Docket No. 50-305

SUMMARY REPORT

FEEDWATER LINE CRACKING

KEWAUNEE NUCLEAR POWER PLANT

July 13, 1979

TABLE OF CONTENTS

1.0 INTRODUCTION

On July 3, 1979 representatives of Wisconsin Public Service Corp., Westinghouse Electric Corp. and Fluor Power Services (AE for Kewaunee) met with the Nuclear Regulatory Commission to present their findings concerning feedwater line cracks found at the Kewaunee Nuclear Power Plant. As a result of discussions, it was agreed that a Summary Report of the presentation would be submitted to the Commission documenting the findings presented at the meeting and certain actions Wisconsin Public Service Corp. would take concerning the short term repair and long term evaluation of the feedwater line problems. Those findings, committments and up-to-date information are contained in this report.

Final metallurgical results were not available at the time of submittal of this report, but a copy of that report will be submitted to the NRC when received from Westinghouse.

2.0 HISTORY OF INSPECTIONS AND RESULTS

2.1 Chronology of Events

The Kewaunee Plant was in the process of refueling when FW line cracks were discovered at the D. C. Cook plant. The Inservice Inspection Program (ISI) was in progress on the Primary Coolant System, so an extension of the program was quickly adopted to cover examination of the FW pipe to Steam Generator (SG) nozzles.

Radiographs showed linear indications in both nozzle weld areas, and ultrasonic examination determined these indications to be on the order of 20 mils deep. It was determined that the indications were at or near the inside surface, however, no firm conclusions could be made as to whether the indications were cracks, fitup mismatch or discontinuities. Several important factors were considered which led us to the decision to cut out the section of feedwater piping with the indications. First, several other plants had also found cracks near the nozzles and the situation appeared to be coming more common. Second, due to turbine and generator problems the Kewaunee Plant was going to be put into an extended outage and ample time was available to cut out the pipe for a physical examination. Third, replacement piping was available on site, consequently, no delays were anticipated in reconstructing the FW piping.

When the sections of pipe were removed, about an 8 inch section on loop B and a 12 inch section on loop A, see figures 2.1-1 and 2.1-3, circumferential cracks were identified on the inside surface of pipe in the weld area and in pipe base metal near the weld. Several shallow surface cracks were also noticed on the nozzle side of the weld remaining attached to the S/G. These shallow cracks were removed by cutting away an additional 1/8 to 1/4 inch section of the nozzle on S/G A and by grinding and polishing loop B. The pipe sections were then flown to Westinghouse's metallurgical laboratory for detailed examination.

2.2 Metallurgical Examination

Visual examination showed distinct areas (lines) of corrosion in the cracked regions on the inside surface of the pipe. Radiography and ultrasonic examinations were conducted to determine areas of maximum crack depth for metallurgical specimen selection. Crack profiles of extent and depth are shown in Figures 2.2-1 and 2.2-2 for loops A and B, respectively.

Loop A had lesser cracking with less depth than Loop B. Loop B's cracking extended almost 360^{o} around the I.D. circumference. Metallurgical microstructure was typical ferrite/pearlite and the chemical composition checked out correct. Metallurgical properties, charpy and tensile tests, are still being checked and will be included in the full metallurgical report.

Transmission Electron Microscopy (TEM) showed evidence in isolated areas of high cycle fatigue. Scanning Electron Microscopy (SEM) work is still in progress.

A microchemical analysis (EDAX) was completed and no elements were detected which could be identified as contributing to the cracking/corrosion problem. Kewaunee's analysis was typical of other plants examined.

For both loops most of the cracking occurred at the geometric discontinuity area. Cracking was observed originating from the I.D. surface in the heat affected zone and propagating into weld metal. Some cracking occurred in the land region. Oxide was observed in the cracks.

The fracture mechanism is identified as high cycle fatigue. In some cases cracks were associated with corrosion pits. The cracks appear to be stress controlled and propagate through the ferrite/pearlite microstructure transgranularly. The cracking observed in the Kewaunee Plant is similar to the other plants examined by Westinghouse, but less severe.

2.3 Continuing EXAMINATIONS/BULLETIN 79-13

On June 25, 1979, IE Bulletin 79-13 was issued requiring all PWR plants to examine their FW to S/G nozzle welds and to perform additional FW line weld inspections in several phases. Several interpretations in regards to what sections of FW piping should be examined and what should be the timing of these exams could be made. Our interpretation is that Auxiliary Feedwater to the S/G integrity be maintained. This implies that the integrity of the section of FW pipe that includes the Aux. Feed connection and the FW check valve would have to be maintained. Therefore, all welds from the S/G nozzle to the first rigid support upstream of the FW check valve should be examined. This interpretation was discussed with NRC IE Region III, NRC Washington and with Westinghouse licensing with no objections on anyones' part.

A further problem exists at Kewaunee in that loop B FW line is partially encapsulated. Therefore, five welds upstream of the FW check valve, but before the first rigid support, could not be examined. Our intention was to perform all the examinations required within the current refueling outage, so no further shutdowns would be necessary to complete the required exams within the time allowed in the bulletin. Therefore, recognizing the increased protection afforded by the encapsulation, we sought a waiver of the bulletin's requirements for the encapsulated welds.

Investigations of both loops showed linear indications (shallow cracking or pitting) on the inside surface in the two additional welds in each loop between the FW check valve and S/G nozzle, but no cracking was detected in any welds upstream of the check valves. A minor slag inclusion in a weld upstream of the check valve on loop A was noted, but is completely unrelated to the cracking noted downstream of the check valves. Based on these findings there appears to be no reason to suspect any problems associated with the welds contained in the encapsulated piping.

2.3 (Continued)

The preliminary evidence, therefore, suggests that the cracking that occurred was cyclic fatigue stress cracking aided by corrosion, and is associated only with the short section of FW piping interfaced with the Aux Feedwater connection.

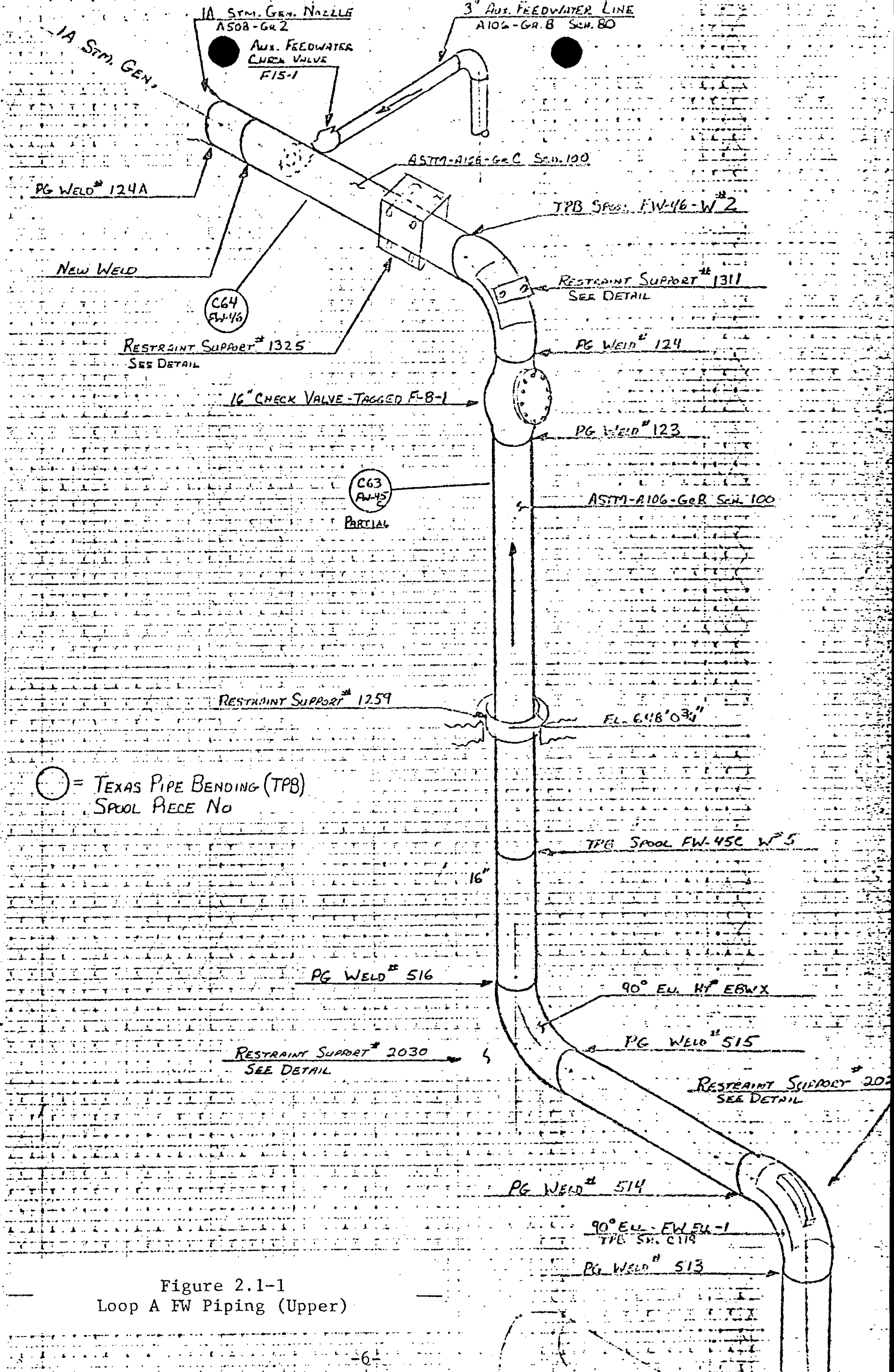
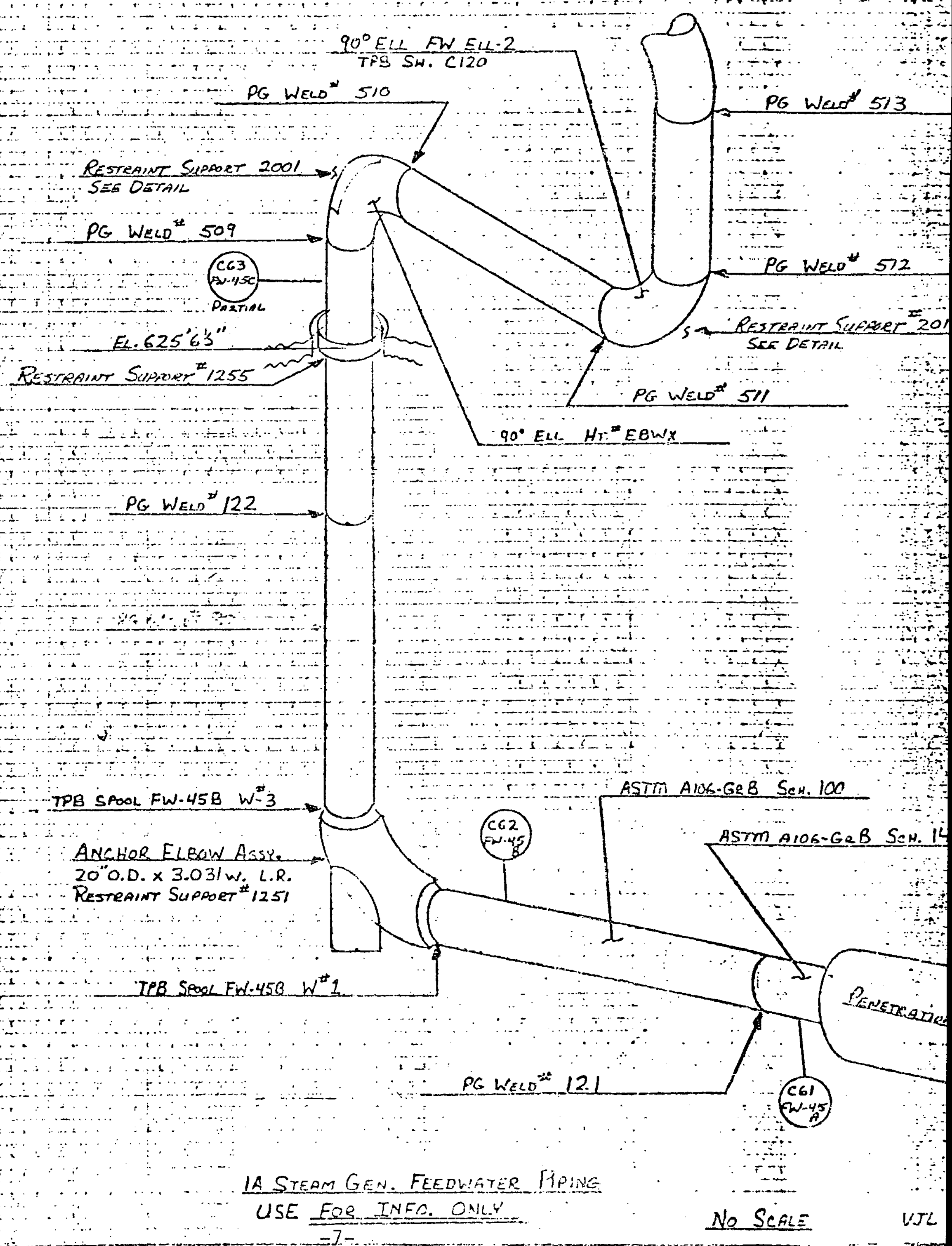


Figure 2.1-1
Loop A FW Piping (Upper)

Figure 2.1-2
Loop A FW Piping (Lower)



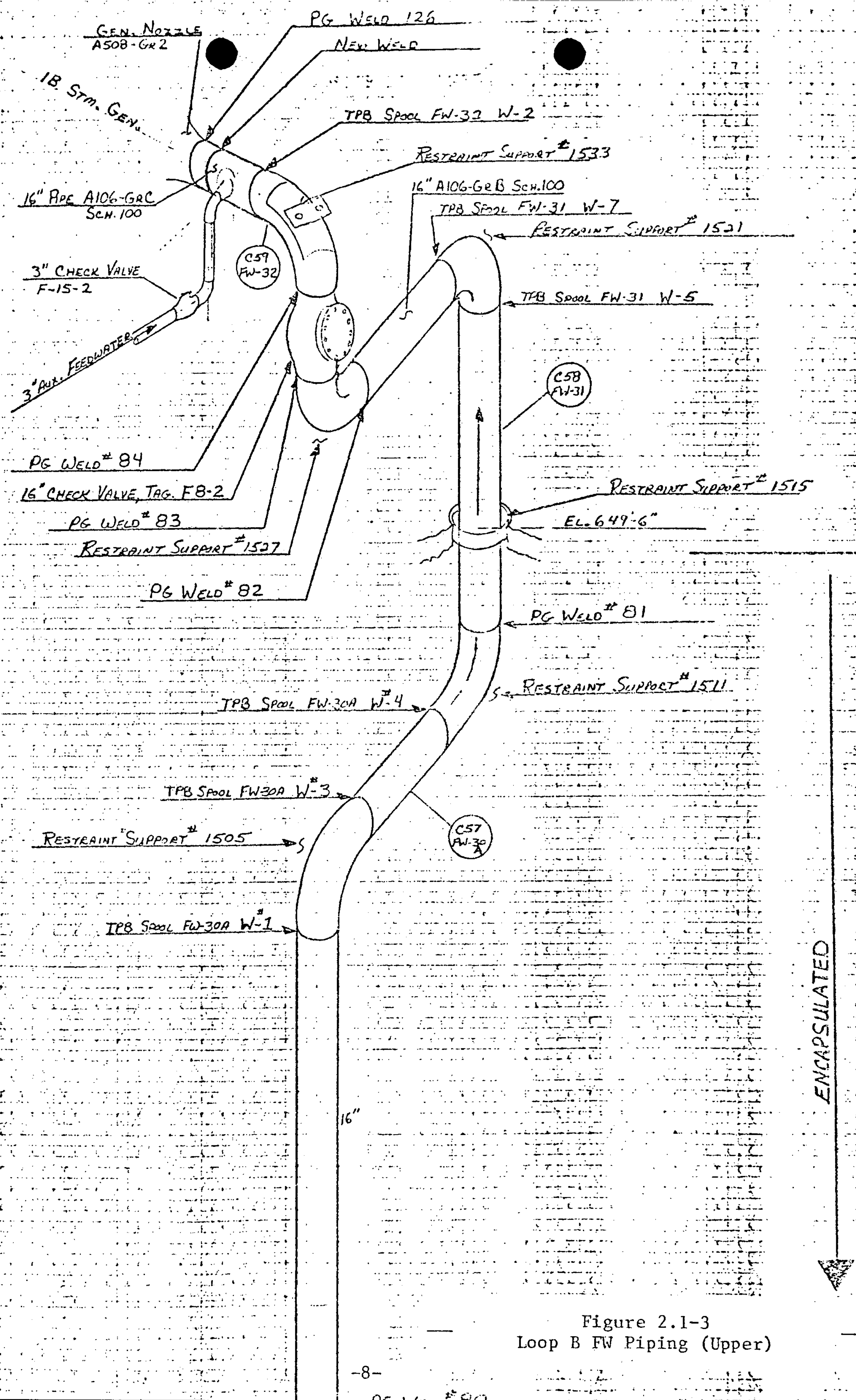


Figure 2.1-3
Loop B FW Piping (Upper)

Figure 2.1-4
Loop B FW Piping (Lower)

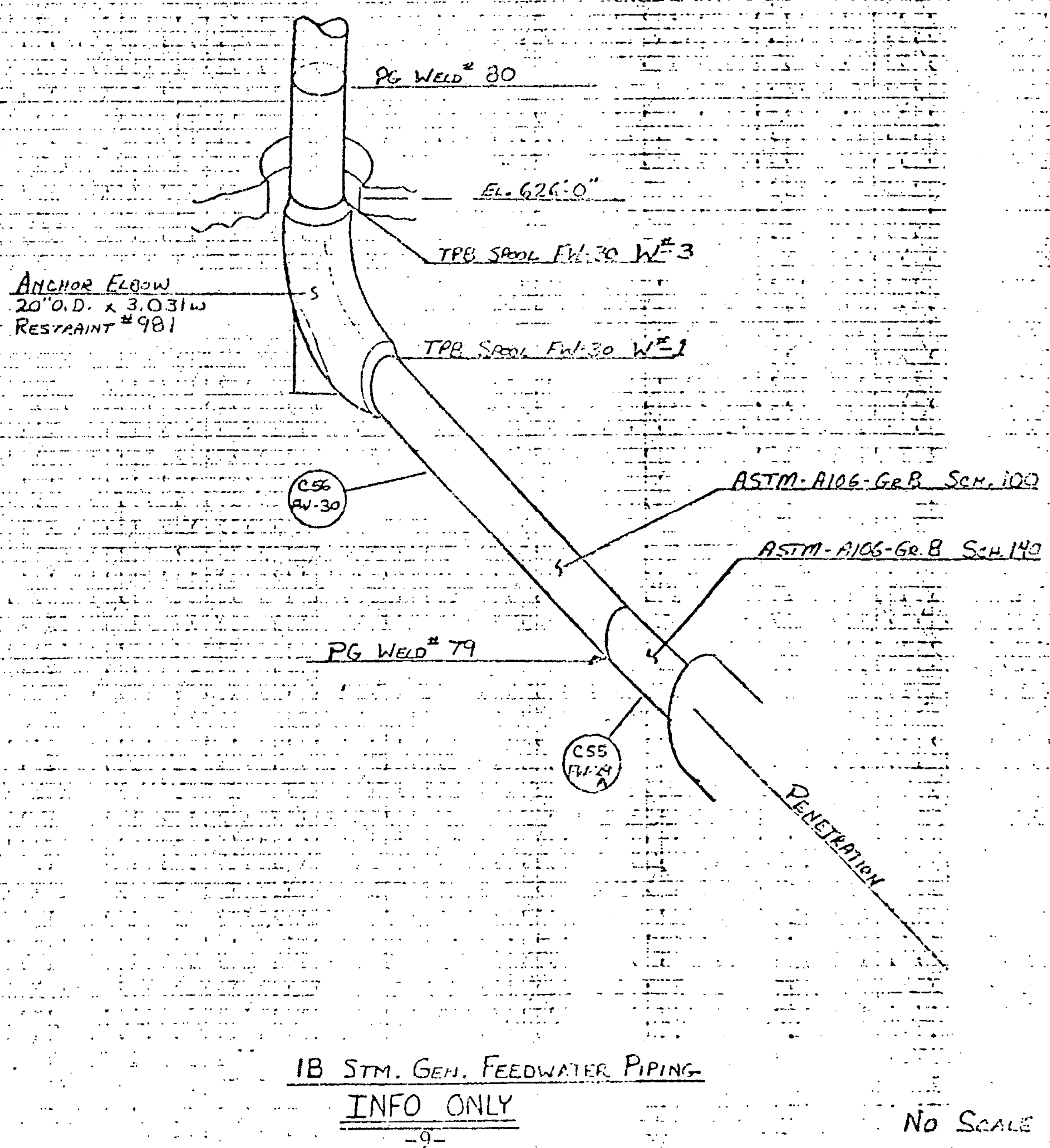


Figure 2.2-1
FW Nozzle to Pipe Loop A

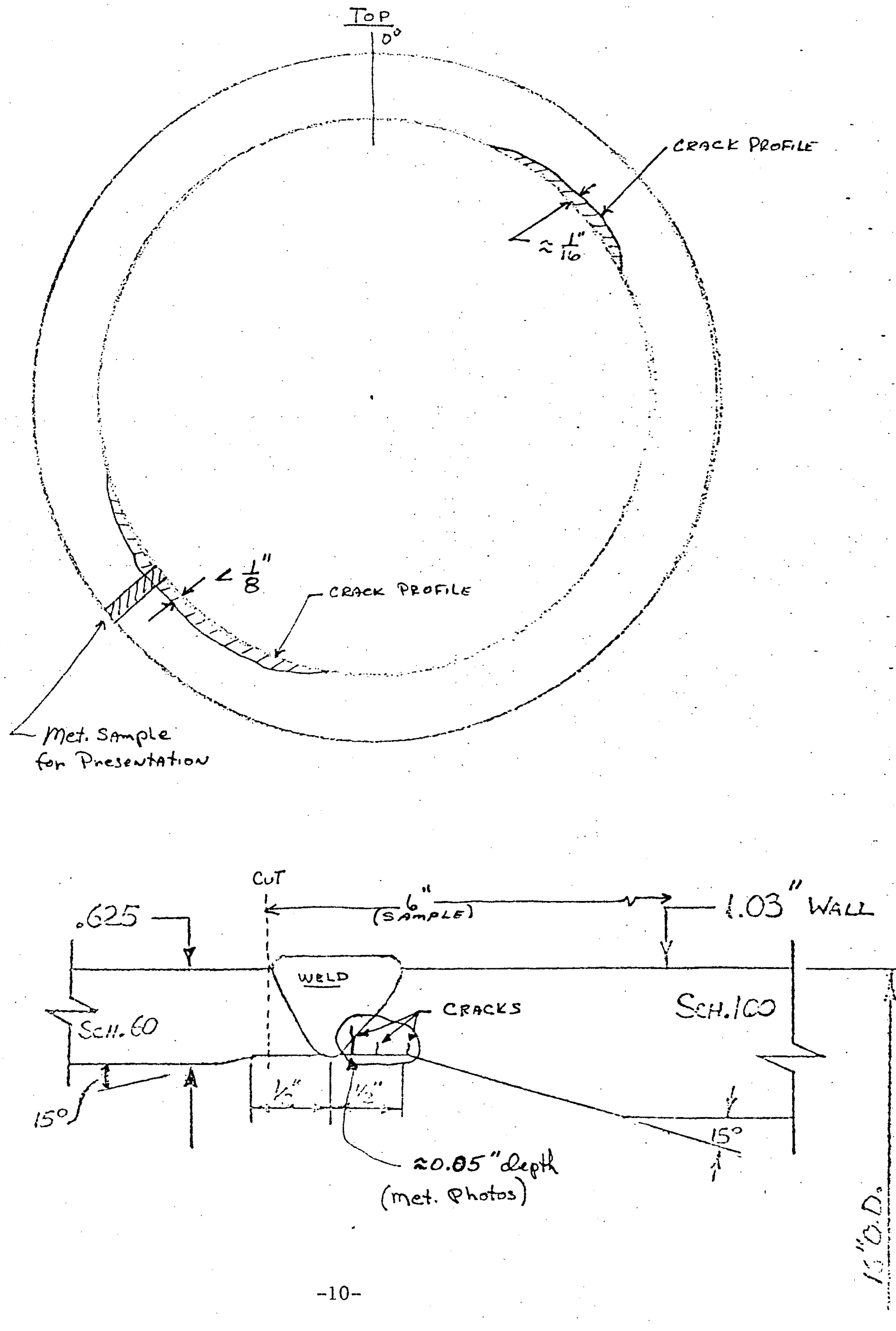
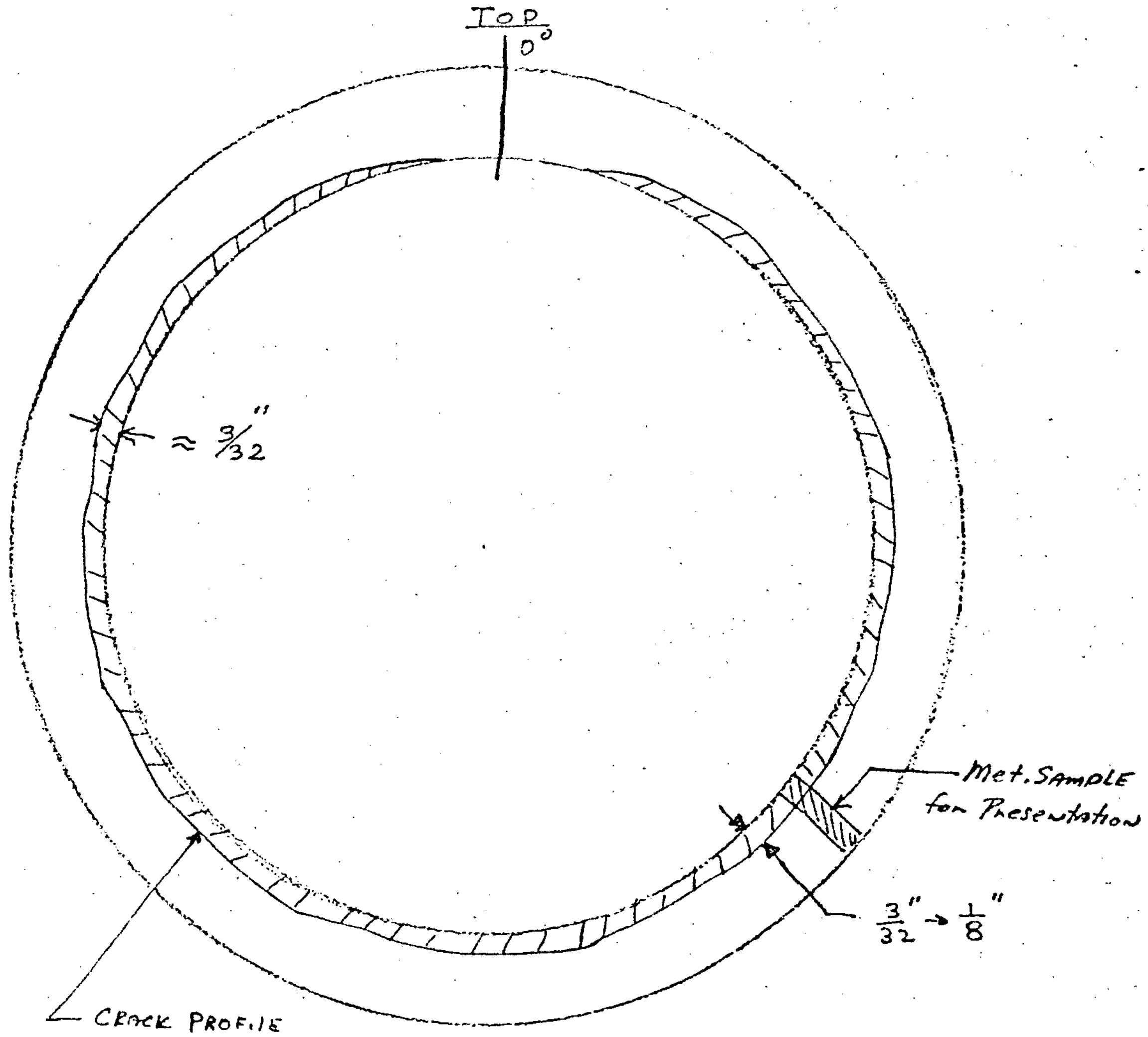
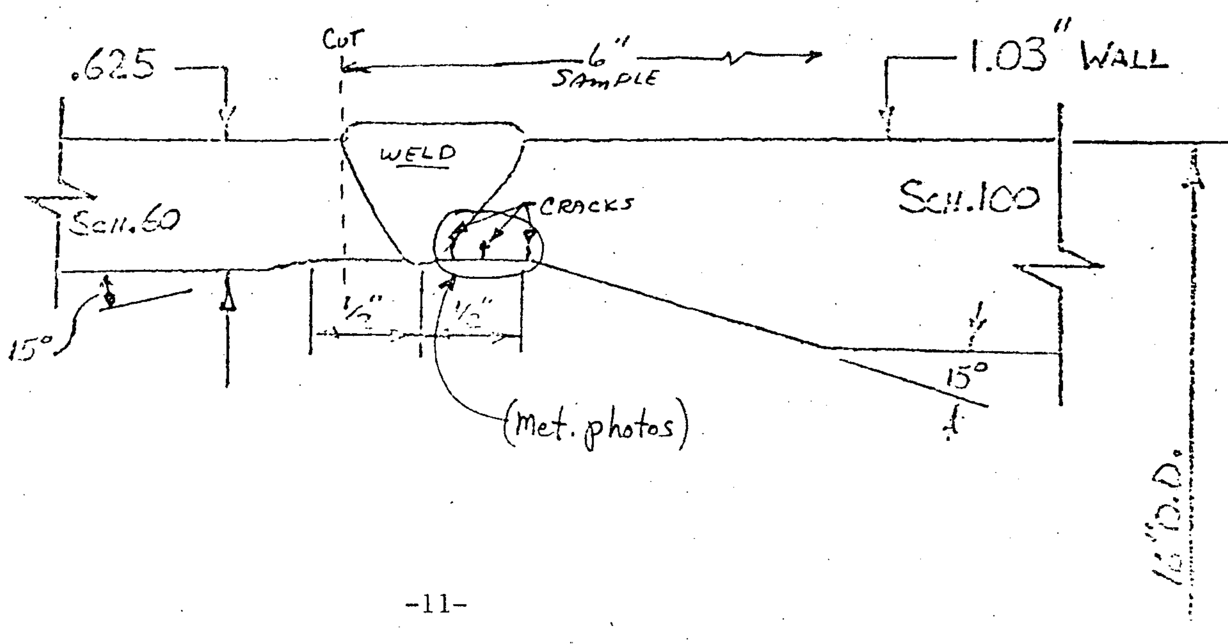


Figure 2.2-2
Nozzle to Pipe Loop B





3.0 DATA ACCUMULATION

A May 25, 1979 letter from the NRC requested design, fabrication and operating history data from all PWR's. This background information can be used to compare and analyze situations at various plants to determine the causes of the FW pipe problems. We had provided some of the data to the NRC in our 20 day response and the intent of this portion of the presentation (report) was to complete the information package requested and use it to summarize possible causes for the cracking found at Kewaunee. Detailed drawings of the FW lines inside containment and a summary of the stress analysis results were presented at the meeting. A summary of operating history and chemistry was presented and an updated summary is included in this section of the report.

3.1 Stress Analysis

A summary of the stress analysis results are included in Attachment A to this report. The Kewaunee Plant FW system was designed to ANSI B.31.1 - 1967 addition of the code. The FW piping of concern is Quality Assurance Type I and Design Class I. The piping is ASTM A-106 Grade B, Schedule 100, with the exception of short section of piping attached to the S/G nozzle which is ASTM A-106 Grade C, Schedule 100. The grade C piping near the nozzle gives added strength to the section of piping that realizes the highest thermal stress.

A review of the design stresses on the FW piping indicated that the pipe should handle the thermal changes without cracking. The analysis did not consider the thermal transient that would be induced in the case of a reactor trip followed by main feedwater isolation and Aux feedwater injection at much colder temperatures. Details of the programming necessary to calculate the pipe stress under these conditions is being evaluated and will be performed if feasible.

3.2 Feedwater Pipe Support Structure

An inspection and visual examination of the FW piping inside containment was performed to ensure that no discrepancies existed between the physical plant and the input to the stress analysis. Several changes had occurred since initial startup of the plant. They are as follows:

(1) The rods for the pipe rupture restraints at the first elbow out from the S/G's were found to be tight against the slotted holes of the pipe bracket. These holes will be enlarged to accomodate the rods without interference.

(2) Pipe rupture restraint on second elbow of loop A was bound with the pipe. Clearance was not adequate for pipe movement and will be ground off 1/2 inch to provide clearance.

(3) Guard pipe on loop B at the 644 foot level was bound to pipe. The guard pipe will be cut and restraint shimming will be removed to accomodate pipe movement.

It is felt that these minor discrepancies did not create sufficient additional stress problems to cause the indicated cracking. However, they will be input to the analysis and the results will be reviewed.

3.3 Operating History

A summary of operating events that have a potential to change the induced stress associated with the FW piping is presented in Table 3.3-1. Approximately 40 reactor trips occurred from power levels above 50% power. These trips had the potential of uncovering the S/G feed ring due to shrink in the S/G, thereby causing the feed ring and section of FW piping back to the check valve to drain. Lo-Lo S/G levels would then cause automatic starting of Aux. FW into those sections of pipe at temperatures about 400°F lower than normal feedwater and piping temperatures. It should be noted that none of these events caused a noticeable or measurable FW hammer event.

3.3 (Continued)

Another significant factor that is not recorded as a single event was the FW pump vibration problems encountered from startup through the end of cycle I. The original even number vane FW pump impellers caused large vibration problems in the FW system. This problem was corrected with the installation of 7-vane impellers during cycle I - II refueling.

As documented with our February 3, 1978 transmittal of Feedwater Line Water Hammer report, no feedwater hammer events were ever noticed at the Kewaunee Plant and the design of our feedwater system precludes a water hammer event.

No other significant operating events have been noted.

3.4 Chemistry Summation

Chemistry data covering the period of January, 1974 through May, 1979 for the secondary systems was reviewed to determine whether any parameters were outside of their limits, see Table 3.4-1, for extended periods of time.

Chlorides and oxygen data was examined in great detail and Table 3.4-2 summarizes the results. Chlorides have been maintained within 10% of the limit since startup of the plant. Oxygen limits have been exceeded, but this has been due to oxygen leaks at the sample panel. Feedwater pump suction oxygen values were less than 0.005 mg/1.

Suspended solids were high during early 1974, when the plant was undergoing startup tests, averaging about 50 mg/1. They remained above 5.0 mg/1 until late 1975. Through 1976 and 1977 they were well below 2.0 mg/1, but increased again in June, 1978 to average about 50 mg/1. This lasted only ten days, due to blowdown rate changes. Solids were reduced to 1 mg/1 or less following the ten day period and remained under 2.0 mg/1 for the remainder of the year. During the first five months of 1979 suspended solids exceeded 5.0 mg/1 on a few occasions, averaging about 6.0 mg/1.

3.4 (Continued)

Sodium measurements, for the steam generator were above limits through the middle of September 1974 averaging about 20 mg/l. Sodium values fell below 1 mg/l, then increased again to average about 10 mg/l until October, and have been less than 0.005 mg/l with occasional samples approaching 0.15 mg/l. Since late 1974, samples have measured well within the action level limits.

Other secondary system parameters have not shown any significant change from the limits specified.

TABLE 3.3-1

OPERATING HISTORY SUMMARY

Number of Heat Ups

21 Total

5 Prior to June '74

Number of Cooldowns

21 Total

4 Prior to June '74

Number of Reactor Trips

63 Total

12 Prior to June '74

26 from $\geq$ 90%

14 from $\geq$ 50%

Number of Reactor Shutdowns

32 Total

4 Prior to June '74

Number of Reactor Startups (G1 closed)

95 Total

17 Prior to June '74

TABLE 3.4-1

SECONDARY CHEMISTRY LIMITS

Parameter	Limits	Action Level
pH	8.8 - 9.2	8.8, 9.2
Cation Conductivity	2.0	increasing
Ammonia (mg/1)	0.25	0.25
Sodium (mg/1)	0.005	24 hrs. 0.02
		72 hrs. 0.01
		7 days 0.005
Suspended Solids (mg/1)	5.0	5.0
Soluble Iron (mg/1)	0.5	0.5
Soluble Copper (mg/1)	0.05	0.05
Free Hydroxide, Cation	0.05	0.05
Oxygen, O_2 (mg/1)	0.005	0.005
*Hydrazine	0^2 + 5 ppb	0^2 + 5 ppb
Chlorides (mg/1)	1.0	1.0

*Only additive is hydrazine

TABLE 3.4-2

SECONDARY CHEMISTRY SUMMARY

Year	Parameter	No. of days exceeded limit	High Value (mg/l)	Avg. Value (mg/l)
1974	Cl	0	0.53	0.1
	O_2	9	0.114*	0.002
1975	Cl	0	0.3	0.1
	O_2	8	0.07*	0.005
1976	Cl	0	0.04	0.01
	O_2	19	0.07*	0.002
1977	Cl	0	0.01	0.02
	O_2	2	0.01	0.005
1978	Cl	0	0.05	0.05
	O_2	4	0.015*	0.005
1979	Cl	0	0.05	0.05
	O_2	2	0.015*	0.002

*The high values of O_2 are partially due to O_2 leakage at the sample panel.

4.0 CORRECTIVE ACTION

4.1 Short Term Repair

The two welds between the S/G weld (both A & B loops) and the feedwater check valves were repaired by grinding out the very shallow linear indications on the inside surface. This was done by gaining access through disassembled feedwater check valves. After grinding, the welds were radiographed and liquid penetrant tested to insure the indications were completely removed. The weld containing the slag inclusion was repaired by grinding from the outside surface and rewelded.

The two sections of pipe that were cut out for metallurgical analysis were replaced with sections of pipe having a 5^{o} chamfer rather than the original 15^{o}. This essentially eliminated the discontinuity at each end of the chamber. All new welds were then stress relieved.

At the completion of the repair, all repaired welds were baseline radiographed and ultrasonically tested. The test results were reviewed for weld flaws and to insure that the grinding did not approach the required minimum wall thickness. All test results were satisfactory.

4.2 Long Term Evaluation & Inspection

All feedwater system welds that were repaired as a result of the IE Bulletin 79-13 inspection will be radiographed and ultrasonically inspected at our next refueling. These test results will be compared to the baseline radiographs and ultrasonic test results to determine if any cracking is occurring.

The test programs at D. C. Cook and other plants that have installed instrumentation will be closely monitored. Results from these programs will be evaluated to determine if modifications or changes in operating practices are necessary.

4.2 (Continued)

When completed by Westinghouse, the final metallurgical analysis report will be reviewed and the failure mode results used for possible long term corrections.

ATTACHMENT A

STRESS ANALYSIS RESULT SUMMARY

KNPP

FEEDWATER SYSTEM

- Piping System

  ANSI B.31.1 - 1967

  Quality Assurance Type I

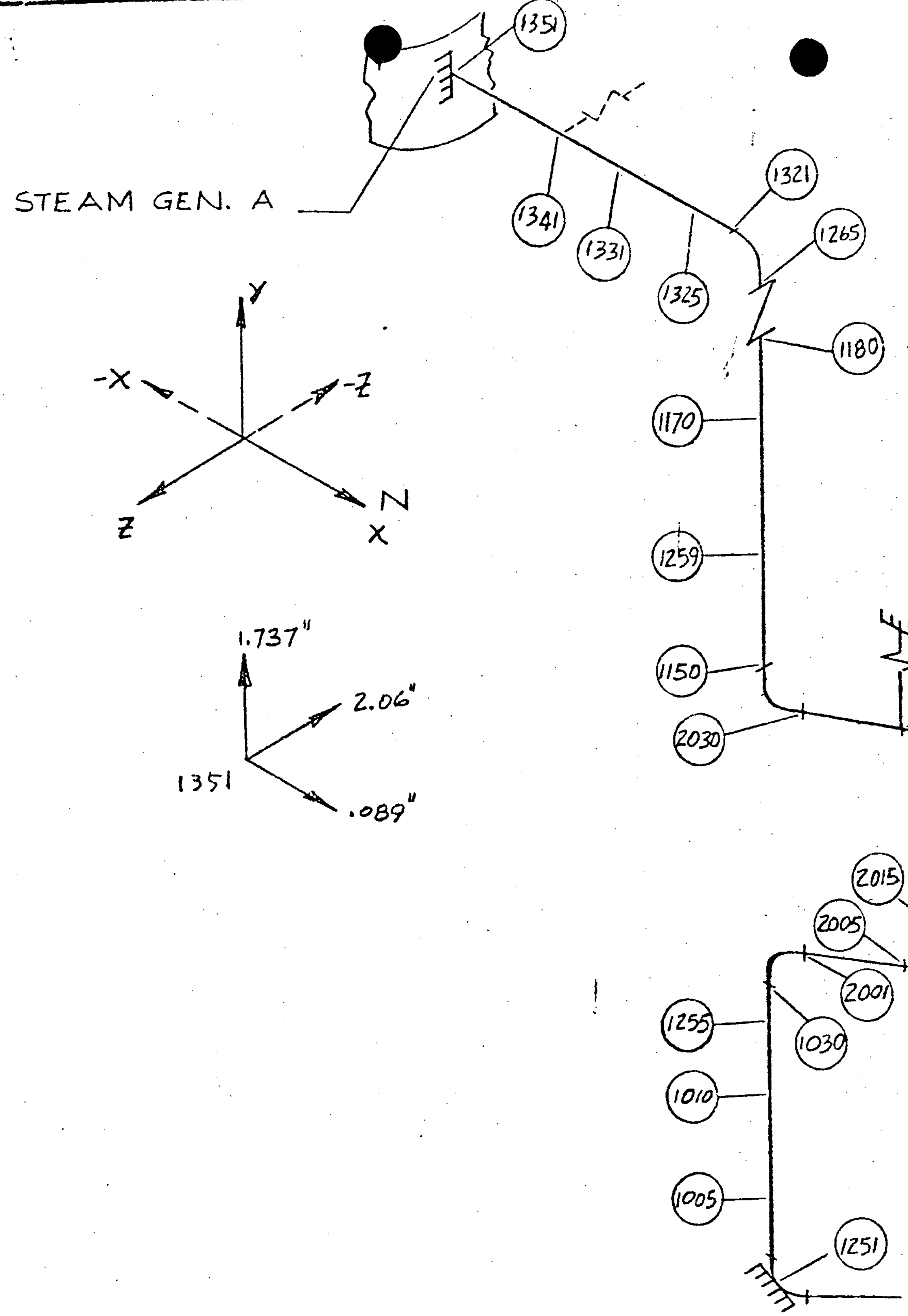
  Design Class I

- Material

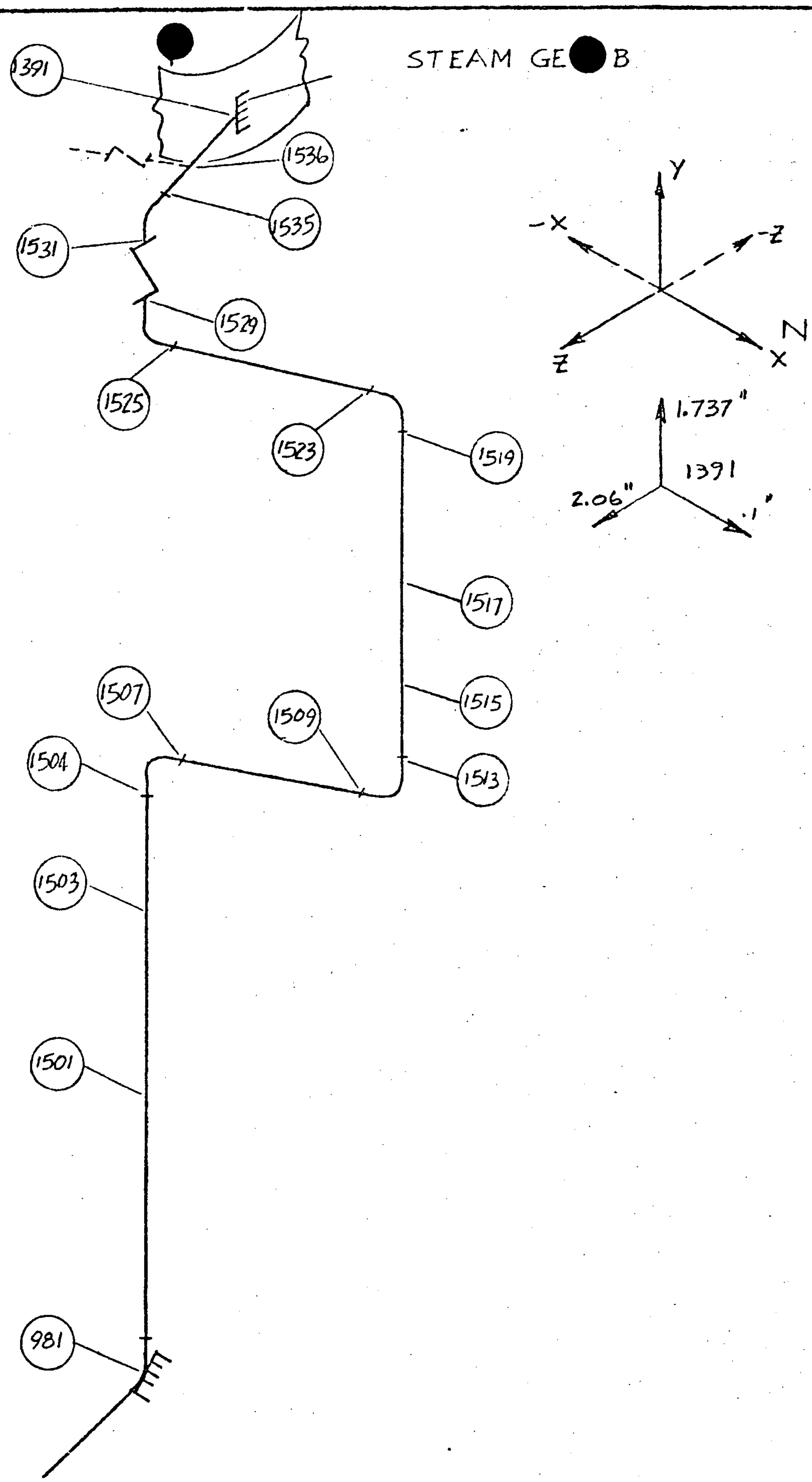
  ASTM A-106, Grade B - Piping

  ASTM A-106, Grade C - Nozzle Attachment

  Schedule 100



Form I-136 2/2/77



Form I-136 2/2/77

PIPE STRESS ANALYSES FOR FEEDWATER PIPING

(I) THERMAL EXPANSION STRESS ANALYSIS

(1) START-UP CONDITION

(2) NORMAL OPERATING CONDITION

(II) WEIGHT ANALYSIS

(III) DYNAMIC SEISMIC ANALYSIS

(1) OPERATING BASIS EARTHQUAKE

(2) DESIGN BASIS EARTHQUAKE

(IV) STRESS COMBINATION ANALYSIS

WISCONSIN PUBLIC SERVICE COMPANY   KEWAUNEE NUCLEAR POWER PLANT   PROJECT 23-7127
FEED WATER PIPING SYSTEM 224   DATA BY: C.KOSTENKO   PART NUMBER I
FEED WATER PIPING ANCHORED ELBOW TO STEAM GENERATOR 1A

POINT NUMBER	INTERNAL PRESSURE STRESS-PSI	THERMAL EXPANSION STRESS-PSI	PRESS.+WEIGHT + X-EARTHQUAKE LONG. STRESS-PSI	PRESS.+WEIGHT + Z-EARTHQUAKE LONG. STRESS-PSI	PRESS.+WEIGHT + MAX. HYPOTH. EARTHQUAKE LONG. STRESS-PSI
1251	11639.	3770.	6451.	7543.	10040.
1005	11639.	3090.	5764.	6402.	8070.
1010	11639.	2391.	5133.	5521.	6230.
1255	11639.	1664.	5113.	5113.	5331.
1030	11639.	2544.	5554.	5536.	6056.
2001	11639.	1700.	5762.	5921.	6503.
2005	11639.	1614.	5509.	5531.	5700.
2015	11639.	1534.	5651.	6005.	6765.
1090	11639.	689.	5408.	5652.	6615.
2018	11639.	556.	5929.	6752.	6144.
2022	11639.	818.	6531.	6511.	5972.
2022	11639.	533.	5857.	5937.	6171.
2030	11639.	307.	6237.	5922.	6977.
1150	11639.	433.	7558.	7671.	9275.
1259	11639.	1122.	6211.	6373.	7193.
1170	11639.	1966.	5503.	5619.	5744.
1180	11639.	2576.	5763.	5870.	6373.
1263	11639.	0.	4720.	4720.	4720.
1265	11639.	4462.	5573.	6839.	8033.
1321	11639.	3211.	5765.	5872.	6798.
1325	11639.	3155.	5670.	5835.	6453.
1331	11639.	3208.	6748.	7185.	8037.
1391	11639.	3578.	8034.	8995.	10825.

POINT NUMBER	INTERNAL PRESSURE STRESS-PSI	THERMAL EXPANSION STRESS-PSI	PRESS.+WEIGHT + X-EARTHQUAKE LONG. STRESS-PSI	PRESS.+WEIGHT + Z-EARTHQUAKE LONG. STRESS-PSI	PRESS.+WEIGHT + MAX. HYPOTH. EARTHQUAKE LONG. STRESS-PSI
1341	11639.	3576.	8004.	6999.	10825.
1351	11639.	3360.	9308.	10000.	11375.

*** INDICATES THE POINT WHERE IS OVERSTRESSED

[illegible]
[illegible]
PIPING FROM [illegible] TO ANCHOR [illegible]

[illegible] NUCLEAR PLANT UNIT NO. [illegible]
[illegible] PART-2 DATA BY: I.P. ACHACOSO

23-7127

POINT NUMBER	INTERNAL PRESSURE STRESS-PSI	THERMAL EXPANSION STRESS-PSI	PRESS.+WEIGHT + X-EARTHQUAKE LONG. STRESS-PSI	PRESS.+WEIGHT + Z-EARTHQUAKE LONG. STRESS-PSI	PRESS.+WEIGHT + MAX. HYPOTH. EARTHQUAKE LONG. STRESS-PSI
981	11639.	7550.	6491.	6572.	7399.
1501	11639.	5073	4905.	4985.	5150.
1503	11639.	3885.	5487.	5431.	5665.
1504	11639.	4522.	6862.	6790.	7431.
1507	11639.	2569.	6088.	5911.	6572.
1509	11639.	2807.	5798.	5683.	6098.
1513	11639.	4474.	5952.	6220.	6750.
1515	11639.	3134.	5221.	5417.	5744.
1517	11639.	3366.	4943.	5097.	5330.
1519	11639.	5946.	5729.	5690.	5989.
1523	11639.	4419.	5731.	5626.	6018.
1525	11639.	2179.	5466.	5626.	6032.
1529	11639.	4495.	5946.	5983.	6208.
1530	11639.	0.	4720.	4720.	4720.
1531	11639.	5383.	5643.	5778.	6159.
1535	11639.	7875.	6531.	7067.	7922.
1536	11639.	8342.	6625.	7119.	7981.
1536	11639.	8342.	6625.	7119.	7981.
1391	11639.	6272.	7428.	7722.	8339.

*** INDICATES THE POINT WHERE IS OVERSTRESSED

WISCONSIN PUBLIC SERVICE COMPANY KEWAUNEE NUCLEAR POWER PLANT PROJECT 23-7127
FEED WATER PIPING SYSTEM 224 DATA BY: C.KOSTENKO PART NUMBER I Start up
FEED WATER PIPING ANCHORED ELBOW TO STEAM GENERATOR 1

POINT NUMBER	BRANCH NUMBER	EXPANSION STRESS(PSI)	DEFLECTION IN INCHES D(X)	D(Y)	D(Z)	MOMENT ABOUT AXIS(FT-LB) M(X)	M(Y)	M(Z)	ROTATION ABOUT AXIS(RAD) R(X)	R(Y)	R(Z)
1251	1	8693.	-.000	-.000	-.000	-930.	1395.	123569.	.000000	.000000	.000000
1005	1	7535.	-.092	.002	.000	4618.	1395.	107017.	.000041	.000040	.002543
1010	1	6372.	-.359	.003	.008	10325.	1395.	89992.	.000210	.000081	.004778
1255	1	5519.	-.661	.004	.025	14655.	1395.	77074.	.000425	.000112	.006217
1030	1	8017.	-.813	.005	.036	16507.	1395.	71548.	.000540	.000126	.006754
2001	1	1325.	-1.002	.193	.051	-10327.	-2985.	12953.	.001047	.000250	.005755
2005	1	10916.	-1.007	.534	.042	-60615.	-10650.	-79657.	.000524	.000164	.003514
2015	1	17892.	-1.135	.673	.011	-87449.	-15030.	-138252.	-.002562	-.000095	.003220
1090	1	11963.	-1.223	.674	-.099	-24596.	-15030.	-146765.	-.003538	-.000317	.001635
2016	1	18964.	-1.248	.674	-.192	-82693.	-15030.	-152440.	-.004171	-.000465	.000472
2022	1	12862.	-1.211	.822	-.337	-52055.	-10650.	-105195.	-.007382	-.000819	-.005339
2022	2	8290.	-1.211	.822	-.337	-52055.	-10650.	-105195.	-.007382	-.000819	-.005337
2030	2	810.	-1.229	1.194	-.370	978.	-2985.	-7531.	-.007704	-.000909	-.006093
1150	2	5897.	-1.106	1.407	-.565	33163.	1395.	42002.	-.006664	-.000875	-.004943
1259	2	3207.	-.703	1.409	-1.143	40338.	1395.	21112.	-.005810	-.000824	-.004030
1170	2	3339.	-.303	1.411	-1.608	47452.	1395.	39.	-.004577	-.000773	-.003753
1130	2	3812.	-.134	1.413	-1.857	52258.	1395.	-14296.	-.003624	-.000738	-.003869
1263	2	0.	-.073	1.413	-1.915	53525.	1395.	-16079.	-.003624	-.000738	-.003869
1265	2	6442.	-.011	1.413	-1.973	54793.	1395.	-21861.	-.003624	-.000738	-.003869
1321	2	5509.	.089	1.515	-2.051	56696.	3297.	35969.	-.001973	-.000178	-.003973
1325	2	5802.	.089	1.552	-2.052	56696.	4010.	59783.	-.001764	-.000158	-.003637
1331	2	10064.	.089	1.649	-2.057	56696.	6151.	131226.	-.001137	-.000125	-.003034
1341	2	22702.(***)	.089	1.700	-2.059	56696.	7653.	121395.	-.000697	-.000084	-.002090

ALLOWABLE STRESS AT 1341 IS 22500. PSI

A-8

POINT NUMBER	BRANCH NUMBER	EXPANSION STRESS(PSI)	DEFLECTION IN INCHES D(X)	D(Y)	D(Z)	MOMENT ABOUT AXIS(FT-LB) M(X)	M(Y)	M(Z)	ROTATION ABOUT AXIS(RAD) R(X)	R(Y)	R(Z)
1341	3	22702.(***)	.089	1.700	-2.059	56696.	7653.	181393.	-.000697	-.000084	-.002090
		ALLOWABLE STRESS AT 1341 IS 22500. PSI									
1351	3	18785.	.089	1.737	-2.060	56696.	10031.	260776.	.000000	.000000	-.000000

(***) INDICATES POINT WHERE PIPE IS OVERSTRESSED MAXIMUM STRESS = 22702. AT POINT 1341

WISCONSIN PUBLIC SERVICE CORPORATION   KEWAUNEE NUCLEAR PLANT UNIT NO. 1   23-7137
FEEDWATER PIPING SYSTEM NO. 224   DATA BY: J.R. ACHACOSO   PART PART-2
PIPING FROM STEAM GENERATOR 1-B TO ANCHORED ELBOW

Start up

POINT NUMBER	BRANCH NUMBER	EXPANSION STRESS(PSI)	DEFLECTION IN INCHES D(X)	D(Y)	D(Z)	MOMENT ABOUT AXIS(FT-LB) M(X)	M(Y)	M(Z)	ROTATION ABOUT AXIS(RAD) R(X)	R(Y)	R(Z)
981	1	8682.	-.000	-.000	-.000	112832.	-9717.	49094.	.000000	.000000	.000000
1501	1	7833.	-.124	.003	.259	88892.	-9717.	66423.	.003814	-.000475	.002164
1503	1	7591.	-.295	.004	.519	76850.	-9717.	75139.	.005391	-.000712	.003531
1504	1	11606.	-.492	.006	.804	67274.	-9717.	82070.	.006481	-.000909	.004720
1507	1	4263.	-.523	.235	1.039	33769.	-3907.	24810.	.008600	-.001307	.007493
1509	1	10758.	-.595	.741	1.066	-23666.	7713.	-96643.	.008758	-.001278	.005911
1513	1	17950.	-.670	.938	1.271	-57171.	13523.	-153903.	.006546	-.001119	.001294
1515	1	11460.	-.667	.938	1.460	-63155.	13523.	-149571.	.005978	-.000953	-.000141
1517	1	11336.	-.652	.939	1.662	-70338.	13523.	-144372.	.005220	-.000750	-.001808
1519	1	17369.	-.489	.940	1.910	-61111.	13523.	-136575.	.003732	-.000485	-.003139
1523	1	9957.	-.342	1.088	1.969	-57181.	7713.	-72353.	.001097	-.000563	-.005147
1525	1	5087.	-.347	1.487	1.957	253.	-3907.	49069.	.000581	-.000274	-.004553
1529	1	12663.	-.177	1.661	1.975	24182.	-9717.	113261.	.001512	-.000679	-.005599
1530	1	0.	-.087	1.661	1.999	20991.	-9717.	115571.	.001512	-.000679	-.005599
1531	1	13034.	.002	1.661	2.023	17800.	-9717.	117801.	.001512	-.000679	-.005599
1535	1	14277.	.101	1.720	2.060	-47714.	-8631.	150064.	.000483	.000051	-.001489
1536	1	16435.	.100	1.730	2.060	-73039.	-8177.	162021.	.000339	.000035	-.000898
1536	2	16438.	.100	1.730	2.060	-73039.	-8177.	162021.	.000339	.000035	-.000898
1391	2	14730.	.100	1.737	2.060	-108776.	-7537.	178915.	.000000	.000000	-.000000

(***) INDICATES POINT WHERE PIPE IS OVERSTRESSED   MAXIMUM STRESS = 17950. AT POINT 1513

A-10

KEWAUNEE

F.W.S.G. NOZZLE

STRESS LEVELS (psi)

	(A) Internal Pressure *	(B) Thermal Expansion	(C) Press, weight plus x-Earthquake Longitudinal Stress	(D) Press, weight plus z-Earthquake Longitudinal Stress	(E) Press, weight plus Design Basis Earthquake Longitudinal Stress
S.G.A. Pt. 1351	15,122	4,910 (1) 27,455 (2)	13,463	14,474	16,484
S.G.B. Pt. 1391	15,122	9,166 (1) 21,540 (2)	10,715	11,144	12,048

* Design pressure 1,085 psig

(1) Normal operating condition

(2) Hot stand-by condition

Remarks:

I. Allowable stresses for (A) is 17,500 psi.

II. Allowable stress for (B) is 26,250 psi. Including the additive stress, the allowable stress range at pt. 1351 is 26,250 + (17,500 - 6,757 - 5,709) = 31,286 psi; at pt. 1391 is 26,250 + (17,500 - 6,757 - 3,490) = 33,503 psi.

III. Allowable stress for (C) and (D) is 21,000 psi.

IV. Allowable stress for (E) is 31,500 psi.

PIONEER SERVICE AND ENGINEERING CO.
ANCHOR DESIGN SHEET

IT NO. I   ANALYSIS PT. NO. 1351

'.   ANCHOR NO.

TE: DETAIL DWG. NO.

ENT: WISCONSIN PUBLIC SERVICE COMPANY   PROJECT: KEWAUNEE NUCLEAR POWER PLANT

JECT NO. 23-7127   DATA BY: C.MOSTENKO

TEM ME + NO. FEED WATER PIPING SYSTEM 224   CHECKED:

CRIPTION: FEED WATER PIPING ANCHORED ELBOW TO STEAM GENERATOR 1A

RDINATES: X= -9.060 FT. Y= 55.051 FT. Z= .000 FT.

	FX	FY	FZ	MX	MY	MZ
GHT LOAD	-275.	-8356.	297.	-999.	-2729.	-55435.
RMAL EXPANSION	-137.	-510.	1659.	-43964.	-15332.	-10664.
SIGN SEISMIC X-QUAKE	994.	1478.	778.	5496.	7403.	6289.
(O.B.E.) Z-QUAKE	655.	1070.	1732.	12674.	17517.	8475.
UBLE SEISMIC X-QUAKE	1988.	2955.	1555.	10993.	14807.	12579.
(D.B.E.) Z-QUAKE	1310.	2141.	3464.	25346.	35234.	16951.
IGHT + THERMAL EXP.	-412.	-8867.	1956.	-44962.	-18061.	-66099.
.+ RMAL + OBE (X)	-1406.	-10344.	2734.	-50459.	-25464.	-72388.
.+ RMAL + OBE (Z)	-1067.	-9937.	3688.	-57636.	-35598.	-74574.
.+ THERMAL + DBE (X)	-2400.	-11822.	3511.	-55955.	-32867.	-78677.
.+ THERMAL + DBE (Z)	-1722.	-11007.	5420.	-70310.	-53314.	-83049.
X. LOAD X-QUAKE..	2400.	11822.	3511.	55755.	32867.	78677.
X. LOAD Z-QUAKE..	1722.	11007.	5420.	70310.	53314.	83049.

S. + E. DRNG. NO.

NDOR DRNG. NO.

MARKS: STEAM GENERATOR 1-A

[illegible] CO.

[illegible] SHEET

PAGE 2

ANALYSIS PT. NO. 1391

ANCHOR NO.

DETAIL DWG. NO.

PROJECT: [illegible] NUCLEAR PLANT UNIT NO. 1

DATA BY: J.B. ACHACOSO

CHECKED:

[illegible] TO ANCHORED FLOOR

X= [illegible] FT. Y= [illegible] FT. Z= -3.626 FT.

	FX	FY	FZ	MX	MY	MZ
[illegible]	[illegible]	[illegible]	-402.	29459.	5514.	[illegible]
[illegible]	[illegible]	[illegible]	-3646.	74949.	12187.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	2759.	3921.	[illegible]
[illegible]	[illegible]	[illegible]	1035.	4623.	6026.	[illegible]
[illegible]	[illegible]	[illegible]	1416.	5517.	7642.	7431.
[illegible]	[illegible]	[illegible]	2050.	12066.	12557.	[illegible]
[illegible]	[illegible]	[illegible]	-5131.	144427.	17762.	[illegible]
[illegible]	[illegible]	-18971.	-4649.	107155.	21924.	[illegible]
[illegible]	[illegible]	[illegible]	-6166.	110459.	23731.	[illegible]
[illegible]	3163.	[illegible]	-5147.	109944.	25345.	-71073.
[illegible]	[illegible]	-13749.	-6201.	116473.	29769.	[illegible]
[illegible]	3763.	[illegible]	5147.	109944.	25345.	71073.
[illegible]	[illegible]	13749.	6201.	116473.	29769.	68279.

STEAM GENERATOR 1-B

A-13