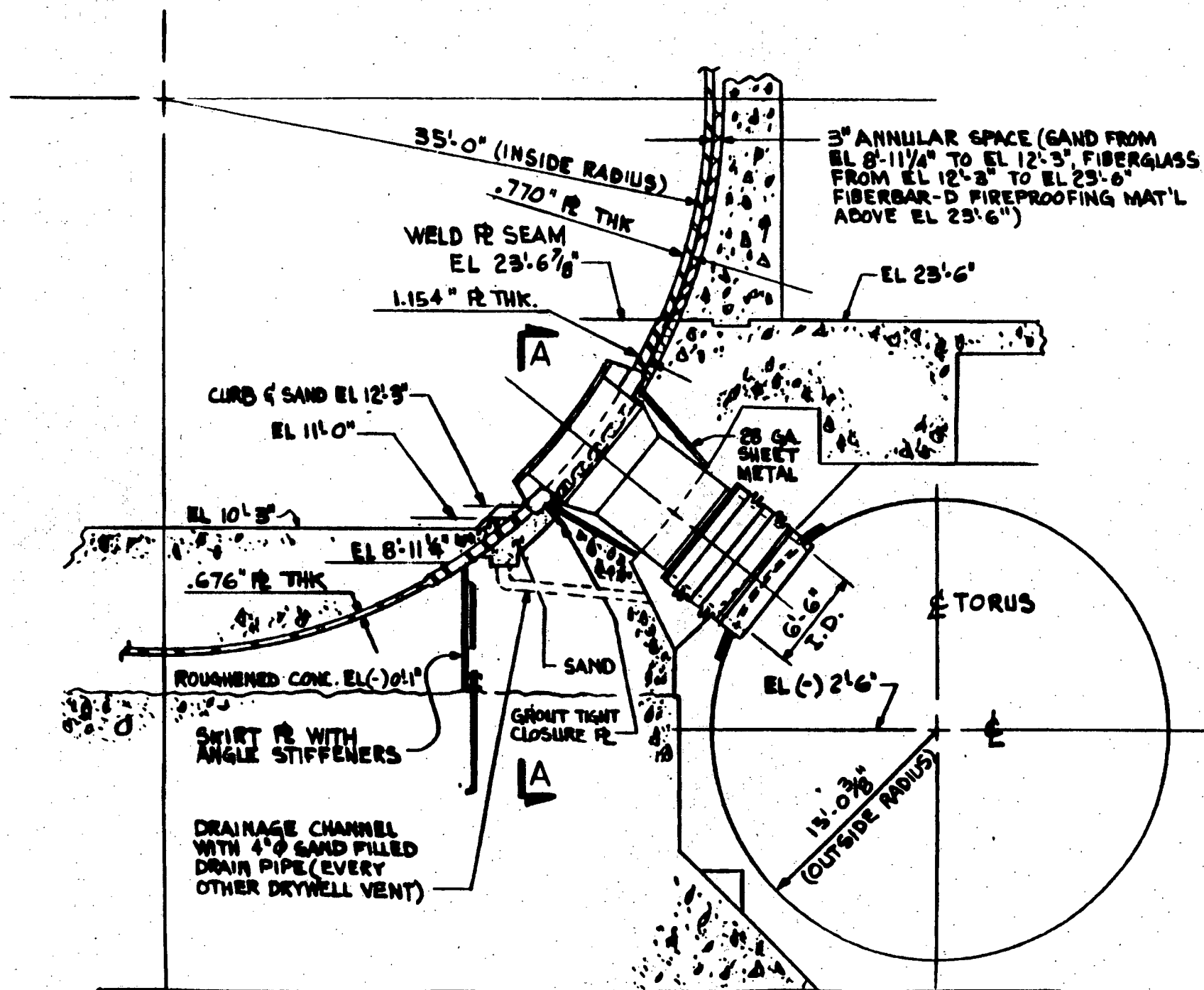


FIGURE 4.

PARTIAL CROSS SECTION OF DRYWELL & TORUS

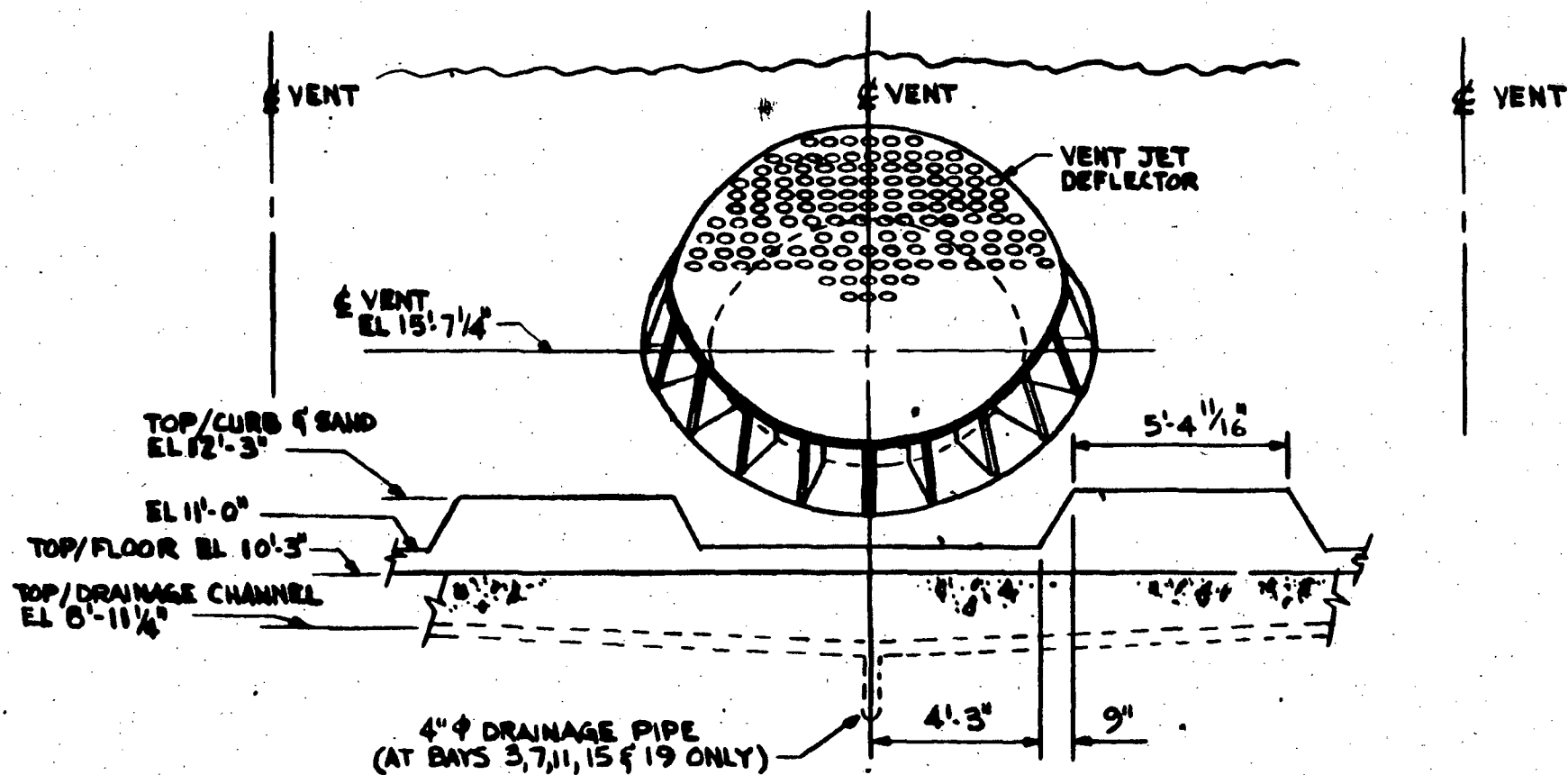


FIGURE 5. SECTION A-A AT VENT

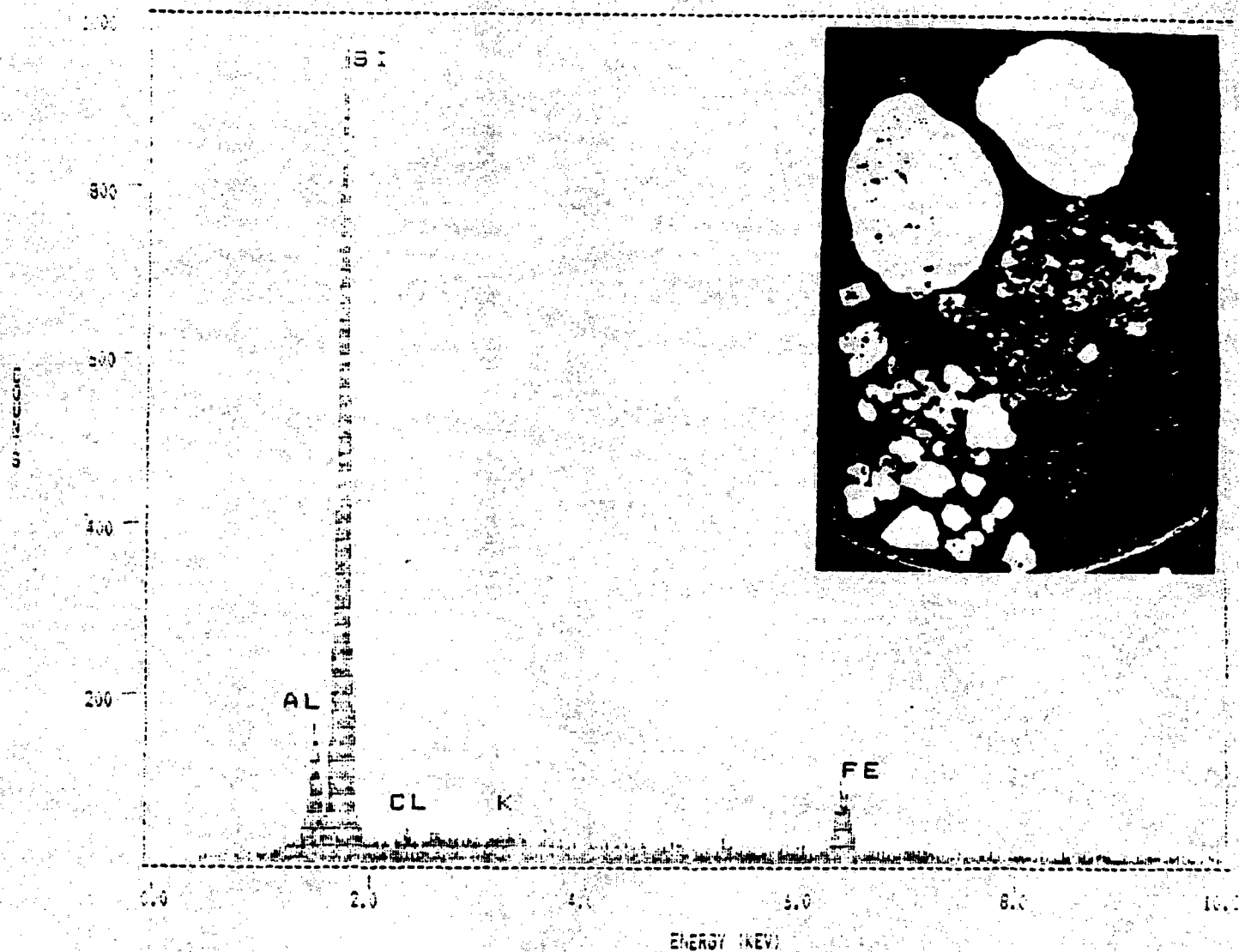
SAND/GROUP OF SMALL PEBBLES

SPECTRUM LABEL

SAND/GROUP OF SMALL PEBBLES

SPECTRUM FILE NAME

000780



% PISIT

Figure 6. Photo shows distribution and type of sand particles.
Spectra shows basic elemental composition. (GPUN)

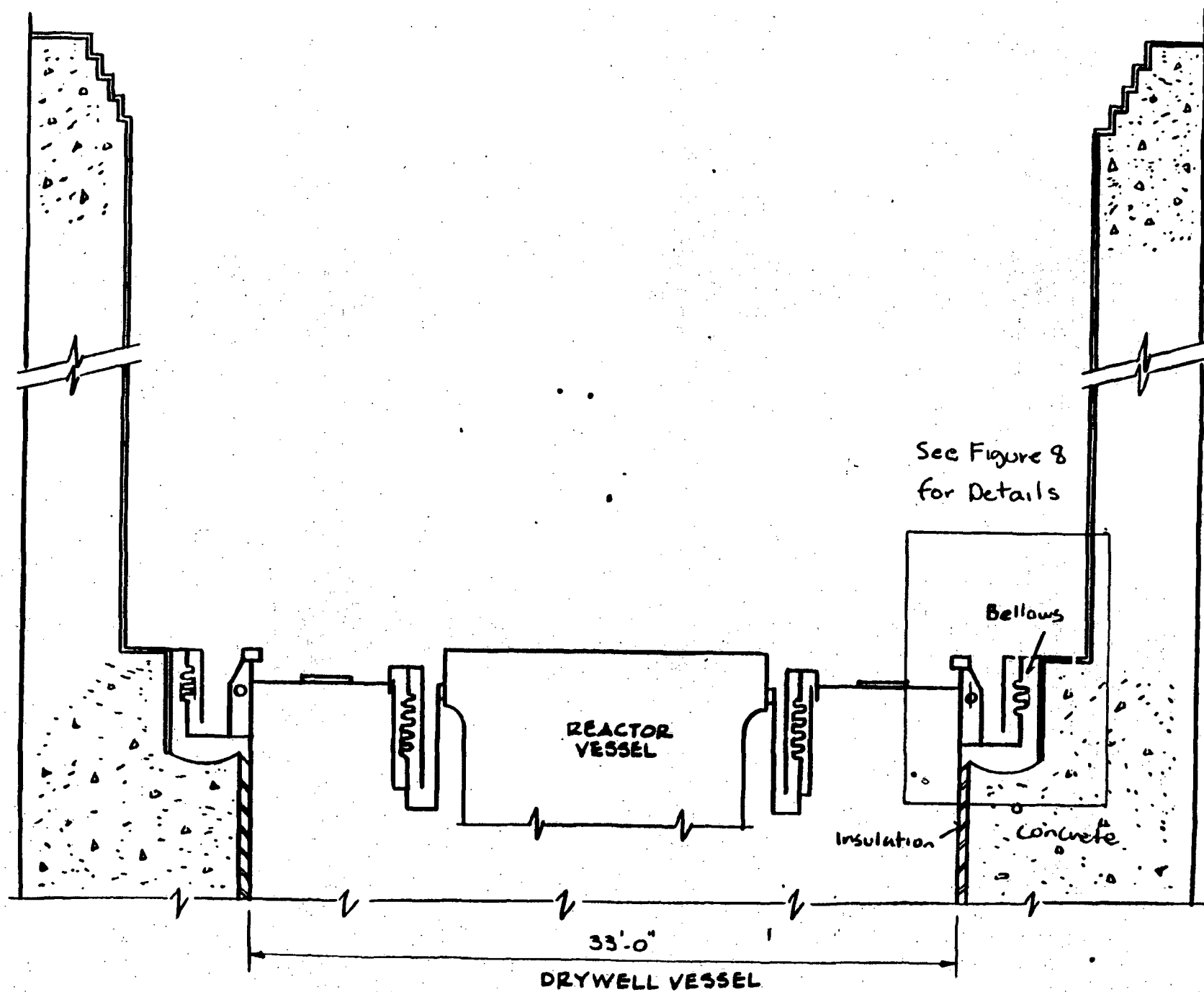


Figure 7. Top of Reactor Vessel. Note location of bellows, insulation and concrete.

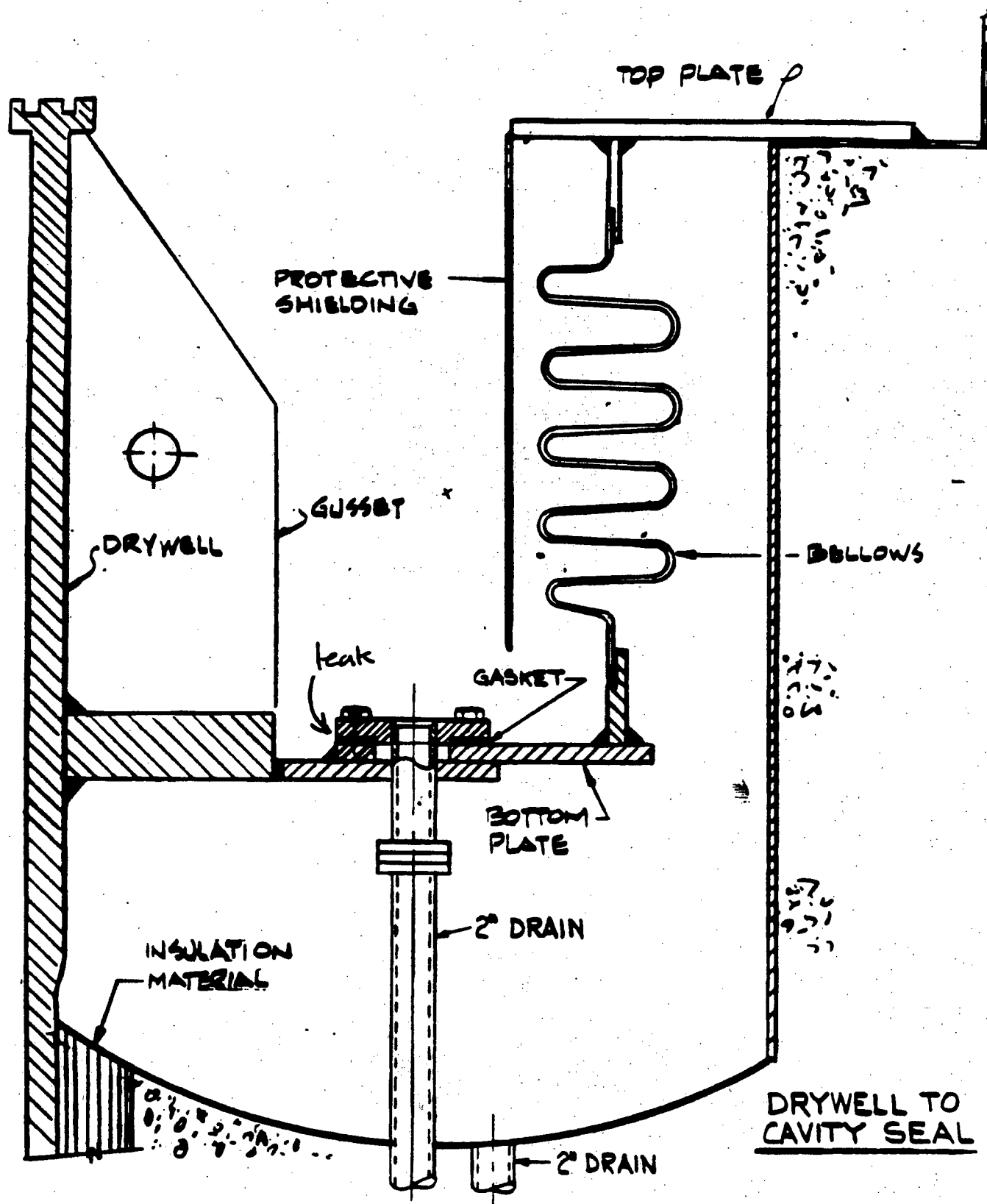
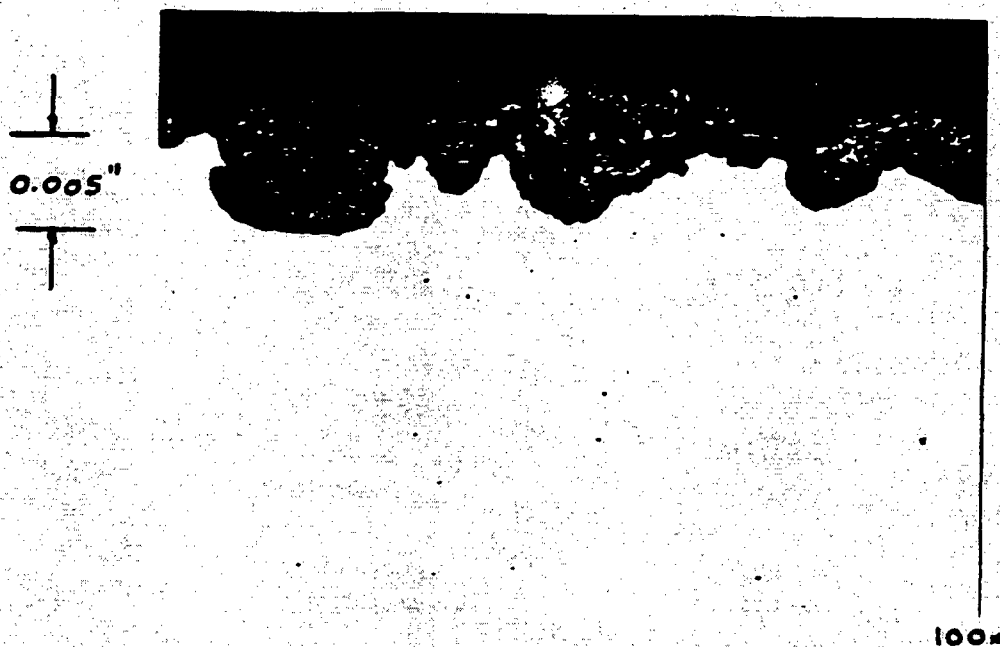
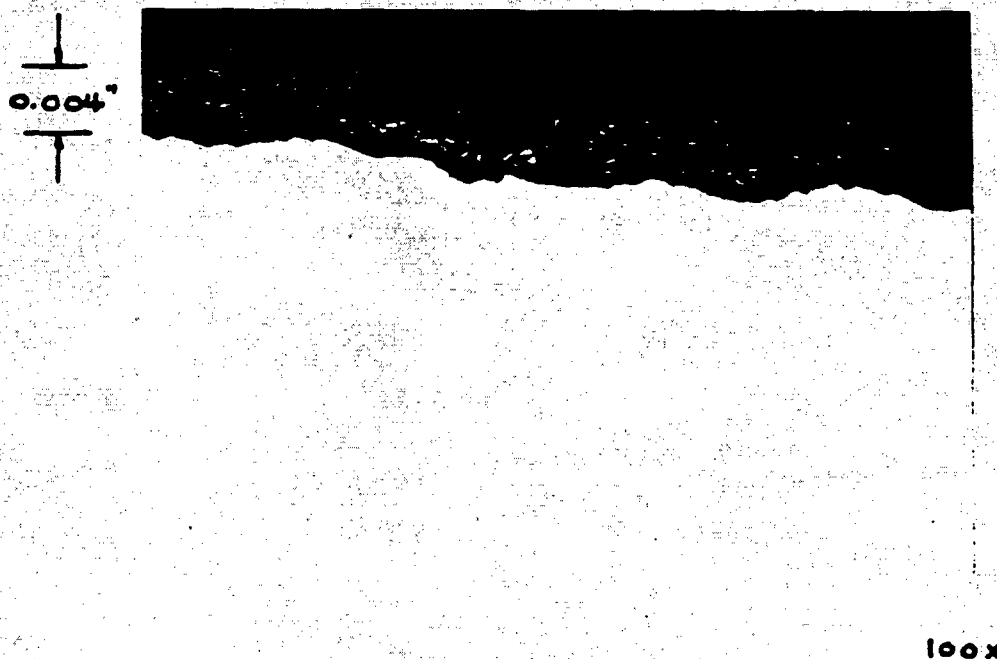


Figure 8. Close-up view of bellows and location of the two 2" drain lines.

FIGURE 10. CROSS-SECTION VIEWS OF DRYWELL
WALL CONDITIONS



PLUG 15A
(PITTING)



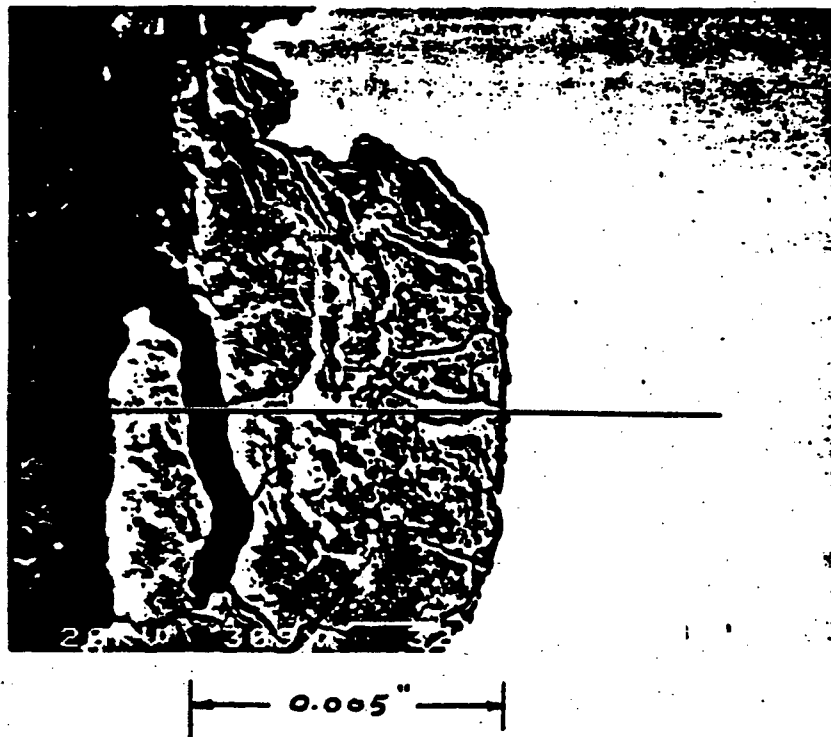
PLUG 19C
(UNIFORM CORROSION)

FIGURE 11.

PLUG 15A
SCALE CHARACTERIZATION
MAGNIFICATION = 309x

OXIDE SCALE

DRYWELL WALL



LINE REPRESENTS ENERGY
DISPERSION LINE PROFILE
LOCATION.

FIGURE 12. OYSTER CREEK DRYWELL PLUG 2 (15A)

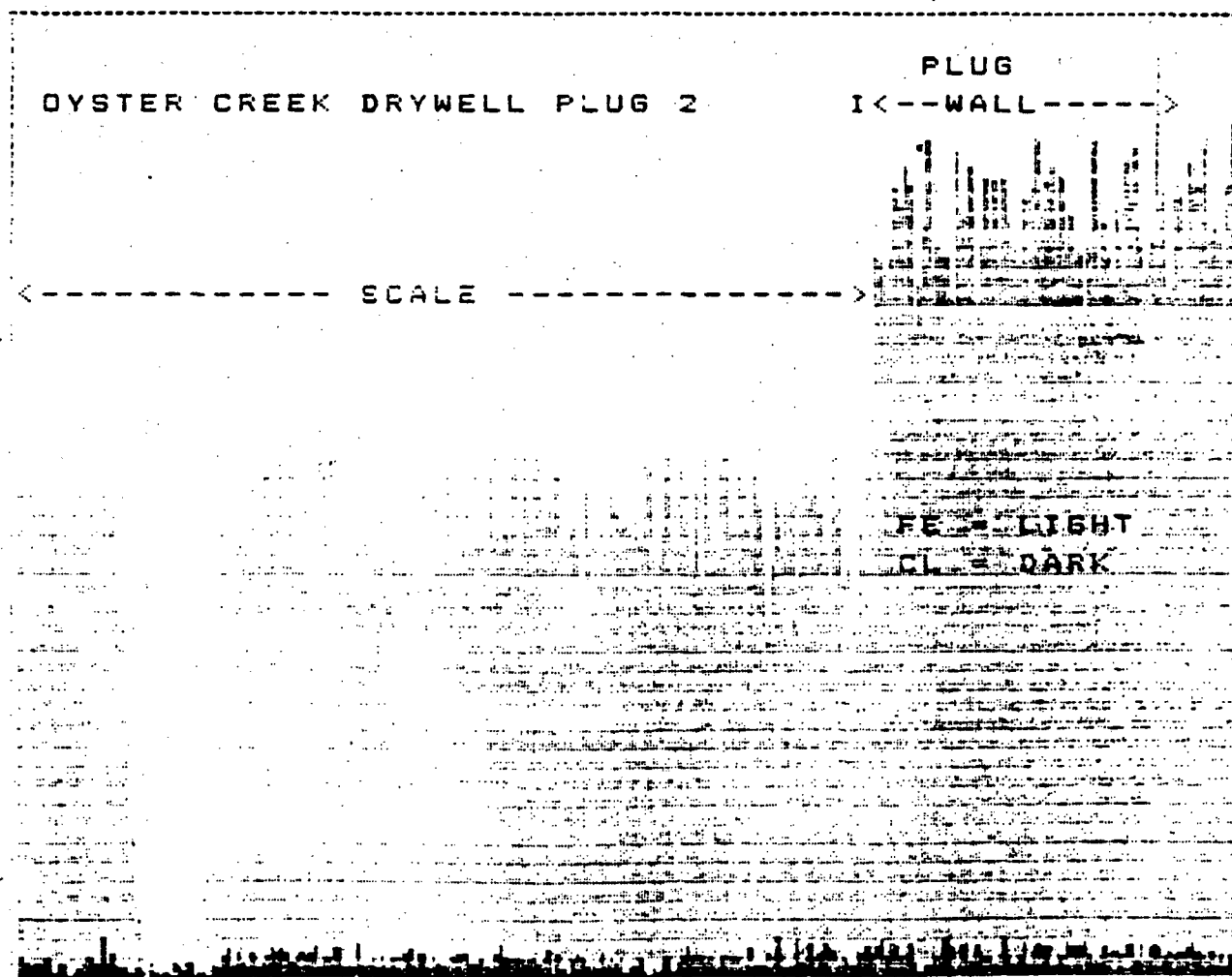
SPECTRUM LABEL

SPECTRUM FILE NAME

0000

PLUG2
PLUG2

000



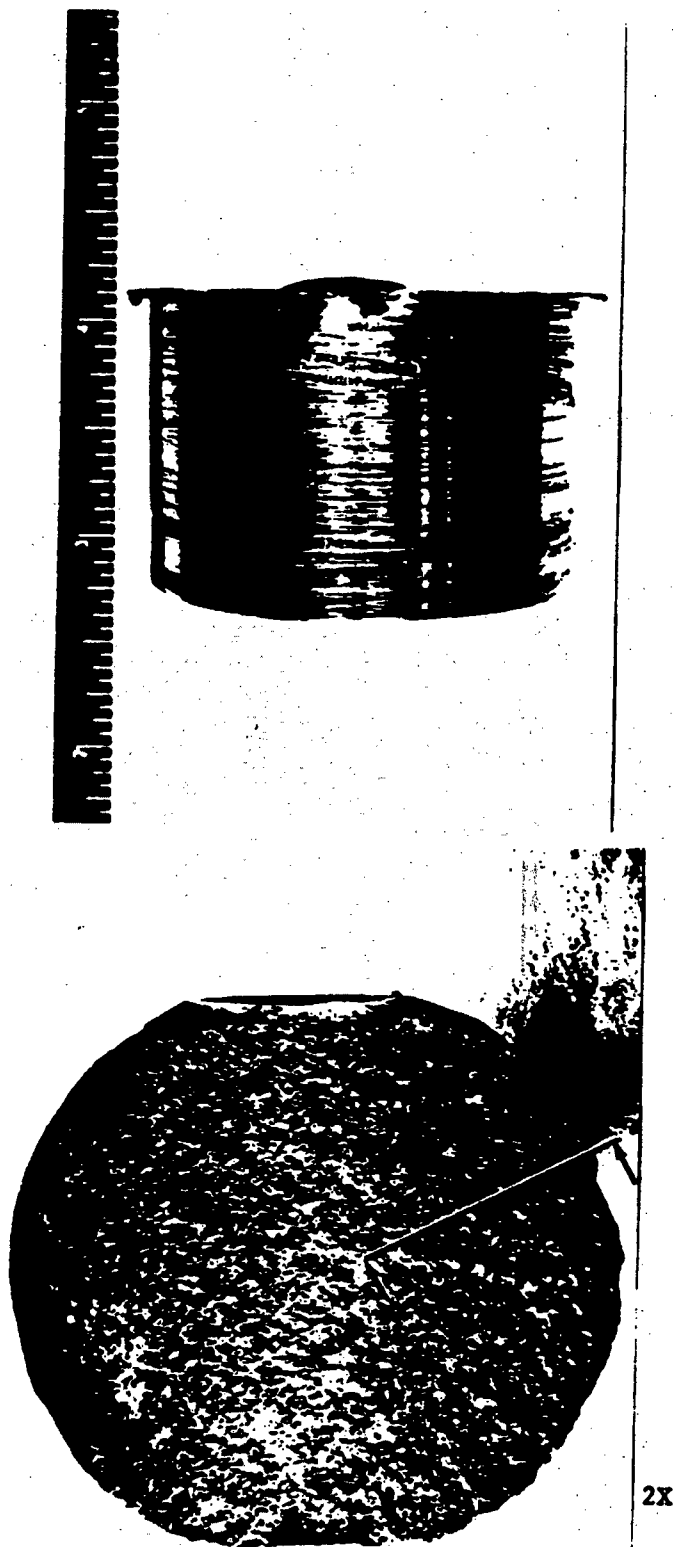


Figure 13. Plug 15A outside surface of drywell.
Uniform red brown corrosion product.



Figure 14. Plug 15A Aluminide stringer at mid-wall.
Plane parallel to rolling direction.

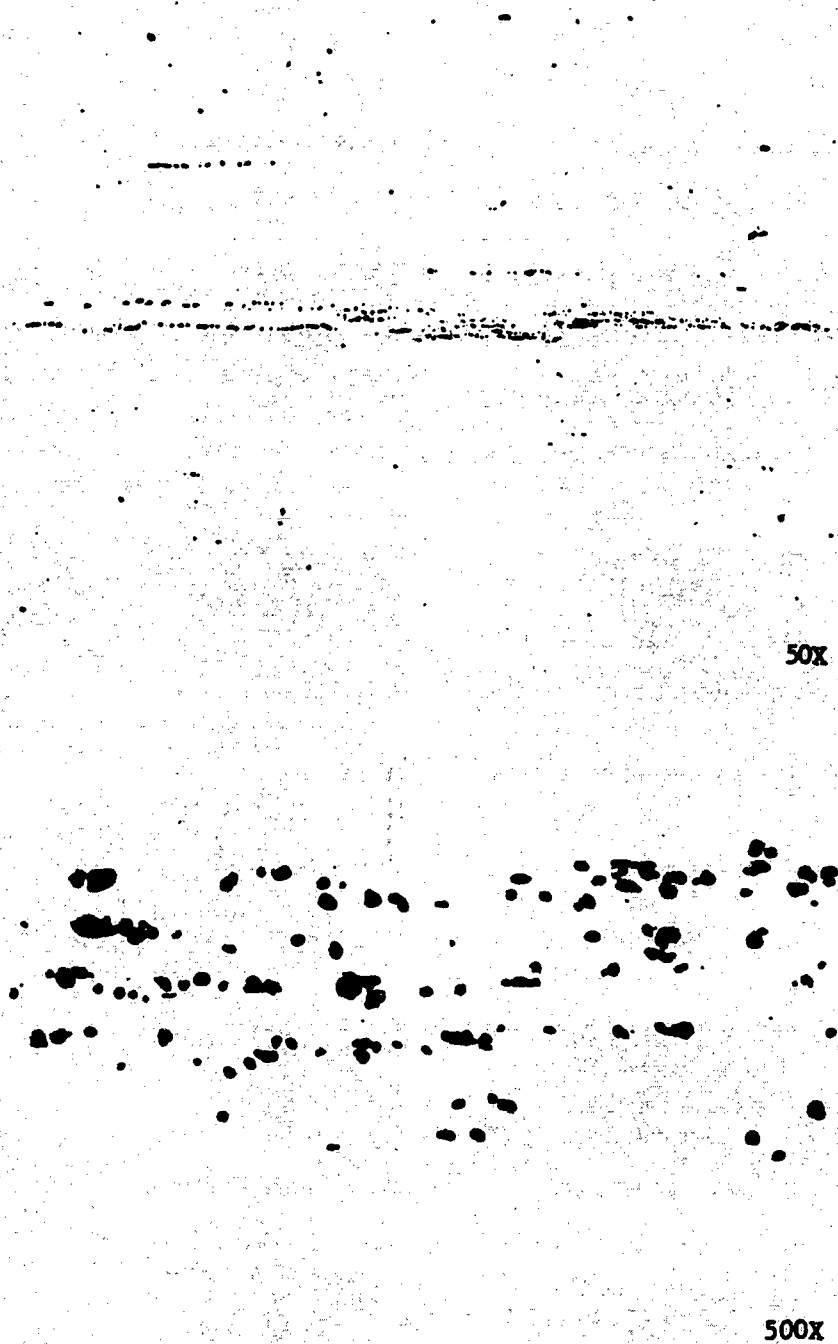
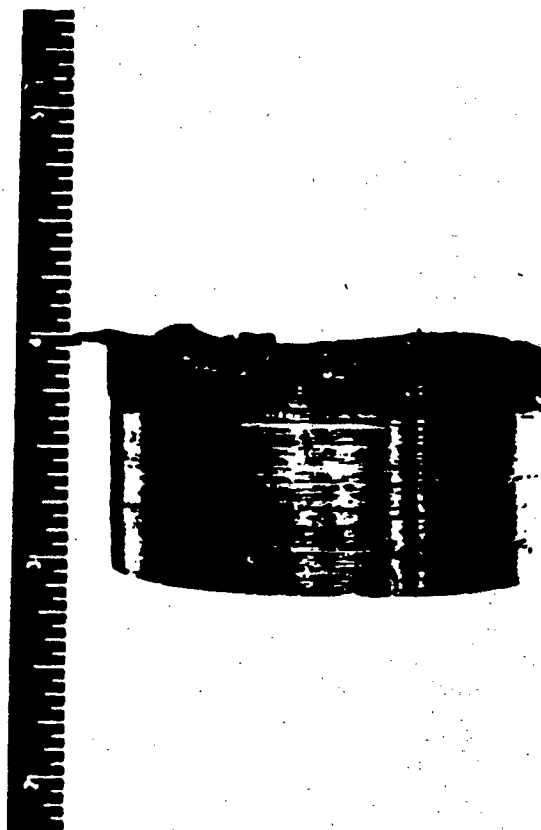


Figure 15. Plug 15A Aluminide Stringer at mid-wall.
Plane perpendicular to rolling direction.



Plug #1



Figure 16. Plug19C outer wall surface microplane is located

PLUG#19CD#13-GENERAL DEPOSIT

SPECTRUM LABEL

SPECTRUM FILE NAME

PLUG#19CD#13-GENERAL DEPOSIT

000000

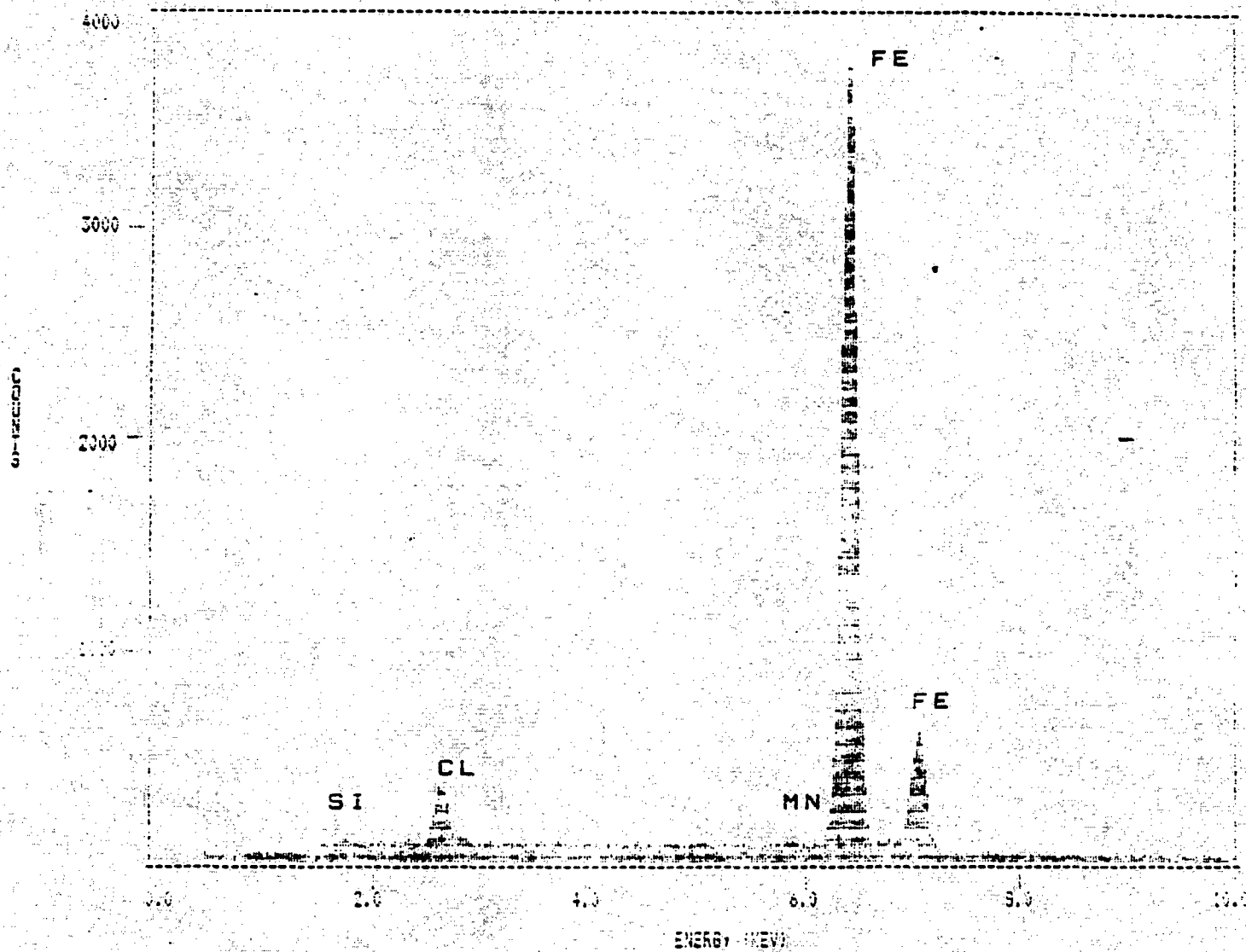


FIGURE 17

Figure 17. Typical elemental analysis of sample 19C corrosion product.

FIGURE 18. PLUG 19C
SCALE CHARACTERIZATION
MAGNIFICATION = 56X

SCALE

DRYWELL WALL



0.034"

LINE REPRESENTS ENERGY
DISPERSION LINE PROFILE
LOCATION.

Figure 19. OYSTER CREEK PLUG 1 (19C)

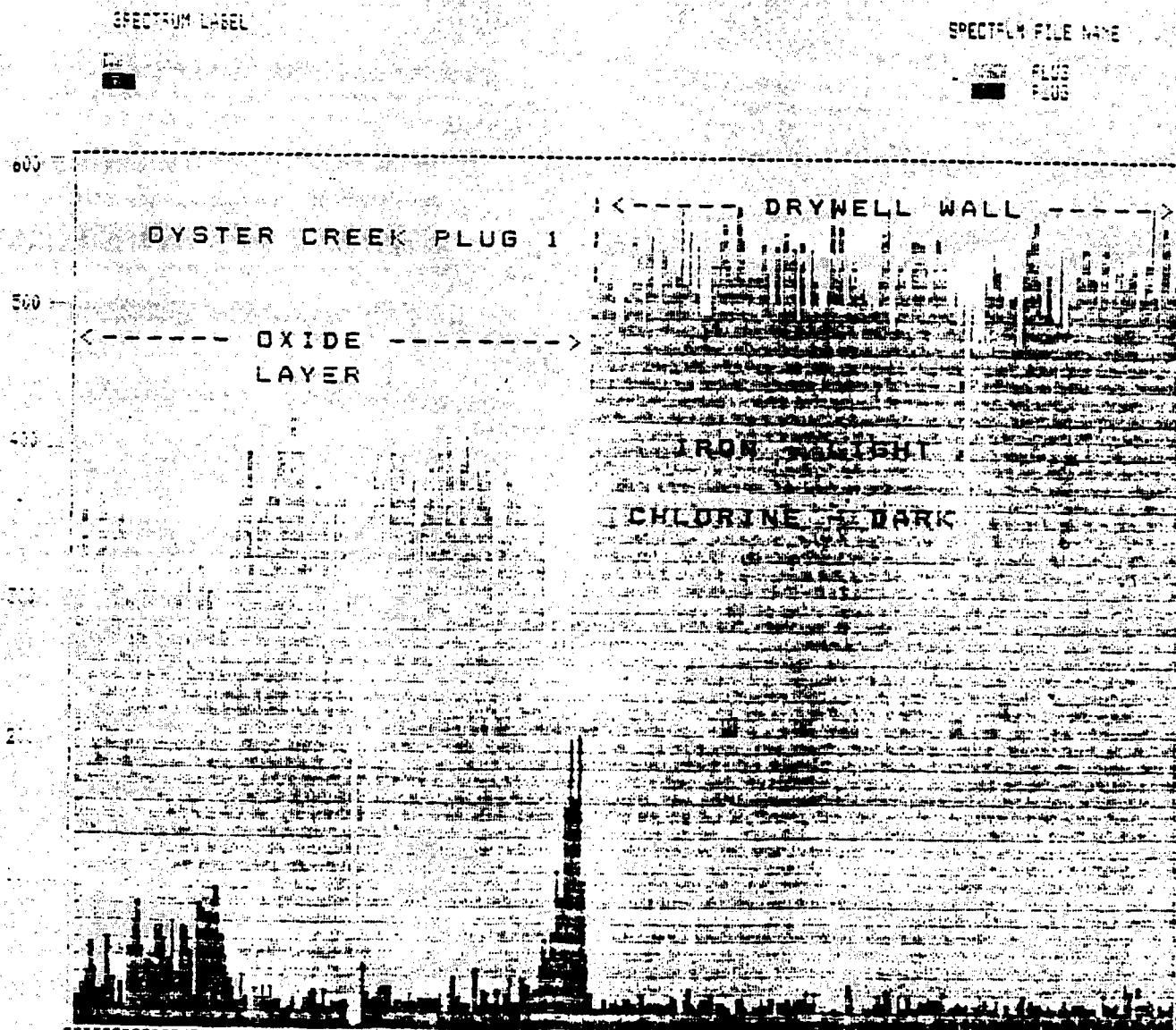


FIGURE 20. PLUG 19C
SCALE CHARACTERIZATION
MAGNIFICATION = 580X

SCALE

DRYWELL WALL



0.006"

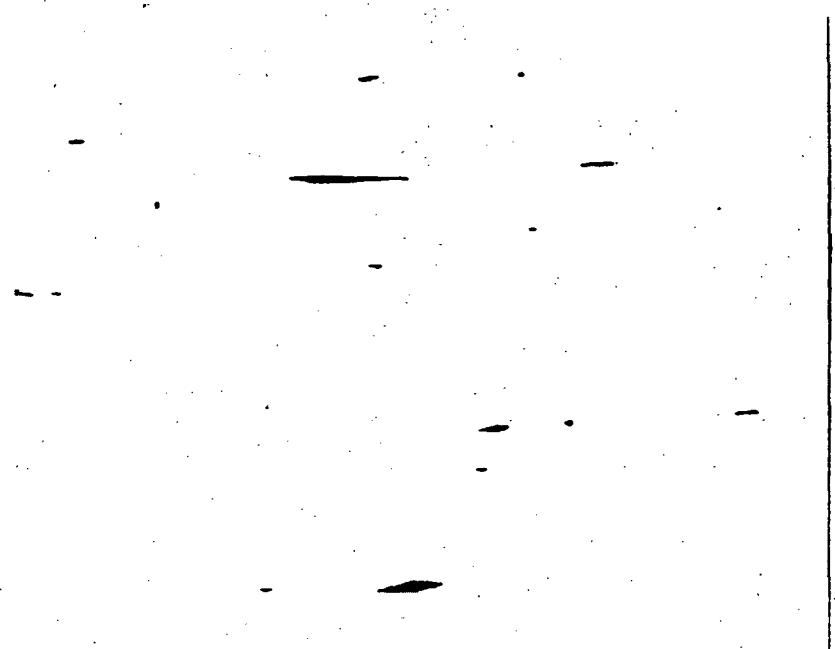
LINE REPRESENTS ENERGY
DISPERSION LINE PROFILE
LOCATION.

THE ARROW LOCATES A
MANGANESE-SULFIDE INCLUSION
WITHIN THE SCALE LAYER.



100X

O.D. surface; Plug #1



200X

Figure 21. MnS inclusions below surface.

SEM No. 1335

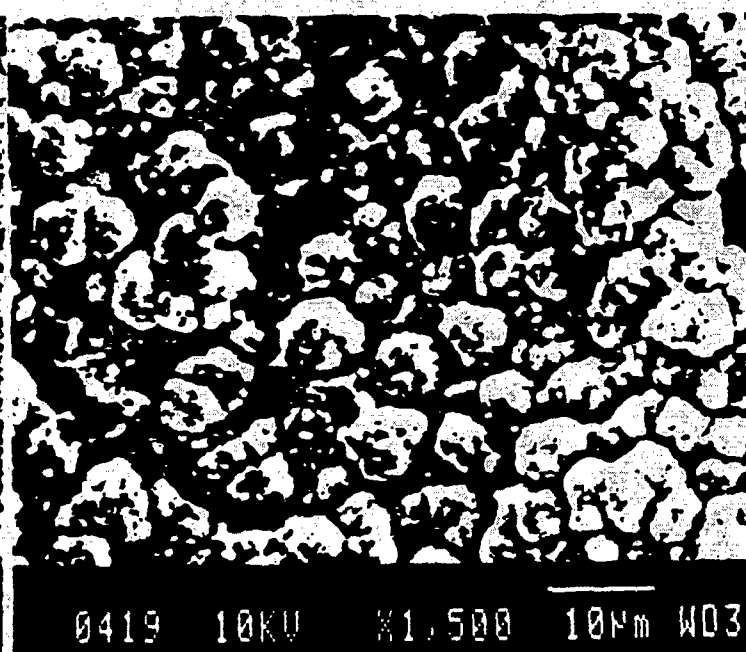
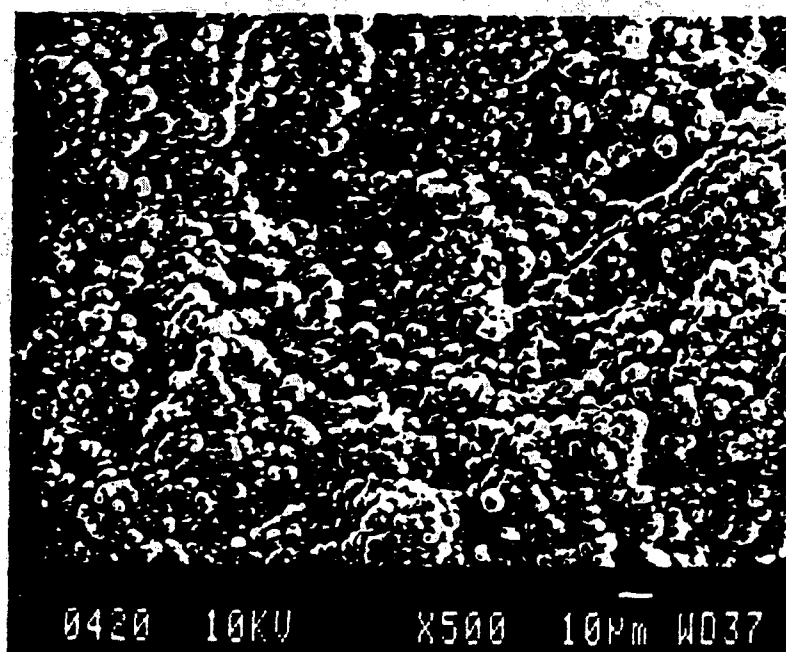
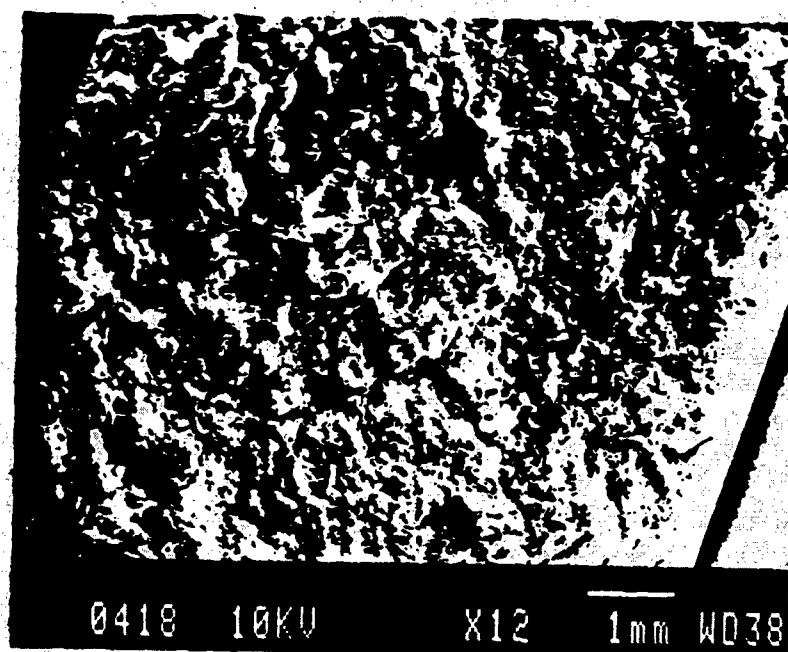
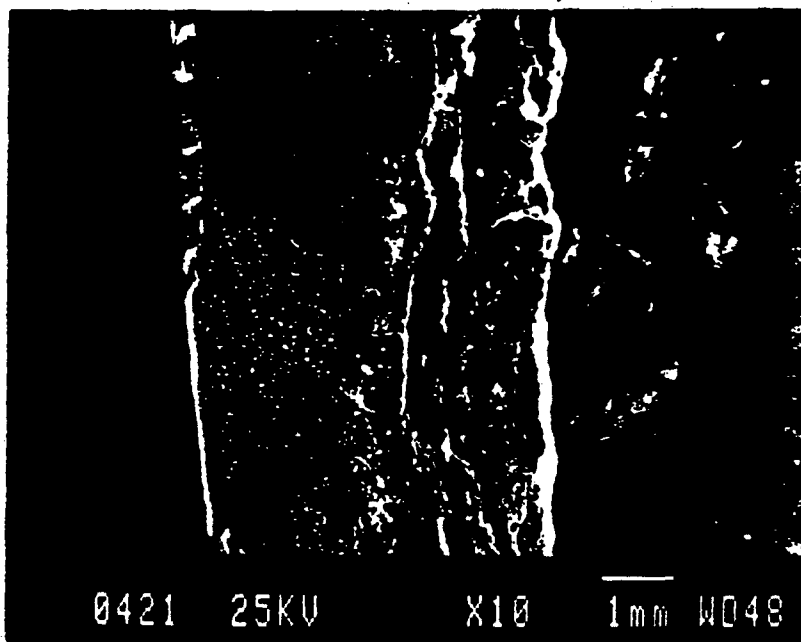


Fig. 22 Sample I.D. Core Plug Sample #3 (17D)
Corrosion Surface

SEM No. 1335

Corrosion
layer



typical cross-section

Fig. 23 Sample I.D. Oyster Creek Core Plug #3 (170)

D.I. Warner

86C-61

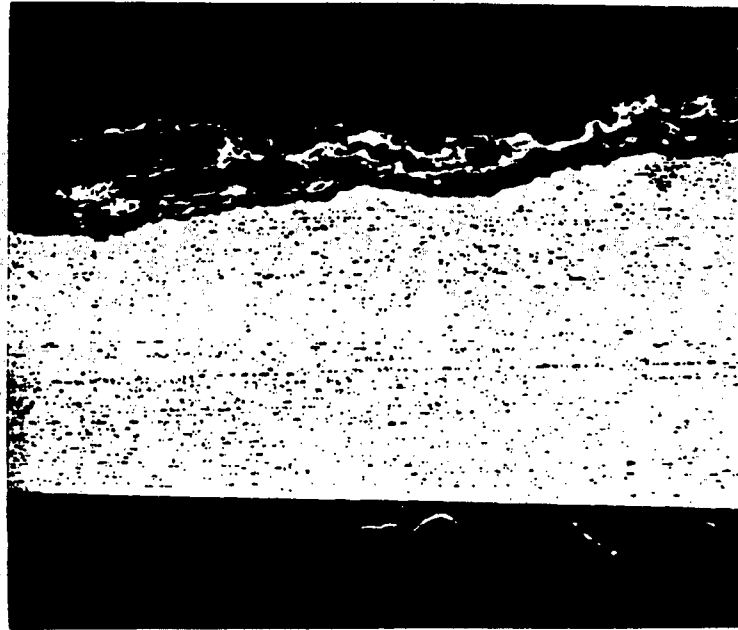
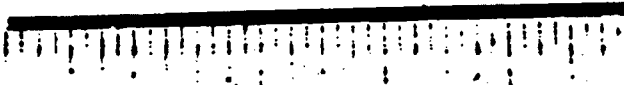
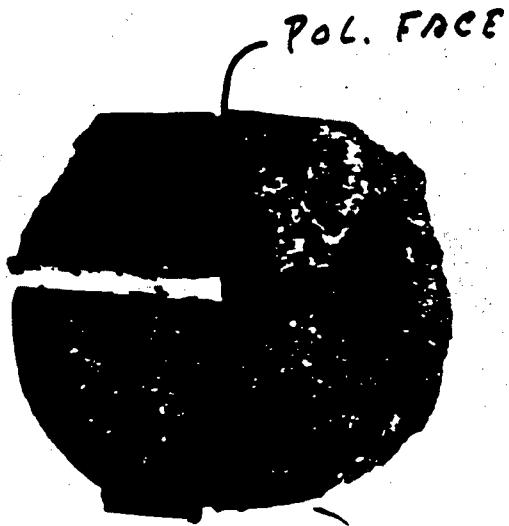


Fig. 24 BF ☐ PL ☐ ET ☐ AP ☐ Mag. _____

Fig. _____ BF ☒ PL ☐ ET ☒ AP ☐ Mag. 8X

MARJ

6C-61

OYSTER CREEK DRYWELL KINER - PLUG #3 (17)

86C-61



Fig. _____ BF ☒ PL ☐ ET ☐ AP ☒ Mag. 33X

CARBIDES FACE

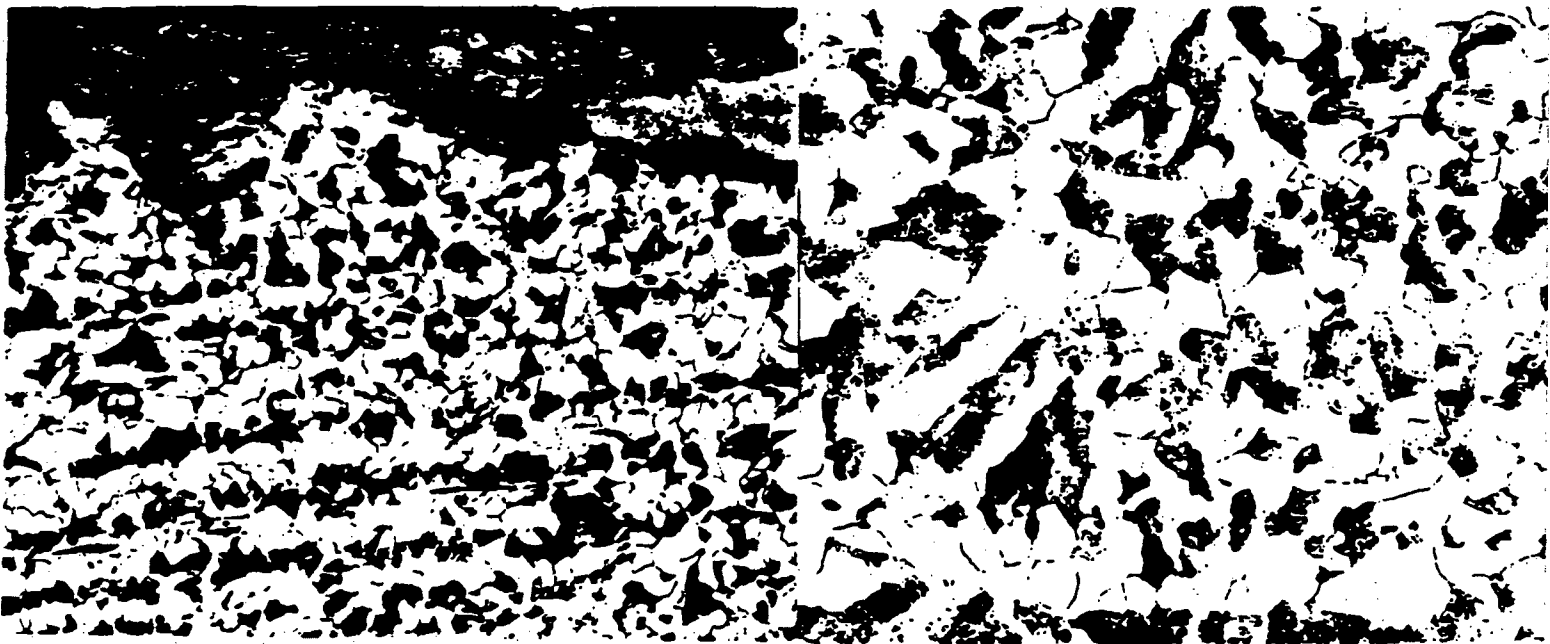


Fig. 25 BF ☒ PL ☐ ET ☒ AP ☐ Mag. 250

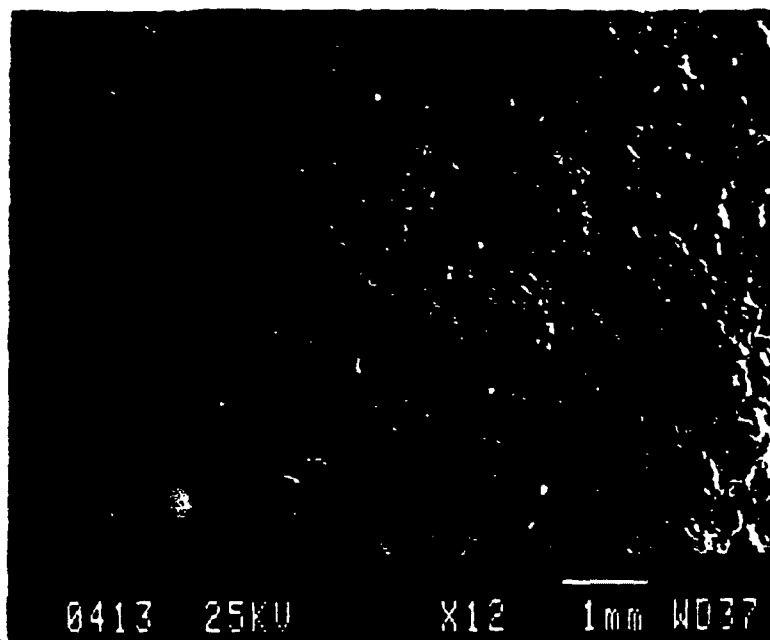
86C-61

CARBIDES FACE

Fig. _____ BF ☒ PL ☐ ET ☒ AP ☐ Mag. 525

TYPICAL MICROSTRUCTURE

82(17D)



Typical region

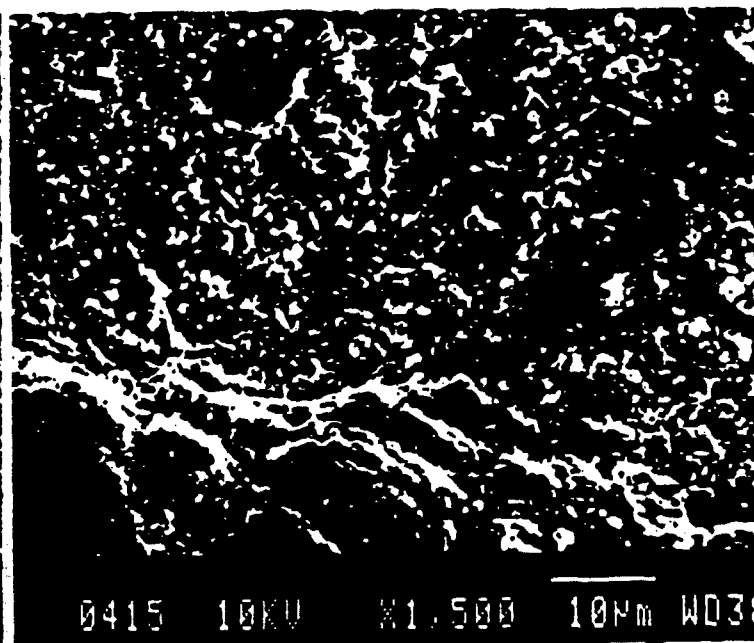
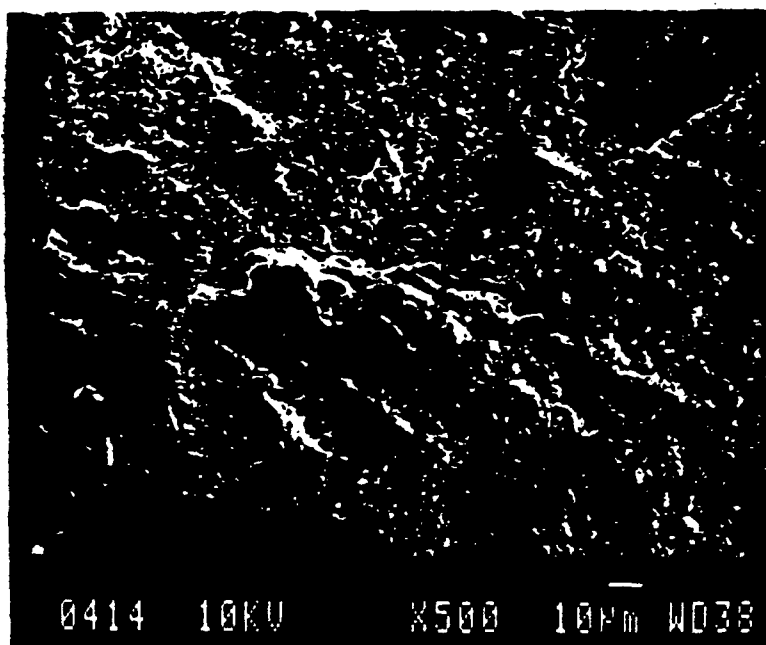
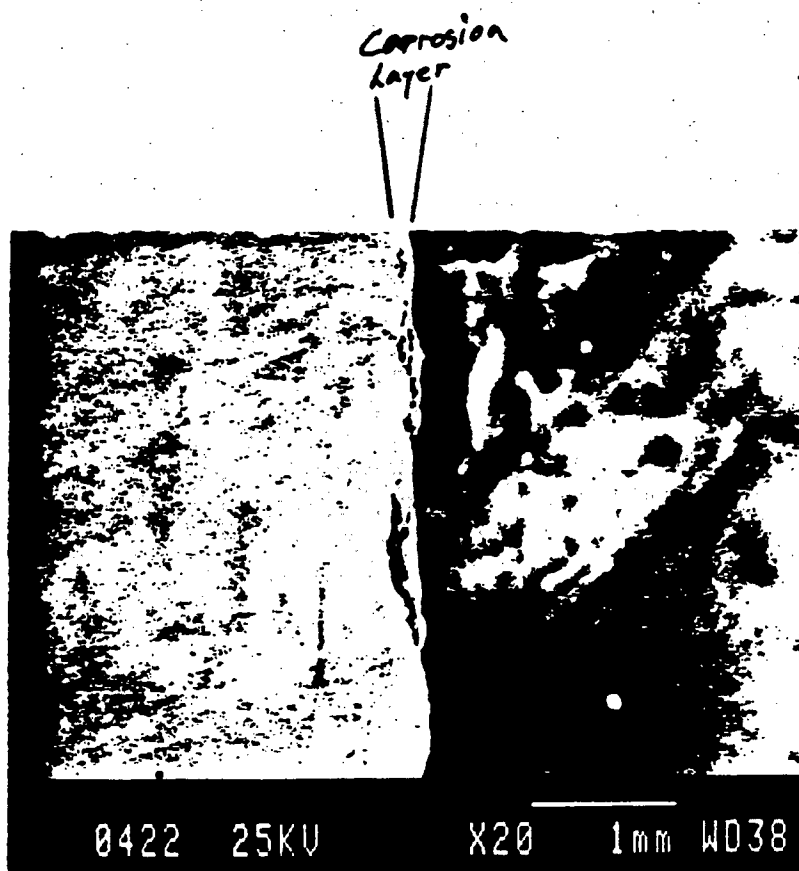


Fig. 26 Sample I.D. Core Plug Sample # 4 (19A)
Corrosion Surface

R. W. Warner



typical cross-section

Fig. 27 Sample I.D. Oyster Creek Core Plug #4 (19A)

R. W. Warner

86C-61

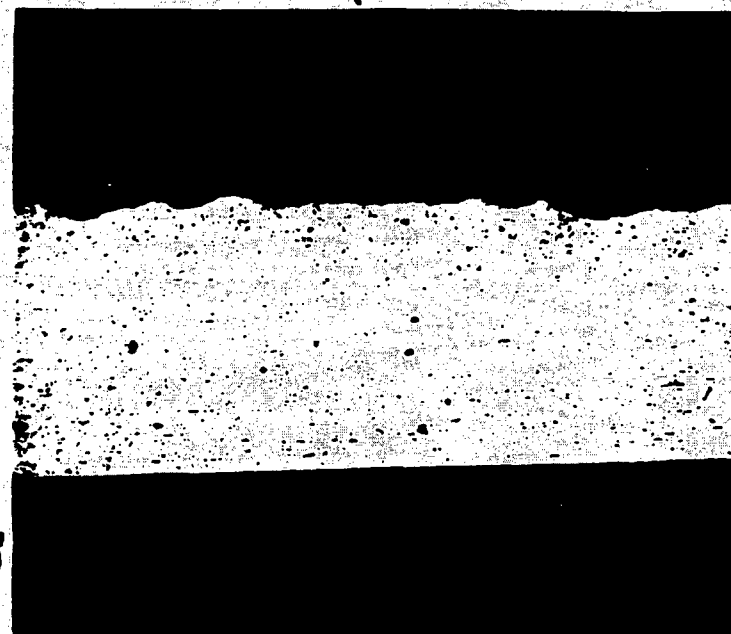
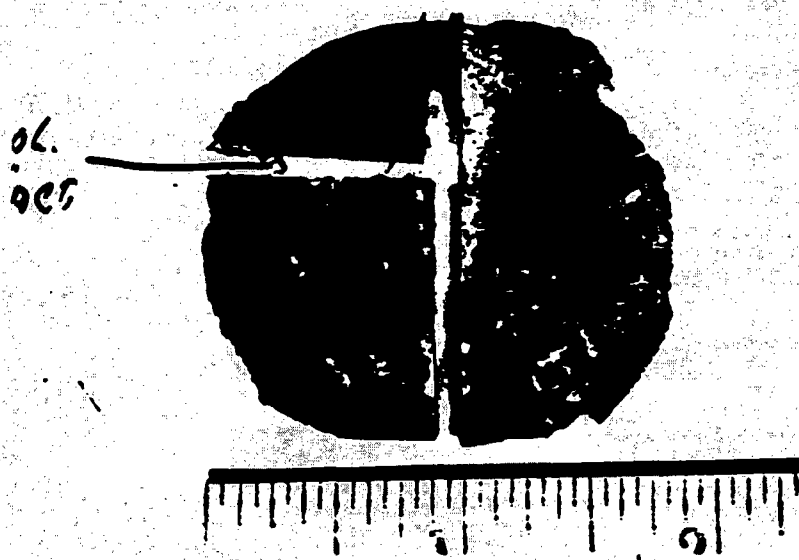


Fig. 28 BF ☐ PL ☐ ET ☐ AP ☐ Mag. _____ Fig. _____ BF ☒ PL ☐ ET ☒ AP ☐ Mag. 8X

LC-62 OYSTER CREEK DRYWELL LINER - DING #4 (19A)

86C-61

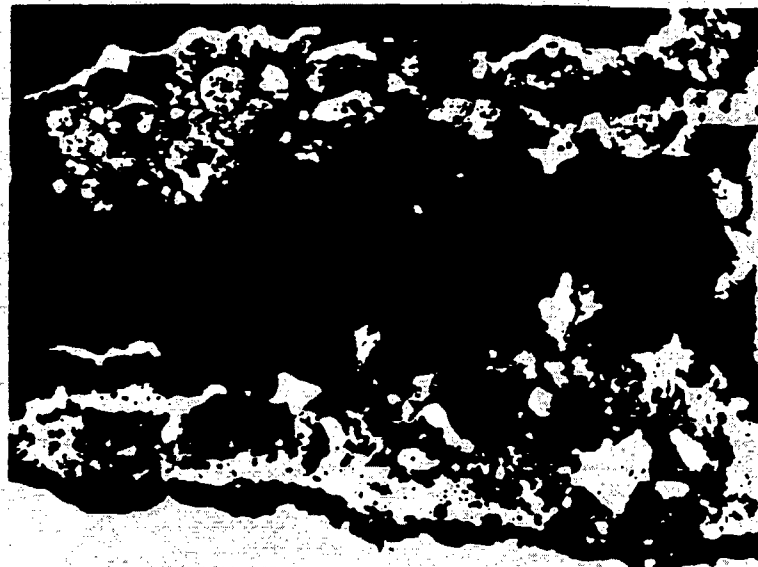
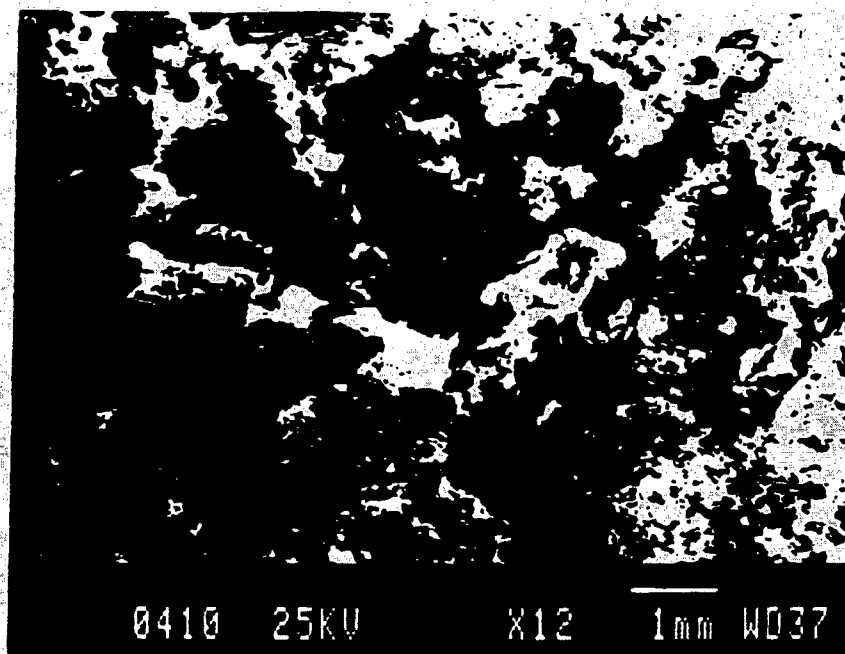


Fig. _____ BF ☒ PL ☐ ET ☐ AF ☒ Mag. 33X Fig. _____ BF ☒ PL ☐ ET ☐ AF ☒ Mag. 125X
CORRODED FACE



Fig. 29 BF ☒ PL ☐ ET ☒ AF ☐ Mag. 250X Fig. _____ BF ☒ PL ☐ ET ☒ AF ☐ Mag. 525X
CORRODED FACE TYPICAL MICROSTRUCTURE
NOTES: CORROSION PRODUCT LINEAR-PLUC #4(19A)



Typical region

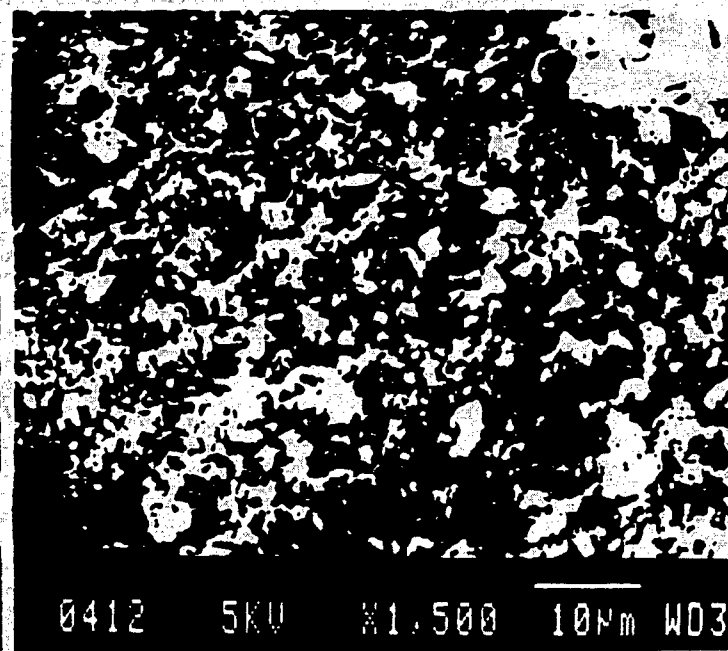
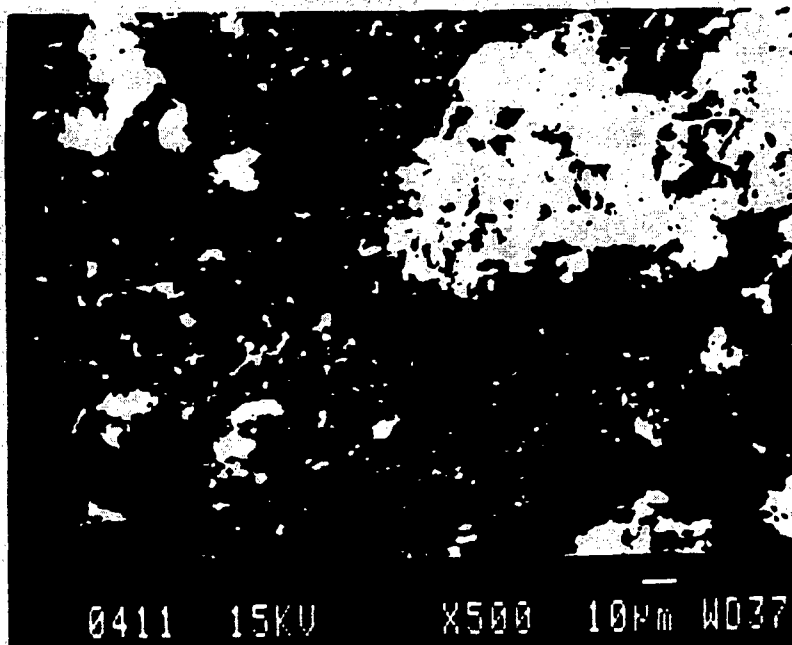
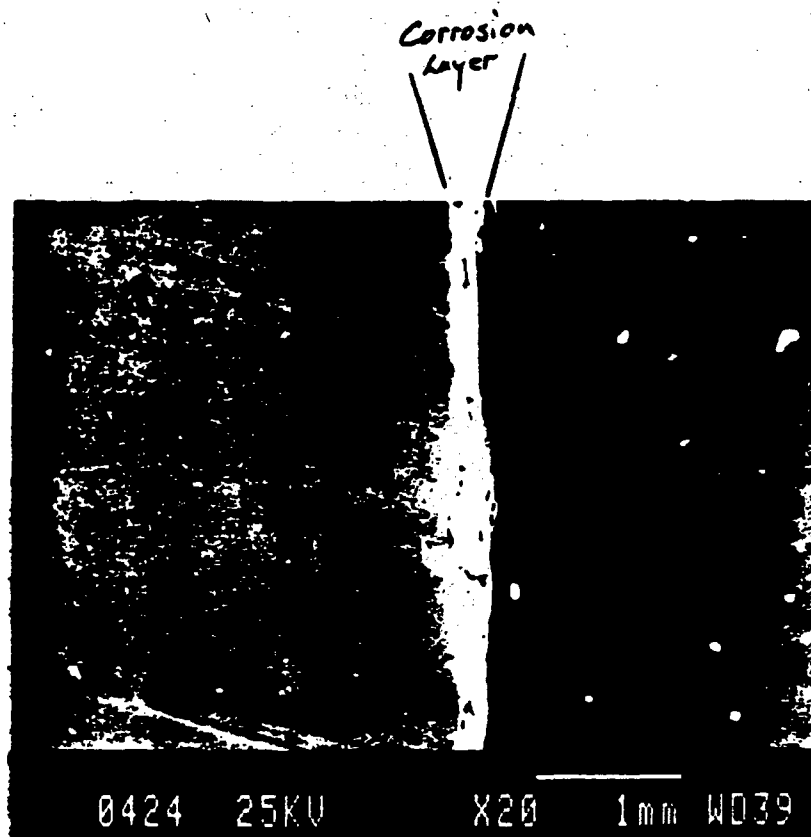


Fig. 30 Sample I.D. Core Sample #6 (11A-H)
Plug Corrosion Surface

R. W. Warner



typical cross-section

Fig. 31 Sample I.D. Oyster Creek Core Plug #6 (11A-H)

R. G. Warner

86C-61

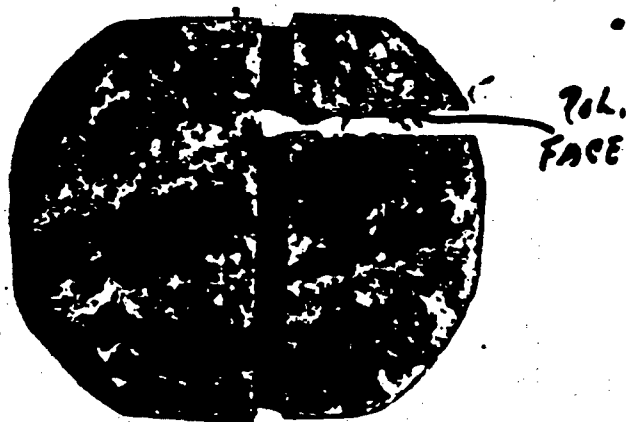


Fig. 32 BF ☐ PL ☐ ET ☐ AP ☐ Mag. _____

Fig. _____ BF ☒ PL ☐ ET ☒ AP ☐ Mag. 8X

MADRID

LC-59

OYSTER PACK DRYWELL LINER-PLUG #6

86C-61



Fig. _____ BF ☒ PL ☐ ET ☐ AP ☒ Mag. 33X

CORRODED FACE



Fig. 33 BF ☒ PL ☐ ET ☐ AP ☒ Mag. 125X

Fig. _____ BF ☒ PL ☐ ET ☐ AP ☒ Mag. 125

6C-59

CORRODED FACE

85C-61

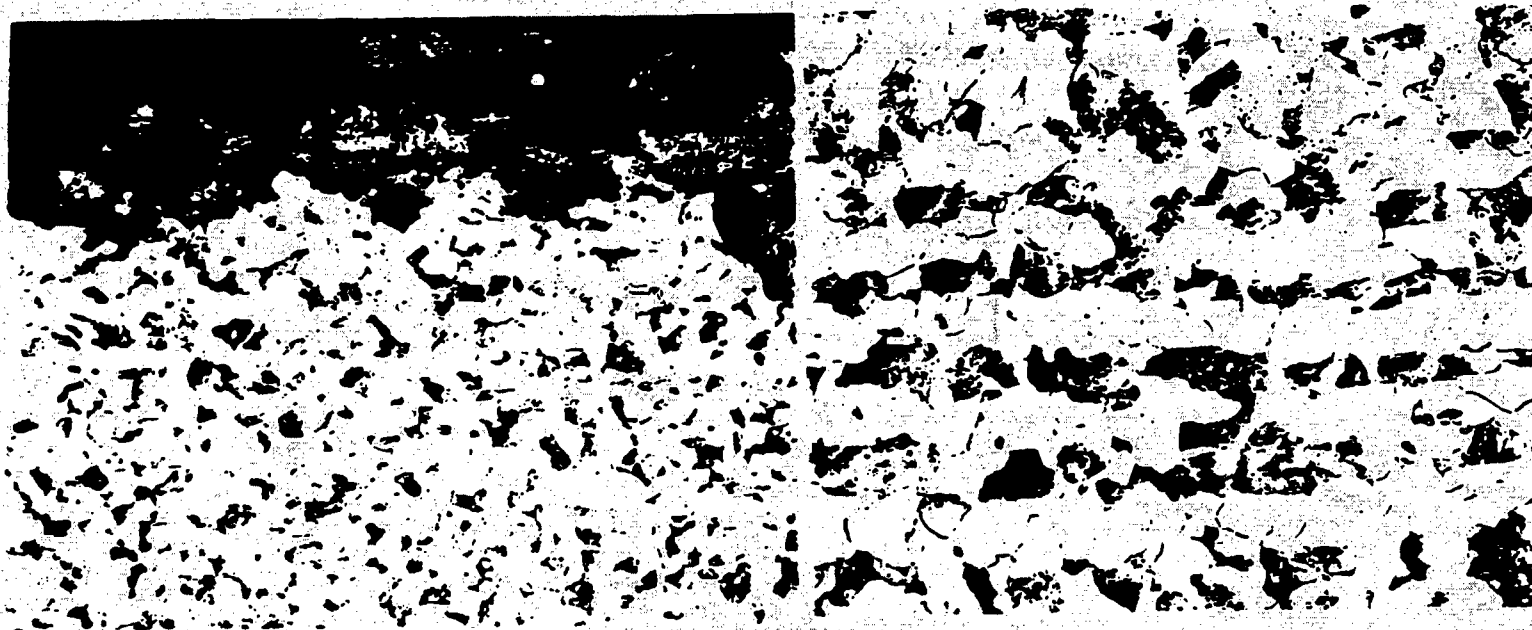


Fig. 34 BF ☐ PL ☐ ET ☐ AP ☐ Mag. 250X

CORRODED FACE

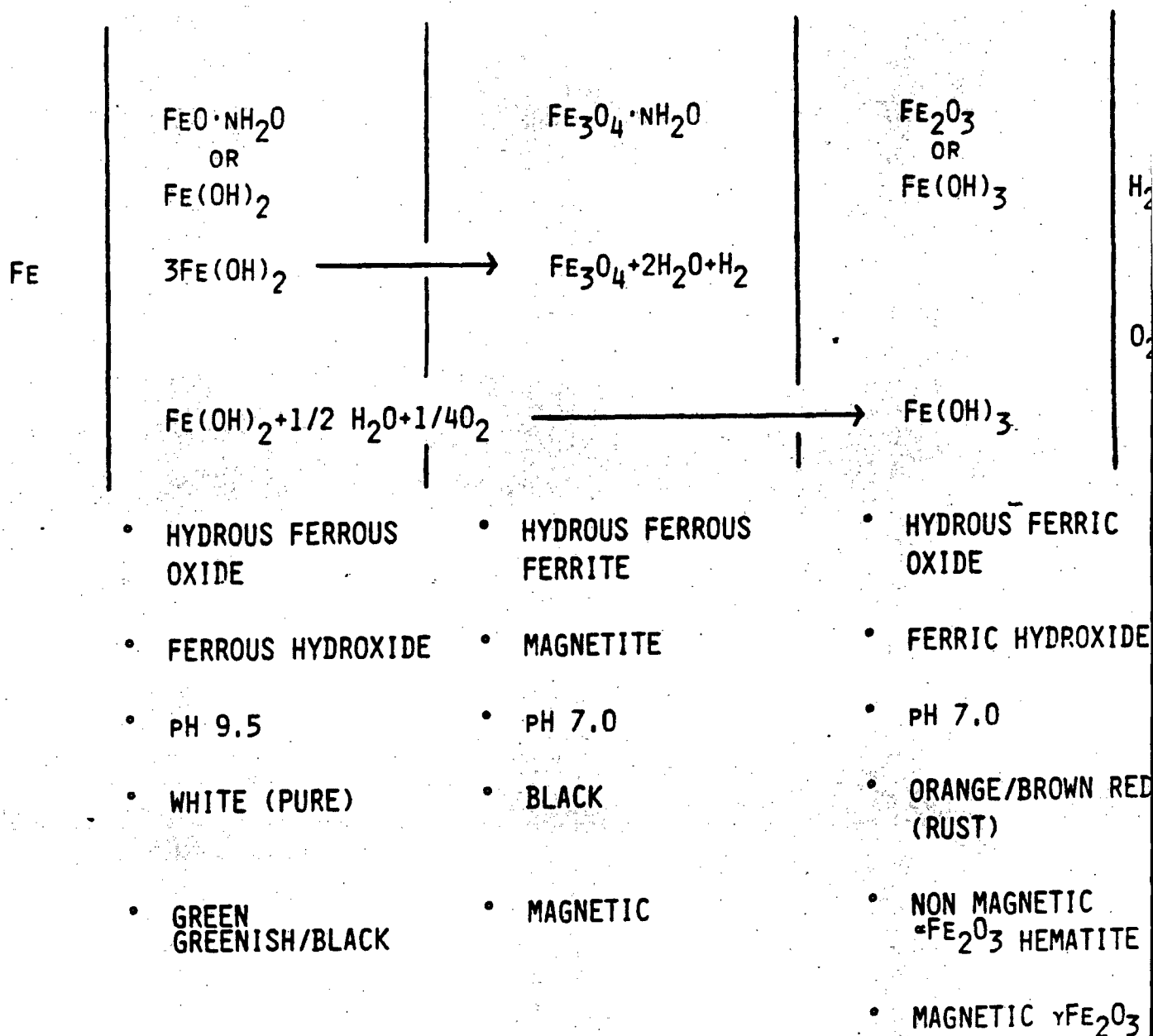
Fig. BF ☐ PL ☐ ET ☐ AP ☐ Mag. 525

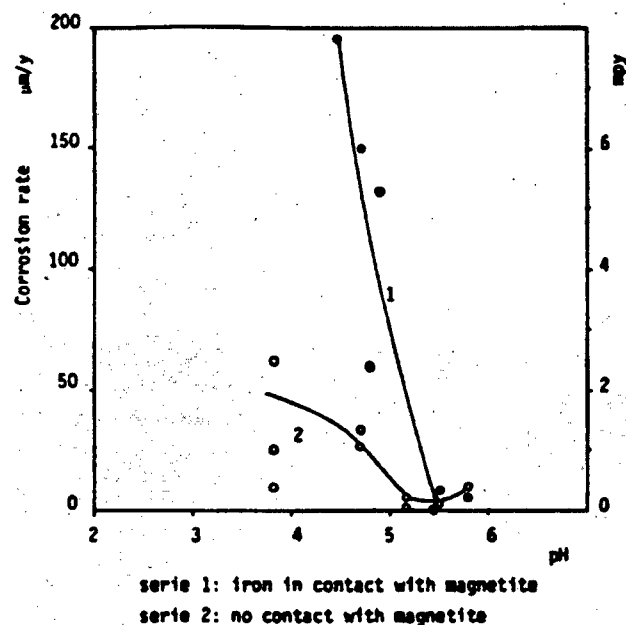
TYPICAL MICROSTRUCTURES

6C-59

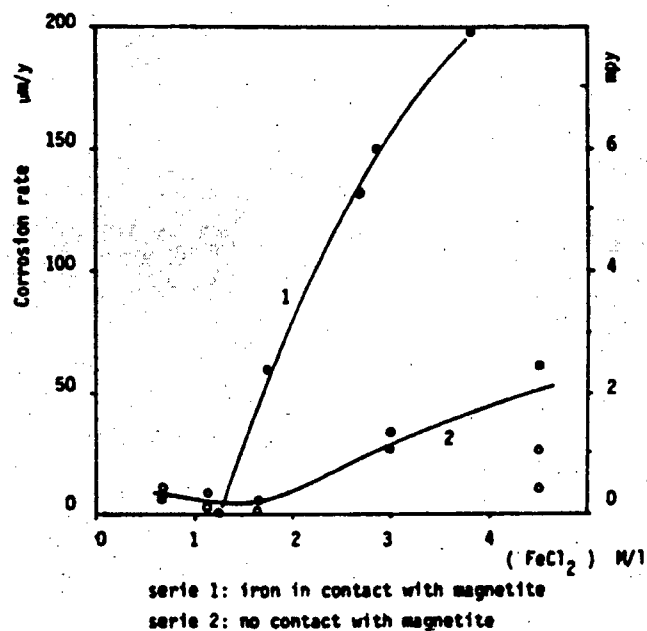
SYSTEM CREEK DRYWELL LINER. PLUG #6

FIGURE 35. CORROSION PRODUCTS OF IRON/STEEL WITHOUT CONTAMINANTS





a. Corrosion rate of iron versus pH of solutions of FeCl_2 at 20°C (68°F)



b. Corrosion rate of iron versus (Fe^{++}) of solutions of FeCl_2 at 20°C (68°F)

Figure 36. Increase in instantaneous corrosion rate of iron in solutions of FeCl_2 with and without magnetite.⁹

Figure 37. Corrosion Rates Under Static / Air Saturated Conditions

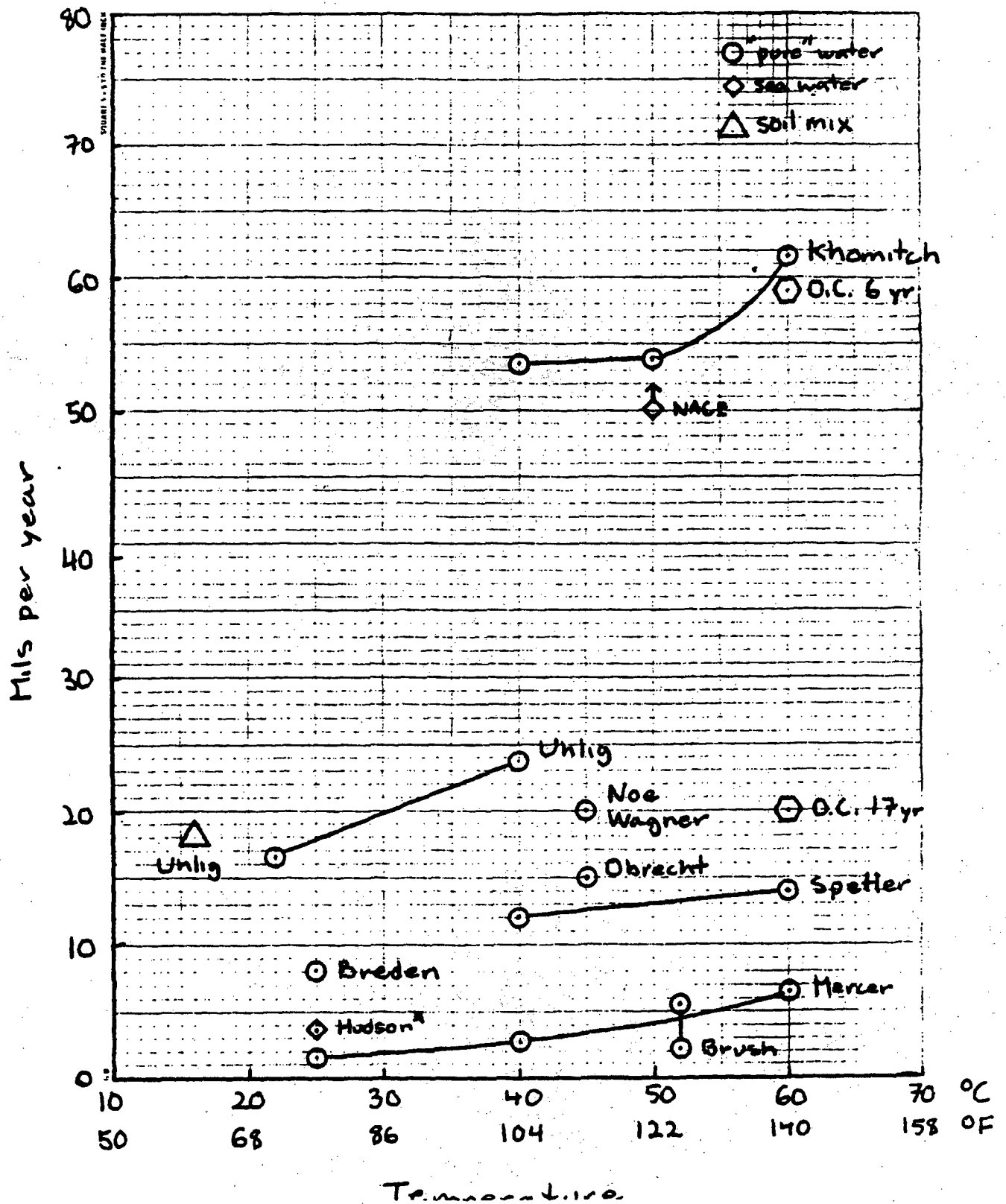


FIGURE 38. POSSIBLE CORROSION MECHANISM OF OYSTER CREEK DRYWELL

