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OMB

September 11, 1987

Mr. A. Bert Davis
Regional Administrator
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Response to NRC Bulletin No. 87-01
Dresden Station Units 2 & 3
Quad Cities Station Units 1 & 2
Zion Station Units 1 and 2
LaSalle County Station Units 1 & 2
Byron Station Units 1 & 2
Braidwood Station Units 1 & 2
NRC Docket Nos. 50-237/249, 50-254/265, 50-295/304,
50-373/374, 50-454/455 and 50-456/457

Reference: NRC Bulletin No. 87-01, dated July 9, 1987

Dear Mr. Davis:

The above Referenced NRC Bulletin requested that licensees submit information concerning their programs for monitoring the thickness of pipe walls in high energy singe-phase and two-phase carbon steel piping systems.

Commonwealth Edison has completed its review pursuant to the request outlined in NRC Bulletin 87-01 for Dresden, Quad Cities, Zion, LaSalle, Byron and Braidwood Nuclear Power Stations. The information is attached in Enclosures 1 through 6, respectively.

To the best of my knowledge and belief, the statements contained above are true and correct. In some respect these statements are not based on my personal knowledge, but obtained information furnished by other Commonwealth Edison employees, contactor employees, and consultants. Such information has been reviewed in accordance with company practice, and I believe it to be reliable.

Please address any questions that you or your staff may have concerning this response to this office.

SEP 14 1987

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One signed original with enclosures is being sent directly to the U. S. Nuclear Regulatory Commission Document Control Room in Washington for reproduction and distribution as requested in the bulletin.

Respectfully,

M. S. Turbak

M. S. Turbak
Assistant Licensing Manager

cc: U. S. NRC Document Control Desk
Washington DC 20555

Resident Inspector - Dresden
Resident Inspector - Quad Cities
Resident Inspector - Zion
Resident Inspector - LaSalle
Resident Inspector - Byron
Resident Inspector - Braidwood

SUBSCRIBED and SWORN to
before me this 11th day
of September, 1987
Celia I. Mayo
Notary Public

3567K

Enclosure 1

DRESDEN STATION

Response to Items 1 - 5 of NRC Bulletin 87-01

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

High energy two phase and single phase carbon steel piping systems at Dresden inboard of the first isolation valve are designed and fabricated to USAS B31.1, 1967 Edition and ASME Section I, 1965 criteria. The remaining piping is designed and fabricated to USAS B31.1, 1967 Edition.

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. selecting points at which to make thickness measurements

   b. determining how frequently to make thickness measurements

   c. selecting the methods used to make thickness measurements

   d. making replacement/repair decisions

Response

In response to the Surry feedwater pipe rupture, a comprehensive long term inspection Erosion/Corrosion (E/C) program was developed and an initial short term inspection of the Dresden Unit 2 Feedwater System piping was performed.

Criterion for the long term program will be discussed in Item #5.

The short term inspection program consisted of numerous ultrasonic (UT) examinations of feedwater and condensate booster piping on Unit 2 during the 1986-1987 refueling outage. The scope and results of this inspection program are provided in the response to Item #4. The criterion established for point selection were: material (carbon steel systems), piping geometry (tees, elbows, orifices, other flow restrictions), velocity (8 ft/sec to 15 ft/sec) and temperature (>200°F). The number of measurements taken at each location was based on pipe size and accessibility. Baseline criteria for repair/replacement was not necessary during the short term inspection since the results indicated that wall thicknesses were well within code allowables.

In the past, for several cycles, Dresden has performed examinations of the extraction piping from the low pressure stages of the turbine to the feedwater heaters. Each refueling outage, one low pressure heater string is examined. The areas included in the inspection consist of fittings in the extraction steam piping, the extraction check valve bodies and trim, and the 'C' heater shells in the vicinity of the steam inlet nozzles. These areas were selected for periodic inspection because of the material and the piping configuration (elbow to nozzle with steam hitting the impingement plate which protects the tubes and being redirected to the heater shell). The frequency of the inspection was based on outage duration, past data, and expected corrosion rates.

These factors were also the basis for repair/replacement decisions. Repairs have been necessary at the 'C' heater shell/nozzle area.

In addition, the stop and control valve trim and the bypass and combined intermediate valve trim are routinely inspected. The turbine crossaround piping and one moisture separator and its associated piping are internally inspected each refueling outage. There have been no signs of significant corrosion detected in the crossaround piping. Some repairs have been necessary for the moisture separators.

3. For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping

<u>Response</u>

Prior to the Surry event, the only liquid phase E/C monitoring performed on an established frequency at Dresden was monitoring of piping at the Feedwater Regulating Valve (FRV) stations. The FRV stations for each unit are inspected each refueling outage. The inspection consists of UT examination of all six 18" elbows and two 24" tees on each station. This inspection program was initiated in 1976 as an indirect result of a feedwater minimum flow line rupture at Quad Cities Station. The inspection points were determined based on piping configuration.

The short term inspection program performed on the Unit 2 Feedwater System was based on material (carbon steel), piping configuration (elbows, tees, orifices, control valves, etc.), temperature (>200°F) and velocity (8-15 ft/sec). Systems reviewed for inclusion in the program were not restricted based on pH and oxygen content. The systems chosen contained deaerated water with a relatively neutral pH.

The criterion for the long term inspection program is discussed in the response to Item #5.

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspections).

c. Report thickness measurement results and note those that were identified as unacceptable and why.

d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

I. 1976-1986 Units 2 & 3 Feedwater Regulating Valve (FRV) Station

This program was specifically intended to measure pipe wall thicknesses. The piping and points examined are illustrated in Attachment A. Six elbows (18") and two tees (24" x 18") are routinely examined. Data is given for the 1976 and 1986 inspections in Table 1 to illustrate the E/C measured over a ten year period. The Attachment A illustration is used to identify locations for inspection. The piping insulation is marked to show the pieces which require removal for the inspection, however, the piping itself is not marked. No actions, except continued monitoring, have been taken since measured wall thicknesses are within code allowables.

II. 1978-1987 Low Pressure Extraction Lines to Feedwater Heaters

This program was developed to measure pipe wall thicknesses for possible erosion/corrosion. The piping is 1 1/4% chrome, 1/2% molybedum which is not as susceptable to two phase erosion as carbon steel and has not experienced significant corrosion over the past few cycles. The valve trim and heat exchanger nozzles and shells are carbon steel, A106GrB and A212GrB, and are not as resistant to E/C.

At Dresden there are three strings of cascading feedwater heaters. After experiencing leakage through the 'C' heater shell in the vicinity of the inlet nozzle, a review of the heater designs for the 'C', 'B', and 'D' heaters was performed. Since the design of the 'C' heaters is significantly different from the 'B' and 'D' heaters, and as such, is more susceptible to E/C, an inspection program was initiated for the 'C' heaters.

The shells of the three 'C' feedwater heaters are inspected every refueling outage. The inspection includes the nozzle and the heat exchanger shell in the area around the nozzle. This area on the 'C' heaters is insufficiently protected by the liner and is very susceptable to E/C. Steam flowing through the nozzle hits an impingement plate which protects the tubes and is redirected to the unprotected shell near the nozzle.

All of the nozzles on the Unit 3 'C' heaters have been repaired by installing a stainless steel (316) cladding inside the nozzle and making hard faced full penetration shell patches of A515Gr70.

The "C" feedwater heater nozzles on Unit 2 have also been repaired using either a 14 gage 316 stainless steel jacket or a A515 Gr70 clam shell plate.

One string of extraction check valves was disassembled and inspected on U2 during the 1986-1987 refueling outage. All valves exhibited only minor erosion damage.

III. 1978-1987 Turbine Crossaround and Crossunder piping

Visual inspection of turbine crossaround steam piping is performed every refueling outage to monitor E/C. There have been no signs of significant corrosion detected.

IV. 1986 Unit 2 E/C Inspection Program

This program was specifically designed to obtain wall thickness measurements of susceptable piping in order to detect and prevent the type of events which occurred at Surry Power Station.

UT examinations were performed on:

1) Feedwater pump discharge - five elbows after the 'B' pump

2) Condensate booster pump orifice

3) Feedwater pump suction - first elbow before the pump

4) Feedwater pump minimum flow valve

5) Feedwater Regulating Station elbows (existing program)*

6) Feedwater pump suction manifold

7) 'C' feedwater pump suction line 'back-to-back' 45 degree elbows

8) 'A' and 'C' feedwater pump discharge 45 degree elbows into the manifold and the manifold

9) Extraction check valves and piping from the low pressure stages to the feedwater heaters (existing program).*

10) Feedwater pump discharge piping upstream of the minimum flow valve

The results of these inspections are shown in Table 2. The feedwater pump minimum flow orifice line at the condenser was not inspected because the carbon steel piping was replaced with stainless steel piping in 1979. The inspections did not reveal any pipe wall thinning beyond the code-required minimum wall thickness. No repairs/replacements are planned at this time; however, the results of the long term inspection program described in Item #5 may necessitate additional analysis and/or repairs or replacements.

In summary, comprehensive inspection programs to monitor E/C in high energy single and two phase carbon steel systems were not performed prior to the Surry event. Routine visual inspections and some UT examinations have been performed of turbine crossaround piping, extraction steam lines, and FRV station piping since 1976. In response to the Surry event, extensive initial UT examinations were performed on the Unit 2 Feedwater and Condensate Booster Systems.

Of all of the inspections performed to date, the only areas in which significant E/C has been noted are the inlet nozzles to the 'C' feedwater heaters and the surrounding shell areas. Repair programs are in-place for this equipment as described in Dresden's response to Item #4.

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Commonwealth Edison Company began inspecting its high energy, carbon steel, single-phase liquid piping systems soon after hearing about the Surry Station feedwater pump suction pipe failure. Inspections were performed on several of our operating units in areas similar to that which failed at Surry when they came down for refueling outages. These inspections, which were based on engineering judgment of contributing factors such as temperature, velocity, piping configuration and material were performed to give us a quick indication of whether or not a servere problem of pipe wall thinning existed. None was discovered.

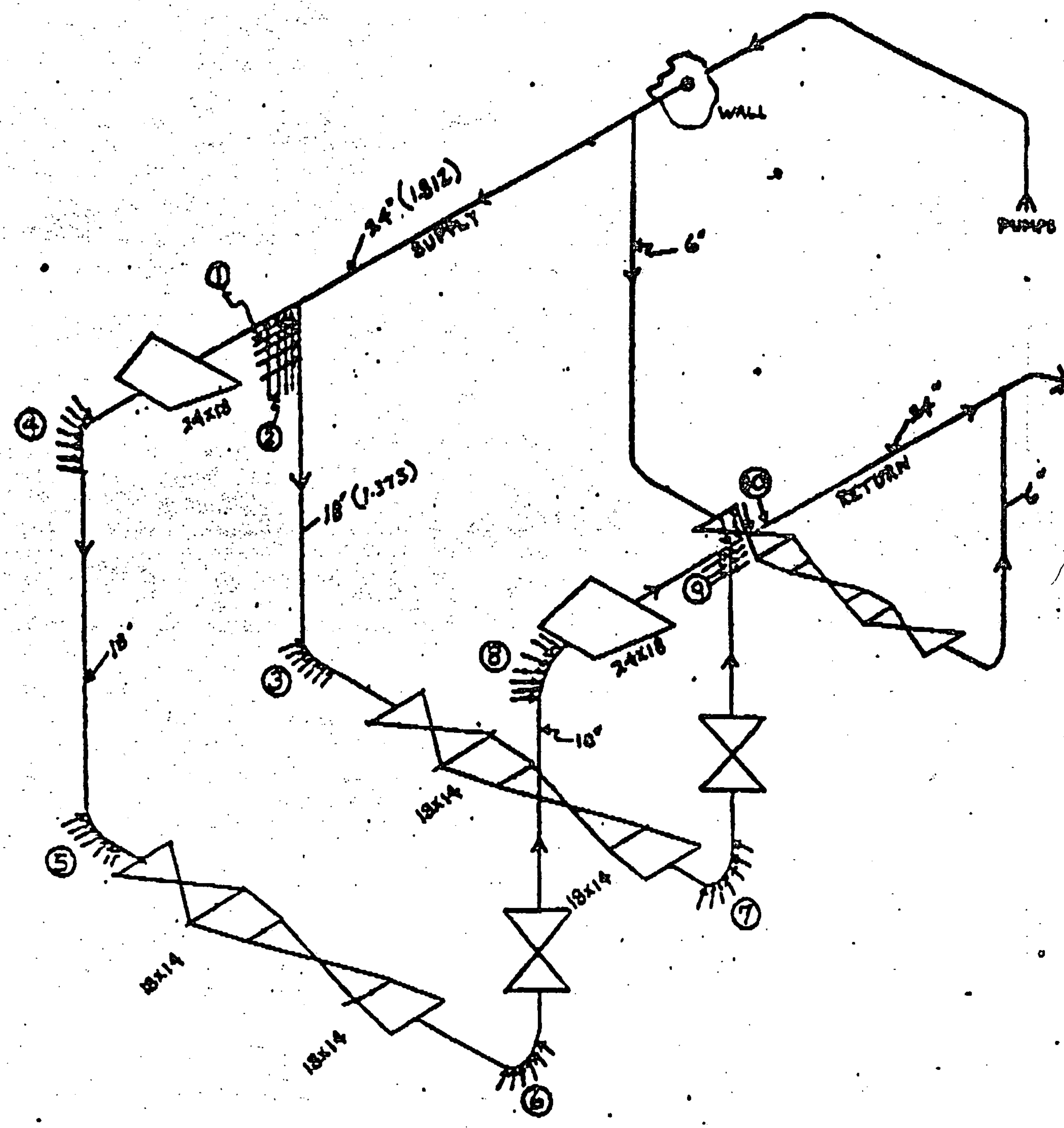
Plans for establishing an ongoing single-phase flow program have been approved. For our first inspection, scheduled at Quad Cities Station, Unit 1, in September, 1987, we are using three diverse methodologies to analyse our piping systems in order to identify those locations most susceptible to erosion/corrosion wall thinning. One of the methodologies is the EPRI CHEC computer program. The other two are methods developed by Technicon Enterprises, Inc. and O'Donnell & Associates, Inc. We chose these methods to evaluate on a trial basis after interviewing several consultants and reviewing their plans and experience. All three analysis methodologies are based on the most current knowledge available on this subject. All three take into consideration the following factors in establishing criteria for selecting piping components for inspection:

a. Piping Material
b. Temperature
c. Oxygen
d. pH
e. Velocity
f. Piping Configuration

Comparisons of the analyses and ranking techniques will be made after the inspection data has been collected and reviewed. We expect to select one of the three techniques for use on the remaining units. Thus, we believe that through this comprehensive, competitive demonstration, we shall be assured of a reliable, state-of-the-art methodology for analyzing our piping systems. This, along with criteria we are developing for acceptance, sample expansion and NDE will provide the basis for our ongoing monitoring program for single-phase liquid systems.

In addition to providing assistance in the establishment of our single-phase inspection program, the consultant we choose will analyze our existing two-phase flow programs and help us to bring them up to current standards. The revised two-phase flow programs shall meet or exceed the guidelines set in EPRI NP-3944, "Erosion/Corrosion in Nuclear Plant Steam Piping: Causes and Inspection Program Guidelines". The updated program will be used at all of our operating stations to assure a consistant and thorough approach to monitoring pipe wall thinning throughout our nuclear system.

Dresden
Attachment A
Ultrasonic Inspection of FDW Reg. Station



Typical Feedwater Regulating Station

TABLE 1
FRV STATION INSPECTION

Unit 2 FRV Station		Minimum Recorded Measurement		Code Min Wall
Location	Nom. Wall	1976	1986	
1	1.375	1.40	1.40	1.157
2	1.812	1.92	1.92	1.510
3	1.375	1.37	1.39	1.157
4	1.375	1.37	1.40	1.157
5	1.375	1.33	1.32	1.157
6	1.375	1.38	1.32	1.157
7	1.375	1.38	1.40	1.157
8	1.375	1.39	1.42	1.157
9	1.375	1.35	1.34	1.157
10	1.812	1.87	1.87	1.510

Instrument: Panametrics Epoch 2002 1986
Sonic FTS Mark 1 1976

Test Method: UT

Unit 3 FRV Station		Minimum Recorded Measurement		Code Min Wall
Location	Nom. Wall	1976	1986	
1	1.375	1.38	1.40	1.157
2	1.812	1.87	1.85	1.510
3	1.375	1.43	1.45	1.157
4	1.375	1.28	1.25	1.157
5	1.375	1.41	1.35	1.157
6	1.375	1.31	1.30	1.157
7	1.375	1.38	1.35	1.157
8	1.375	1.41	1.40	1.157
9	1.375	1.31	1.30	1.157
10	1.812	2.08	2.00	1.510

Instrument: Sonic 601, FTS Mark 1 1976
Sonic Mark 1 1986

Test Method: UT

TABLE 2
UNIT 2 E/C INSPECTION 1986

Areas Inspected

1) 'B' Feedpump Discharge
2) Condensate Booster Pump Orifice
3) 'A', 'B', 'C' Feedpump Suction
4) Feedpump Min. Flow Valve
5) FRV Station Elbows
6) Feedpump Suction Manifold
7) 'C' Feedpump Suction Line
8) 'A', 'C' Feedpump Discharge
9) Extraction Check Valves, Piping
10) Feedpump Discharge-Min. Flow Line

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
1	'B' loop first elbow off pump	18" (1.375)	1.157"	Inner Radius	1.742
					1.674
					1.694
					1.627
					1.789
				Outer Radius	1.441
					1.399
					1.380
					1.409
					1.385
					1.460
					1.429
				Circumference	1.456
1	'B' loop second elbow	18" (1.375)	1.157	Inner Radius	1.676
					1.656
					1.656
				Outer Radius	1.391
					1.380
					1.361
					1.378
					1.371
					1.398
					1.402
				Circumference	1.364
1	'B' loop third elbow	18" (1.375)	1.157	Inner Radius	1.586
					1.817
					1.864
					1.878
					1.867
				Outer Radius	1.519
					1.495
					1.520
					1.565
					1.610
					1.498
					1.658
1	'B' loop fourth elbow	18" (1.375)	1.157	Inner Radius	1.588
					1.572
					1.592
					1.549
					1.508

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
				Outer Radius	1.460
					1.482
					1.439
					1.399
					1.425
					1.397
					1.408
				Circumferential	1.431
				(Upstream)	1.348
					1.398
				(Downstream)	1.330
					1.376
					1.424
					1.383
1	'B' loop fifth elbow	18" (1.375)	1.157	Inner Radius	1.566
					1.546
					1.562
					1.568
					1.565
				Outer Radius	1.472
					1.390
					1.292
					1.287
					1.308
					1.344
					1.386
				Circumferential	1.386
				(Upstream)	1.371
					1.432
					1.401
				(Downstream)	1.467
					1.377
					1.375
					1.393
2	Condensate Booster Orifice	30" (0.545)	0.625	2R Downstream	.740
					.750
					.700
					.695
3	'A' loop first elbow off pump	12" (0.375)	0.289	Outer Radius	.398
					.388
					.369
					.380
					.399
					.397
					.370

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
				Inner Radius	.460
					.445
					.455
					.430
		12" (0.688)	---	Circumferential (Pump S.E.)	.685
					.675
					.680
		12" (0.375)	.289	Downstream	.420
					.390
				Upstream	.405
					.395
3	'B' loop first elbow	12" (0.375)	0.289	Outer Radius	.370
					.373
					.378
					.354
					.346
					.358
					.384
				Inner Radius	.448
					.448
					.430
		12" (0.688)	---	Circumferential (Pump S.E.)	.675
					.695
					.690
		12" (0.375)	.289	Downstream	.380
					.395
				Upstream	.435
					.445
		12"x20" (0.375 to .500)	.289	On Reducer (About Middle)	.630
					.600
				On Reducer (About Middle)	.650
					.650
3	'C' loop first elbow	12" (0.375)	.289	Outer Radius	.375
					.385
					.354
					.378
					.381
					.378
					.354
				Inner Radius	.430
					.430
		12" (0.688)	---	Circumferential (Pump S.E.)	.730
					.670
					.720

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
		12" (0.375)	.289	Upstream	.395
				(Side of El)	.400
				Downstream	.410
				(Side of El)	.375
3	'A' loop second elbow	20" (.500)	.396	Outer Radius	.494
					.480
					.493
					.492
					.489
					.470
				Inner Radius	.553
					.550
					.528
					.510
					.520
				Circumference	.568 (Other Data
3	'B' loop second elbow	20" (.500)	0.396	Outer Radius	.497 Over Welds)
					.479
					.476
					.485
					.463
					.480
					.474
				Inner Radius	.533
					.538
					.535
					.609 (Over Weld)
				Circumference	.520
				(Spool Side)	.530
					.517
					.521
3	'C' loop second elbow	20" (.500)	0.396	Outer Radius	.520
					.520
					.530
					.515
					.520
					.523
					.547
				Inner Radius	.674
					.683
					.673
					.595
					.609
				Circumference	.517
				(Spool Side)	.520
					.523

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
4	'C' Feedpump Min Flow Valve Outlet Piping	6" (.562)	.489	Circumferential (Close to Valve)	.635
					.644
					.649
				1 Ø From Valve	.534
					.522
					.537
				2 Ø From Valve	.520
					.546
5	Feed Reg Station Elbows	24" (1.812)	1.510	(See Table 1)	
		18" (1.375)	1.157	(See Table 1)	
6	Feed Pump Suction Manifold	30" (0.625)	0.545	Top Along Length	.664
					.689
					.689
					.692
					.697
					.694
					.688
					.690
					.688
					.690
					.742 (Weld)
				South Side Along Length	.682
					.684
					.686
					.633
					.636
					.720 (Weld)
	Feed Pump Suction Manifold	30" (0.625)	0.545	Bottom Side Along Length	.710
					.696
					.625
					.696
				North Side Along Length	.696
					.638
					.697
					.690
					.692
					.693
				Opposite 39" Inlet Branch	.685
					.685
					.686
					.689
					.690
					.684
					.686
					.683
					.685
					.688

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
				Reducer Mid-Length to 'A' Pump - Circumf.	.798
					.807
					.752
					.780
				Reducer Mid-Length to 'C' Pump - Circumf.	.740
					.750
					.751
					.772
6	Feed Pump Suction Manifold	20" (.500)	.396	Reducer to Pipe (Pipe Side) 'A' - Circumferential	.530
					.523
					.525
					.521
				Reducer to Pipe (Pipe Side) 'C' - Circumferential	.513
					—
				Branch to 'B' Pump Circumferential	.485
					.484
					.485
					.500
7	Feedpump Suction "Back-to-Back" 40° "Back-to-Back" Elbows on the 'C' Pump	20" (.500)	.396	Circumferential Inlet	—
					—
					—
					—
				Midway	.490 (Bottom)
					.530
					.505
					.440
				Outlet	.550
					.550
					.500
					.500
				Inlet 45 - Outer Radius	.480
					.450
					.470
					.530
					.500
				Inlet 45 - Inner Radius	.525
					.530
					.530
					.600 (Weld)
					—

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
				Outlet 45 Inner	.490
				Radius	.480
					.515
					.500
					——
				Outlet 45 Outer	.520
				Radius	.485
					.445
					.485
8	Feedpump Dis-	24" (1.812)	1.510	Header Opposite	1.980
	charge Manifold			of 'B' Inlet	3.280
	45° Elbows Into			Branch	3.315
	Manifold From				3.270
	A&C Pumps				3.235
					3.260
					3.285
					3.245
		18" (1.375)	1.157	'A' Pump 45°	1.580
				Outer Radius	1.495
					1.575
					1.495
				'C' Pump 45°	1.450
				Outer Radius	1.400
					1.395
					1.435
				'C' Pump 45°	1.560
				Inner Radius	1.635
					1.585
					1.450
					1.625
				'C' Pump Pipe	1.355
				Side (of 45°)	1.350
				Circumferential	1.335

9 Extraction check valves and piping from the low pressure stages to the feedwater heaters (see text).

10 Feedpump discharge piping upstream of the minimum flow valve was also inspected. This line ('B' pump) is of similar configuration to all pumps and contains several elbows.

Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
Min Flow Line	6" (.562)	.489	First Elbow (90°)	.600
Upstream			Inner Radius	.575
			Outer Radius	.575
				.530
			Circumferential	.625
			Second Elbow (45°)	.640
			Outer Radius	.670

TABLE 2 (Cont'd)
UNIT 2 E/C INSPECTION 1986

Area	Description	Pipe Ø (Nominal Wall)	Code Min Wall	Reading Location	Results
				Pipe After 45	.555
				Circumferential	.600
					.670
					.660
				Third Elbow (90°)	
				Inner Radius	.720
				Outer Radius	.640
					.605
					.600
				18x6 Branch – 6	
				Circumferential	.670

Feedpump suction elbow information was difficult to obtain. A 2" drain valve is branched off the bottom outer radius and the elbow is directly above the pump oil reservoir. As a result, outside radius readings are all on the inlet end of the elbow. The area that might be expected to contain the most thinning would be past the drain attachment and is not inspectable. As a result of this, the suction piping sample size was increased to include the second elbow on all three loops and the back-to-back 45° elbows on the 'C' loop.

The initial feedpump suction elbow data reports suggested erosion may be present. Downstream circumferential data recorded thicknesses around .675" with outside radius data around .375". Closer inspection revealed that circumferential readings were performed on the pump nozzle adaptor (safe-end). Byron Jackson was contacted and it was revealed that the safe-ends are 12" schedule 80 A-182Gr.F5 (5% Cr, 1/3% Mo) counterbored to 12.100". This corresponds to a counterbore wall of .375" and pipe wall of .688". The elbow material has not been determined but its wall thickness is believed to be diminished. Four additional circumferential readings and additional inner radius readings were taken of each elbow to reach this conclusion. The pump casing casting is a 6% chromium alloy.

Minimum wall thicknesses were determined using USAS B31.1, Appendix A.

Enclosure 2

QUAD CITIES STATION

Response to Items 1 - 5 of NRC Bulletin 87-01

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

Quad Cities Station piping was designed and fabricated to USAS B31.1-1967, USA Standard Code for pressure piping.

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. selecting points at which to make thickness measurements

   b. determining how frequently to make thickness measurements

   c. selecting the methods used to make thickness measurements

   d. making replacement/repair decisions

Response

The station has performed an ongoing inspection program, during each refuel outage since 1982, to monitor the thinning of two-phase carbon steel piping for both units under the direction of General Electric Co. The program looked for evidence of foreign object damage, steam erosion, loose or broken parts and weld integrity on the crossaround steam piping. Since 1985, the Extraction steam piping has been examined for erosion/corrosion damage and general condition. In 1986, during the fall refuel outage, an examination was performed on the Heater Drain piping to verify adequate wall thickness for Unit 2.

For single-phase carbon steel piping systems the station performed a one-time pipe wall thinning measurement program on the Feedwater supply system during the Fall 1986 Unit 2 refuel outage.

The criteria used for selecting points at which to inspect for erosion/corrosion damage on two-phase systems was flow path geometry. Areas were examined where steam flow impinged on pipe walls at short radius elbows and branch lines. General Electric has directed the station to make such thickness measurements on crossaround steam piping each refuel outage. Ultrasonic examination is the preferred method for inspections.

The criteria used for selecting points on single-phase carbon steel piping was as follows:

-Piping that is "high energy" having operating pressures _275 psig and temperatures _200°F.
-Piping geometry with two or more changes in flow path direction within 5 pipe diameters.

-Piping located immediately downstream of flow restricting device, such as valves, reducers and orifices.
-Piping where bulk flow velocity is high.
-For parallel flow configurations through pumps or other equipment, locations with highest accumulated operating time.

Ultrasonic examination is the preferred method of thickness measurement.

The criteria used to make repair/replacement decisions was:

-Comparision of actual wall thickness with 7/8 of nominal wall thickness measurements.
-If actual thickness is less than 7/8 of nominal wall thickness repair/replacement is warranted.

3. For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness (Item 2a):

   a. piping material (e.g., chromium content)
   b. piping configuration (e.g., fittings less than 10 pipe diameters apart)
   c. pH of water in the system (e.g., pH less than 10)
   d. system temperature (e.g., between 190 and 500°F)
   e. fluid bulk velocity (e.g., greater than 10 ft/s)
   f. oxygen content in the system (e.g., oxygen content less than 50 ppb)

<u>Response</u>

The following factors were considered in establishing criteria for selecting points on single-phase carbon steel systems:

-Piping material.
-Piping configuration-geometry with two or more changes in flow path direction within 5 pipe diameters; piping located immediately downstream of flow restricting devices.
-System temperature _200°F.
-Fluid bulk velocity 3.5FPS

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspections).

c. Report thickness measurement results and note those that were identified as unacceptable and why.

d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

During the Fall 1986 Unit 2 refuel outage an inspection/evaluation was made to determine thinning of pipe walls in feedwater and condensate systems. The piping examined included: condensate piping between the condenser hot well and the condensate booster pump suction; condensate booster pump discharge; reactor feed pump suction; and reactor feedwater system. The piping was examined using a NORTEC NDT-124 ultrasonic scope and calibrated with a carbon steel step wedge. The locations examined and reported thickness measurements are listed on Attachment 1, Tables 3-1 to 3-4. Two components had recorded wall thickness measurements below "minimum wall", CBD-2 and RFS-8. An evaluation was made to insure the remaining wall thickness was adequate for service in accordance with Equation (3) of the 1980 Edition of ANSI/ASME B31.3, "Power Piping" using a maximum service temperature of 310°F and 450 psig. The results demonstrated that the remaining wall thickness is adequate for the maximum service temperature and pressure.

Attachment 2 is a summary of the results of two-phase system examinations.

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Same response as for Dresden Station.

ATTACHMENT 1

TABLE 3-4

DATA SUMMARY - REACTOR FEED PIPING

COMPONENT I.D.	LINE NUMBER	PIPE SCHEDULE	MINIMUM WALL	LEAST RECORDED	COMPONENT DESCRIPTIONS
RFP-1	2-3204-24"-C	120	1.586	1.805	S.R. Elbow
RFP-2	2-3204B-18"-C	120	1.203	1.352	S.R. Elbow
RFP-3	2-3204B-18"-C	120	1.203	1.370	S.R. Elbow
RFP-4	2-3204A-18"-C	120	1.203	1.450	S.R. Elbow
RFP-5	2-3201B-18"-C	120	1.203	1.298	Pipe
RFP-6	2-3201B-18"-C	120	1.203	1.313	90° Elbow
RFP-7	2-3201B-18"-C	120	1.203	1.307	90° Elbow
RFP-8	2-3201B-18"-C	120	1.586/1.203	1.870/1.365	24" x 18" Reducer
RFP-9	2-3201-24"-C	120	1.586	1.840	Pipe
RFP-10	2-3201-24"-C	120	1.586	1.742	90° Elbow
RFP-11	2-3201-24"-C	120	1.586	1.785	90° Elbow
RFP-12	2-3201-24"-C	120	1.586	1.742	90° Elbow
RFP-12.1	2-3201-24"-C	120	1.586	1.840	Pipe

ATTACHMENT 2

U-1 Mainsteam Crossaround Piping (Moisture Separator to C.I.V.'s) - 1982.

Inspected for foreign object damage, steam erosion, loose or broken parts, weld integrity, etc. Utilized visual and ultrasonic N.D.E. methods. Performed from inside of pipe.

Moisture Separators C&D side:
1. Tiger striping erosion in 54" section, 40 to 80 mils. deep erosion.
2. 36" pipe leading to C.I.V. #3 had 4" x 8" section eroded to .330".
3. Other areas of random erosion, 20-40 mils. deep.

Moisture Separator A&B side:
1. Tiger striping in 54" section, 40 to 80 mils. deep.
2. 36" pipe to #5 C.I.V. had 2" x 5" area eroded to .375".
3. Moderate erosion in rest of the pipe.

Recommendation by General Electric was continue monitoring of piping at 12-18 month intervals. Also, change inlet diffusers on moisture separators to increase their efficiency.

Probable instrument used was a NORTEC NDT-124 thickness gage. Carbon steel step wedge was probable calib. block standard.

U-2 Mainsteam Crossaround Piping (Moisture Separators to C.I.V.'s) - 1983.

Inspected for foreign object damage, steam erosion, loose or broken parts, weld integrity, etc. Utilized visual and ultrasonic N.D.E. methods. Performed from inside of pipe. Probable instrument utilized was NORTEC NDT-124 thickness gage with a carbon steel step wedge as a standard.

Moisture Separators A&B side:
1. Tiger striping erosion on 54" section, 20-30 mils. deep.
2. Radial weld on 45^{o} elbow had 70-80 mils. deep erosion on 30% of its radius.
3. Slight tiger striping on 48" pipe area.

Moisture Separators C&D side:
1. Slight tiger striping on pipe walls.
2. Normal erosion and wear otherwise.

U-1 Mainsteam Crossaround Piping (Moisture Separators to C.I.V.'s) - 1984.

Inspected for foreign object damage, steam erosion, loose or broken parts, weld integrity, etc. Utilized visual and ultrasonic methods of N.D.E. from inside the pipe. U.T. instrument was a NORTEC NDT-124 thickness gage utilizing a calibrated carbon steel step wedge as a standard.

Moisture Separators A&B side:
1. Tiger striping erosion downstream of moisture separators, 30 mils. deep.
2. 36" line leading to #5 C.I.V. eroded to .335" (2" x 4" area).
3. 48" line eroded to .562".
4. 36" line to #4 C.I.V. eroded to .429".

Moisture Separators C&D side:
1. Tiger striping erosion downstream of moisture separators, 30-40 mils. deep.
2. 36" line between #1 and #2 C.I.V. tap offs had 20 mils. deep erosion.
3. 36" line to #2 C.I.V. eroded to .436".
4. 36" line to #3 C.I.V. eroded to .319" (3" x 4" area).

Recommendation by General Electric to monitor eroded areas at each outage. If erosion exceeds .200", consult G.E. for recommendations. Recommended procurement of proper weld rod for next major outage.

U-2 Mainsteam Crossaround Piping (H.P. Turbine to C.I.V.'s) - 1985.

Inspected for foreign object damage, steam erosion, loose or broken parts, weld integrity, etc. Utilized visual and ultrasonic methods of N.D.E. from inside the pipe. U.T. instrument utilized was a NORTEC NDT-124 thickness gage utilizing a calibrated carbon steel step wedge as a standard.

Moisture Separators A&B side:
1. Tiger striping in 54" section with 10-50 mils. deep erosion.
2. Erosion on 54" pipe to .678" thickness.
3. 45° slope had erosion to .655" thickness.
4. From 45° slope to 48" pipe had erosion to .603" thickness.

Moisture Separators C&D side:
1. Erosion in 54" pipe to .699" thickness.

H.P. Turbine to 2A Moisture Separator Pipe:
1. One area of 15° elbow reduced to .496" thick due to erosion, .489" thick in another.
2. 90° elbow by H.P. turbine had an area of erosion .495" thick.

U-2 Extraction Steam Lines 30" (2-3104, 3105, and 3106) - 1985.

Inspected for erosion/corrosion and general condition. Visual and ultrasonic N.D.E. methods utilized from inside the pipe. U.T. instrument used was a NORTEC NDT-124 thickness gage utilizing a calibrated carbon steel step wedge as a standard.

Line 2-3104:
1. Elbow position readings: .424" - .530".
2. Random pipe readings: .453" - .476".

Line 2-3105:
1. Erosion on 24" elbow, thicknesses from .413" - .190".
2. Random readings in elbow area: .313" - .376".

Line 2-3106:
1. Random 24" elbow readings: .496" - .532".

Due to lack of material and time, elbow replacement on 3105 line was put off until 1986. NUTECH engineered an evaluation addressing this subject.

U-2 Extraction Steam Lines to 2B, C, and D heaters - 1985.

Performed ultrasonic N.D.E. on 9 elbows to determine their wall thicknesses in areas of probable high erosion. The instrument used was a NORTEC NDT-124 thickness gage utilizing a calibrated carbon steel step wedge as a standard. The inspection was performed from outside the elbow.

B Heater elbows (1 per heater):
1. No measurements below minimum wall (.372" - .613").

C Heater elbows (1 per heater):
1. No measurements below minimum wall (.360" - .436").

D Heater elbows (1 per heater):
1. No measurements below minimum wall (.360" - .435").

U-1 Mainsteam Crossaround Piping (Moisture Separators to C.I.V.'s) - 1986

Inspected for foreign object damage, steam erosion, loose or broken parts, weld integrity, etc. Utilized visual and ultrasonic methods of N.D.E. from inside the pipe. U.T. instruments used were the NORTEC NDT-124 thickness gage and the Krautkramer DM-2 L.E.D. thickness gage utilizing a calibrated carbon steel step wedge as standard.

Moisture Separators A&B side:
1. Tiger striping erosion to top of 45° slope, 0-90 mils. deep.
2. 36" line to #4 C.I.V. has erosion to .371" wall thickness.
3. 36" line to #5 C.I.V. has erosion to .430" wall thickness.

Moisture Separators C&D side:
1. Tiger striping erosion to top of 45° slope, 0-60 mils. deep.
2. 54" - 48" weld eroded to .144" thickness in a small area.
3. 36" line to #3 C.I.V. eroded to .164" thickness in a small area.
4. 36" line to #2 C.I.V. eroded to .418" thickness.
5. 36" line to #1 C.I.V. eroded to .472" thickness.

Areas of extreme erosion were repaired and brought up to area wall thicknesses. M.T.'s were performed afterwards on the weld repairs.

U-2 Mainsteam Crossaround Piping (Moisture Separators to C.I.V.'s) - 1986.

Inspected for foreign object damage, steam erosion, loose or broken parts, weld integrity, etc. Utilized visual and ultrasonic methods of N.D.E. from inside the pipe. U.T. instrument used was a NORTEC NDT-124 thickness gage utilizing a calibrated carbon steel step wedge as a standard.

Moisture Separators C&D side:
1. Tiger striping erosion noted, 0-50 mils. deep.
2. 48" pipe eroded to .606" thickness.
3. Manhole cover eroded $\approx$ 1/16" deep.
4. 36" line to #5 C.I.V. had 4 areas of 1/16" deep tears, thickness of adjacent metal is 1.257".

Moisture Separators A&B side:
1. Tiger striping in 54" pipe, eroded 0-120 mils. deep.
2. Weld at base of 45° slope eroded to .648" thickness.

U-2 Extraction Steam Line Elbow (2-3105A-24) - 1986.

Inspection for erosion worsening. Visual and ultrasonic were the N.D.E. methods used from inside the pipe. The U.T. instrument used was a Krautkramer DM-2 L.E.D. thickness gage probably utilizing a carbon steel step wedge as a standard.

Eroded areas ranged in thickness from .374" - .154".
Elbow was replaced.

U-1 Extraction Steam Elbow - 1986.

Inspected for erosion/corrosion; mirror image of &-2 elbow that was replaced. Visual and ultrasonic N.D.E. methods used from inside the pipe. U.T. instrument used was a Krautkramer DM-2 L.E.D. thickness gage utilizing a calibrated carbon steel step wedge as a standard.

Found two areas of erosion to .327" and .370" thickness.

NUTECH informed of findings. Station management satisfied with its current status.

U-2 Heater Drain Piping Reducer Inspections - 1986.

Six reducers were chosen to verify adequate wall thickness. Ultrasonic N.D.E. was used from outside the pipe. The U.T. instrument used was a NORTEC NDT-124 thickness gage utilizing a calibrated carbon steel step wedge as a standard.

1. 8" - 12" reducer downstream of 2-3506C: .547" - .722".
2. 4" - 8" reducer downstream of 2-3509C: .383" - .742".
3. 4" - 8" reducer downstream of 2-3508D: .399" - .695".
4. 14" - 20" reducer downstream of 2-3501B: .539" - .660".
5. 8" - 14" reducer downstream of 2D Mois. Sep.: .321" - .546".
6. 8" - 16" reducer downstream of 2-3504A: .515" - .847".

Reducers numbers 2, 3 and 5 above are scheduled for re-examination during the next U-2 outage.

ATTACHMENT 1

TABLE 3-1

DATA SUMMARY - CONDENSATE PIPING

COMPONENT I.D.	LINE NUMBER	PIPE SCHEDULE	MINIMUM WALL	LEAST RECORDED	COMPONENT DESCRIPTIONS
C-1	2-3302D-16"-L	30	.328	.404	90° Red. Elbow
C-2	2-3302D-16"-L	30	.328	.354	90° Elbow

ATTACHMENT 1

TABLE 3-2

DATA SUMMARY - CONDENSATE BOOSTER DISCHARGE PIPING

COMPONENT I.D.	LINE NUMBER	PIPE SCHEDULE	MINIMUM WALL	LEAST RECORDED	COMPONENT DESCRIPTIONS
CBD-1	2-3401D-16"-D	30	.328	.345	90° Elbow
CBD-2	2-3401D-16"-D	30	.328	.310 (1)	45° Elbow
CBD-3	2-3401-30"-D	30	.547	.562	Pipe Header
CBD-4	2-3401-30"-D	30	.547	.581	30" x 16" Reducer
CBD-5	2-3401C-16"-D	30	.328	.400	90° S. R. Elbow
CBD-6	2-3401C-16"-D	30	.328	.374	Pipe
CBD-7	2-3401B-16"-D	30	.328	.396	16" x 12" Red. Elbow
CBD-8	2-3406-10"-D	30	.319	.367	Tee (Branch)
CBD-9	2-3406-10"-N	60	.438	.486	S.R. Elbow
CBD-10	2-3406-10"-N	60	.438	.482	Pipe

(1) Less than "Minimum Wall"

ATTACHMENT 1

TABLE 3-3

DATA SUMMARY - REACTOR FEED PUMP SUCTION PIPING

COMPONENT I.D.	LINE NUMBER	PIPE SCHEDULE	MINIMUM WALL	LEAST RECORDED	COMPONENT DESCRIPTIONS
RFS-1	2-3405A-20"	N/A	N/A	1.193	Pump Suction Nozzle
RFS-2	2-3405A-20"-D	30	.438	.495	Pipe
RFS-3	2-3405A-20"-D	30	.438	.504	90° Elbow
RFS-4	2-3405A-20"-D	30	.438	.484	Pipe (Strainer)
RFS-5	2-3405A-20"-D	30	.438	.482	Pipe
RFS-6	2-3405A-20"-D	30	.438	.484	90° Elbow
RFS-7	2-3405A-20"-D	30	.438	.507	Pipe
RFS-8	2-3405A-20"-D	30	.438	.424(2)	45° Elbow
RFS-9	2-3405A-20"-D	30	.438	.495	Pipe
RFS-10	2-3405A-20"-D	30	.438	.457	45° Elbow
RFS-11	2-3405A-20"-D	30	.438	.481	Pipe
RFS-12	2-3405A-20"-D	30	.438	.449	90° Elbow
RFS-12.1	2-3405A-20"-D	30	.438	.494	Pipe

(2) Less than "Minimum Wall"

ATTACHMENT 1

TABLE 3-3

DATA SUMMARY - REACTOR FEED PUMP SUCTION PIPING (cont'd)

COMPONENT I.D.	LINE NUMBER	PIPE SCHEDULE	MINIMUM WALL	LEAST RECORDED	COMPONENT DESCRIPTIONS
RFS-13	2-3405A-20"-D	30	.438	.490	Branch at Cross
RFS-14	2-3405-30"-D	30	.547	.665	Header at Cross
RFS-15	2-3405-30"-D	30	.547	.646	30" X 20" Reducer
RFS-16	-	-	-	-	Not Used
RFS-17	2-3405C-20"-D	30	.438	.490	Branch at Cross
RFS-18	2-3405B-20"-D	30	.438	.500	Pipe
RFS-19	2-3405-30"-D	30	.547	.714	Pipe Cap
RFS-20	2-3405C-16"-D	30	.328	.360	Pipe

Enclosure 3

ZION STATION

Response to Items 1 - 5 of NRC Bulletin 87-01

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

ANSI Standard B. 31.1

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. selecting points at which to make thickness measurements

   b. determining how frequently to make thickness measurements

   c. selecting the methods used to make thickness measurements

   d. making replacement/repair decisions

Response

An informal program has been continuing since 1982. With the advent of the Surry event it was decided that the program should be formalized. However, it should be noted that the programs acceptance criteria and method of selection have not changed. The formalized program has merely allowed for an easier method of tracking.

Specifically the program (formal or informal) defined three catefories for use in selecting testing frequencies.

Category I

a. Those locations in which previous inspections indicate an erosion rate greater than lo percent wall thickness per fuel cycle (whether or not repaired or replaced or measured thickness was less then 75 percent of nominal.

b. Any location which could be expected to have a current wall thickness less than 50 percent, based on a previously measured thickness and erosion rate.

Category 2

a. Those locations in which previous inspections indicated 75 to 90 percent of nominal wall thickness or erosion rates greater than 2 percent per fuel cycle.

b. Carbon steel pipe carrying high velocity steam (150 ft/sec) with high moisture content (percent) not previously inspected.

c. Flashing lines that are normally in use. This may include high level spills if they open frequently, or the heater drain pump or feed pump warm lines.

d. Carbon steel pipes which carry high velocity water (10 ft/s with a fluid temperature between 189 and 440 F not previously inspected.

Category 3

a. Those locations in which previous inspections indicate little or no erosion.

b. Wet steam lines with less than 5 percent moisture or 150 ft/s nominal velocity.

c. Flashing lines that have only occasional use, such as startup/bypass and some high level spills.

d. Water lines with fluid temperatures less than 189 F or 10 ft/s nominal velocity.

Each refueling outage a select representative sample of piping locations (including elbows, tees, reducers, etc.) is chosen for inspection. This sample should include all Category 1 locations, 20% of Category 2, and spot checks of Catefory 3. Additional locations are included if industry experience indicates other potential problem areas or sustained periods of off-normal operation imposed unusually severe conditions.

All measurements are taken with ultrasonic thickness measuring devices by qualified NDE examiners. Any measurements found below 87.5% of nominal wall thickness are referred to engineering for resolution.

3. For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness (Item 2a):

   a. piping material (e.g., chromium content)
   b. piping configuration (e.g., fittings less than 10 pipe diameters apart)
   c. pH of water in the system (e.g., pH less than 10)
   d. system temperature (e.g., between 190 and 500°F)
   e. fluid bulk velocity (e.g., greater than 10 ft/s)
   f. oxygen content in the system (e.g., oxygen content less than 50 ppb)

<u>Response</u>

Since the advent of the Surry event, all parameters listed (a-f) have been taken into consideration when establishing selection criteria.

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspections).

   c. Report thickness measurement results and note those that were identified as unacceptable and why.

   d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

Thickness testing was originally performed as a follow-up to an identified leak in 1982. Subsequent testing continued as directed by either good engineering practice or in response to industry bulletins. The program involved testing, using ultrasonic methods, a selection of wet steam and heater drain piping each refueling outage. The selections were "random" but bound by the category criteria as defined in item 2 response. Following the Surry event the program was expanded to include high temperature liquid phase lines (i.e. feedwater, condensate, etc.).

Since 1982, many sections of piping have been inspected through the testing program, most of which were found to be acceptable. To date two indications of wall thinning have been identified by the testing program. The first in 1982 - a tee in the #5 extraction steam line - identified during testing initiated by the existence of a through wall leak on the other unit. The latter an most recent in February 1987 - the first elbow in the #6 extraction steam line identified during performance of the existing testing program. Thickness measurement data is available at the station for review.

Both indications, identified through the program, were below Code allowable minimum wall and were subsequently replaced. The #6 extraction steam line tee (originally carbon steel) was replaced with a high chrome alloy tee. The #6 extraction steam line elbow (originally carbon steel) was replaced with like for like but will be replaced in the future with a high chrome alloy elbow.

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Same response as for Dresden Station.

Enclosure 4

LASALLE COUNTY STATION

Response to Items 1 - 5 of NRC Bulletin 87-01

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

Suction piping to the feedwater pumps was designed to the ANSI B31.1 Standard and is not ASME Section XI related. The pipe material is seam welded carbon steel, ASTM A155, Gr. KCF70.

All of LaSalle's ASME Section XI related piping was designed to the requirements of ASME Section III. Other LaSalle piping was designed to the ANSI B31.1 Piping Code.

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. selecting points at which to make thickness measurements

   b. determining how frequently to make thickness measurements

   c. selecting the methods used to make thickness measurements

   d. making replacement/repair decisions

Response

Measured thicknesses are evaluated against the minimum wall requirements as presented in the applicable piping design specification. The specification gives the minimum thickness which is permitted during pipe installation, normally this is nominal wall minus 12.5%.

A limited erosion inspection program was directed at the condensate booster piping as a result of the Surry failure, and inspection points were selected based primarily on unfavorable pipe geometry.

The station does not presently have a formal routine erosion inspection program. An extensive erosion inspection program is under development by Engineering and will be used for future inspections.

Ultrasonic Testing (UT) inspection techniques employing a 0 degree transducer and a digital UT scope were used to make the thickness measurements. Inspection grid patterns were laid out on the inner and outer bend radii of the elbows and along the length of the reducer in each of its quadrants.

No pipe sections have been found which were in need of repair or replacement as a result of erosion inspections.

3. For liquid phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness:

   a. Piping material.

   b. Pipe configuration.

   c. pH of water in the system.

   d. System temperature.

   e. Fluid bulk velocity.

   f. Oxygen content in the system.

<u>Response</u>

Pipe material was considered in our condensate booster inspection. The piping specification calls for carbon steel material with no requirement for any chromium or copper content. Pipe geometry was the principal factor in the selection of inspection areas, three 90 degree elbows, one 45 degree elbow, and one 36" to 30" reducer were inspected.

BWR pH is essentially neutral. The temperature in these fittings is approximately 360 degrees Fahrenheit, the fluid velocity in the 30" pipe is 9 fps, and the dissolved oxygen content is rarely below 50 ppb.

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspections).

   c. Report thickness measurement results and note those that were identified as unacceptable and why.

   d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

Inspection results are listed in the table below:

SYSTEM	FITTING	MIN WALL	MIN MEASURED THICKNESS
Condensate Booster System	Reducer (att.1)	1.005"	1.12"
	45 Elbow (att.2)	0.853"	0.92"
	90 Elbow (att.3)	0.853"	0.98"
	90 Elbow (att.4)	0.853"	1.02"
	90 Elbow (att.5)	0.853"	1.12"

The minimum measured thickness for the four elbows inspected was found to be on the outer elbow radius (extradose). For more detailed information on inspection results, see Attachments numbers 1 through 5.

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Same response as for Dresden Station.

ENERAL ELECTRIC
:PPARATUS & ENGINEERING SERVICES

PROJECT: LASALLE COUNTY STATION
FORM NO. QC - 39

SYSTEM: FEEDWATER
WELD NO: REDUCER AREA #3 UNIT NO: II
REPORT NO: 256

SCALE: N/A

	SOUTH	EAST	WEST	NORTH
6	1.12	1.12	1.28	1.26
5	1.28	1.48	1.30	1.48
4	1.52	1.46	1.50	1.48
3	1.44	1.40	1.44	1.46
2	1.40	1.40	1.40	1.40
1	1.38	1.32	1.38	1.36

FLOW

REDUCER AREA #3

APPROX 3" BETWEEN MEASUREMENTS AT EACH QUADRANT

M. [illegible]
LEVEL III
3-30-87

ATTACHMENT 1

-40-

[illegible] LEVEL: II DATE: 3-30-87

Reviewed
WJ Caldwell ANII 4-3-87

GENERAL ELECTRIC
APPARATUS & ENGINEERING SERVICES

PROJECT: LASALLE COUNTY STATION
SYSTEM: FEEDWATER
REPORT NO: 757
WELD NO: 45° ELBOW #4 UNIT NO: II
FORM NO. QC – 39

SCALE: N/A

17½"

	A	B	C	D	E	F
1	.96	.92	.94	.94	.96	.98
2	.96	.94	.94	.96	.96	.98
3	.98	.96	.96	.96	.98	.98
4	.98	.96	.96	.96	.98	.98
5	.96	.98	.98	.98	.98	1.0
6	.98	.96	.96	.96	.98	1.0

18"

45° ELBOW #4
OUTER RADIUS

	A	B	C	D	E	F
1	1.02	1.0	1.0	1.0	1.02	1.02
2	.98	1.0	1.0	1.02	1.02	1.0
3	1.0	1.0	1.0	1.02	1.04	1.04
4	1.0	1.0	1.02	1.02	1.04	1.04
5	1.0	1.0	1.0	1.0	1.02	1.04
6	N/A	N/A	N/A	N/A	N/A	N/A

13"

16½"

45° ELBOW #4
INNER RADIUS

[signature]
LEVEL III
3-30-87

ATTACHMENT 2

BY: [signature] LEVEL: II DATE: 3-30-87

Reviewed
WJ Caldwell ANII 4-3-87

GENERAL ELECTRIC
APPARATUS & ENGINEERING SERVICES

PROJECT: LaSalle County Nuclear Station

SYSTEM: Feedwater

REPORT NO: 753

WELD NO: 90° Elbow #1 UNIT NO: II

FORM NO. QC - 30

SCALE: N/A

90° Elbow No. 1

ATTACHMENT 3

	A	B	C	D	E	F	G	H
1	1.36	1.40	1.38	1.40	1.34	1.32	1.24	1.22
2	1.32	1.38	1.40	1.38	1.34	1.32	1.26	1.22
3	1.30	1.34	1.34	1.36	1.34	1.32	1.28	1.22
4	1.28	1.32	1.32	1.34	1.34	1.34	1.28	1.24
5	1.24	1.26	1.28	1.32	1.32	1.32	1.32	1.28
6	1.22	1.26	1.28	1.28	1.30	1.32	1.30	1.28
7	1.20	1.20	1.24	1.28	1.32	1.34	1.32	1.30
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

20"

24"

Inner Radius

	A	B	C	D	E	F	G	H
1	1.02	1.04	1.06	1.12	1.12	1.14	1.18	1.20
2	1.02	1.02	1.04	1.06	1.08	1.12	1.12	1.14
3	1.0	1.0	1.02	1.04	1.04	1.06	1.08	1.10
4	1.02	1.0	1.0	.99	1.0	1.0	1.02	1.06
5	1.02	1.0	.99	.99	1.0	1.0	1.0	1.02
6	1.04	1.02	.99	.98	.99	1.0	1.0	1.0
7	1.06	1.04	1.02	1.0	1.0	1.02	1.02	1.0
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

20"

24"

Outer Radius

M. [signature]
Level III
3-30-87

BY: [signature] LEVEL: II DATE: 3-30-87

Reviewed
W J [signature] ANII 4-3-87

66

GENERAL ELECTRIC
APPARATUS & ENGINEERING SERVICES

PROJECT: LASALLE COUNTY STATION
SYSTEM: FEEDWATER
REPORT NO: 754
WELD NO: 90° Elbow #2 UNIT NO: II
FORM NO. QC – 39

SCALE: N/A

90° ELBOW NO. 2
OUTER RADIUS

	A	B	C	D	E	F	G
1	1.12	1.10	1.10	1.06	1.08	1.08	1.06
2	1.10	1.08	1.06	1.08	1.08	1.08	1.04
3	1.08	1.08	1.06	1.04	1.06	1.06	1.04
4	1.06	1.04	1.06	1.04	1.04	1.06	1.08
5	1.04	1.04	1.04	1.02	1.04	1.04	1.08
6	1.06	1.02	1.04	1.04	1.04	1.06	1.10
7	1.08	1.04	1.04	1.04	1.06	1.08	1.10
8	1.04	1.02	1.04	1.02	1.04	1.06	1.10
9	1.08	1.08	1.08	1.08	1.08	1.10	1.14
10	1.08	1.06	1.08	1.08	1.10	1.12	1.18
11	1.10	1.10	1.14	1.12	1.12	1.14	1.18
12	1.14	1.12	1.12	1.14	1.16	1.18	1.18

36"

20"

M. [illegible]
LEVEL III
3-30-87

ATTACHMENT 4A

-43-

BY: [illegible] LEVEL: II DATE: 3-30-87

Reviewed
W J Caldwell 4-3-87, ANII

Page 2 of 3

GENERAL ELECTRIC
APPARATUS & ENGINEERING SERVICES

PROJECT: LASALLE COUNTY STATION
SYSTEM: FEEDWATER
REPORT NO: 754
WELD NO: 90° ELBOW #2 UNIT NO: II
FORM NO. QC - 39

SCALE: N/A

90° ELBOW
NO. 2
INNER RADIUS

	A	B	C	D	E	F
1	1.24	1.24	1.24	1.22	1.22	1.20
2	1.28	1.28	1.24	1.24	1.28	1.28
3	1.30	1.30	1.28	1.28	1.28	1.28
4	1.30	1.30	1.30	1.30	1.30	1.30
5	1.32	1.36	1.34	1.32	1.32	1.30
6	1.34	1.36	1.32	1.32	1.32	1.30
7	1.32	1.32	1.32	1.30	1.28	1.28

21"

18"

ATTACHMENT 4B

[signature]
LEVEL III
3-30-87

BY: [signature] LEVEL: II DATE: 3-31-87

Reviewed
W J Caldwell ANII 4-3-87

NERAL ELECTRIC
ɔPARATUS & ENGINEERING SERVICES

PROJECT: LASALLE COUNTY STATION

FORM NO. QC – 39

SYSTEM: FEEDWATER

REPORT NO: 755

WELD NO: 90° ELBOW #5 UNIT NO: II

SCALE: N/A

90° ELBOW No. 5

	A	B	C	D	E
1	1.16	1.14	1.16	1.14	1.16
2	1.20	1.18	1.18	1.16	1.16
3	1.20	1.22	1.20	1.18	1.18
4	1.20	1.20	1.20	1.18	1.18
5	1.20	1.20	1.20	1.20	1.18
6	1.16	1.18	1.18	1.16	1.16
7	1.14	1.16	1.14	1.16	1.14

21"

18"

INNER RADIUS

	A	B	C	D	E	F
1	1.12	1.12	1.14	1.16	1.18	1.22
2	1.14	1.12	1.14	1.16	1.20	1.24
3	1.16	1.16	1.16	1.18	1.20	1.22
4	1.16	1.16	1.16	1.18	1.22	1.24
5	1.18	1.18	1.16	1.16	1.22	1.24
6	1.16	1.20	1.18	1.20	1.20	1.26
7	1.18	1.18	1.18	1.20	1.24	1.26

24"

20"

OUTER RADIUS

ATTACHMENT 5

-45-

M. [signature]
LEVEL III
3-30-87

[signature] LEVEL: II DATE: 3-31-87

Reviewed
W J Caldwell ANII 4-3-87

Enclosure 5

BYRON STATION

Response to Items 1 - 5 of NRC Bulletin 87-01

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

The piping inside containment was designed and fabricated to ASME Section III Class 2, while the piping outside containment was designed and fabricated to ASME Section III, Class 3 and ANSI B31.1

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. selecting points at which to make thickness measurements

   b. determining how frequently to make thickness measurements

   c. selecting the methods used to make thickness measurements

   d. making replacement/repair decisions

Response

Byron Station has a limited program at this time to indicate possible wall thinning problem locations in carbon steel systems. The PWR engineering group is developing a program to be implemented prior to the next refueling outage, considering the items in this bulletin. Byron Station has added thickness measurement locations based on piping configuration and past history of other plants since the Surry event.

3. For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness (Item 2a):

   a. piping material (e.g., chromium content)
   b. piping configuration (e.g., fittings less than 10 pipe diameters apart)
   c. pH of water in the system (e.g., pH less than 10)
   d. system temperature (e.g., between 190 and 500°F)
   e. fluid bulk velocity (e.g., greater than 10 ft/s)
   f. oxygen content in the system (e.g., oxygen content less than 50 ppb)

Response

At the present time Byron Station has no inspection program for erosion/corrosion on liquid-phase systems. An approved program is being developed by the PWR Engineering Department.

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspections).

   c. Report thickness measurement results and note those that were identified as unacceptable and why.

   d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

Currently Byron Station has two surveillances, BVS XII-3 and BVS XII-4, in place for monitoring carbon steel systems. They encompass selected secondary side systems and crossunder leg piping. All the thickness measurements recorded during the Byron Unit One first refuel outage were found acceptable. The surveillances are on file at Byron Station.

Byron Station does not have a liquid phase system thickness measurement program to date. Since the Surry feedwater event, and inspection of the WYE connections on the feedwater pump suction lines was performed using a straight beam ultrasonic transducer. This inspection was performed during the Unit One refueling outage. The Wye connection examination data sheets summarizing the pertinent data are attached. (Attachments 1 & 2) The data is baseline data; however, results indicate that measurements exceeded nominal wall thickness and are found acceptable.

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Same response as for Dresden Station.

DATA SHEET 3 (Continued)

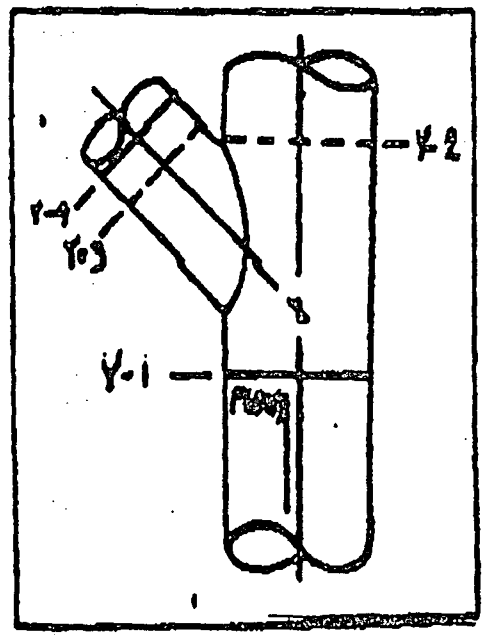
ATTACHMENT 1

3.0 EXAMINATION REQUIREMENTS

COMPONENT: Y2
DESCRIPTION: 18" x 24" Wye CONNECTION
LINE 1CB118-18"

NOMINAL WALL THICKNESS (IN.): 1.19 (18) 10.94 (24)
75% OF WALL THICKNESS (IN.): 0.89 (18) 10.70 (24)
MINIMUM WALL THICKNESS (IN.): 0.59 (18) 10.47 (24)

3.1 TEST EQUIPMENT: NORTEC 1246 683C
QA NUMBER: 204839 BY
CALIBRATION DATE: 7-86
DUE DATE: 7-87



NOTE

0° (TDC) is located at the tip of "V" stamped into pipe.

NOTE

If a measured thickness is less than 75% of nominal wall thickness, examine four additional points located 6 inches upstream, 6 inches downstream, and 6 inches circumferentially on either side, and record in space provided around original point.

RESULTS

LOCATION	0° (TDC)	90° (CW)	180° (CW)	270° (CW)
18" UPST Y-1	1.322	1.320	1.319	1.309
18" DWST Y-2	1.310	1.287	1.286	1.312
24" DWST Y-3	1.044	1.043	1.081	1.043
24" DWST Y-4	1.039	1.039	1.032	1.036

3.2 EXAMINER [signature], [signature] DBS 3/24/87
UT II 3-17-87 UT-II 3-17-87

3.3 EXAMINATION MEETS ACCEPTANCE CRITERIA (YES/NO) DBS 3/24/87

3.4 EXAMINATION COMPLETE DBS 3/24/87

APPROVED

ULTRASONIC THICKNESS EXAMINATIONS OF

SELECTED SECONDARY SIDE SYSTEMS

DATA SHEET 3 (Continued)

ATTACHMENT 2

3.0 EXAMINATION REQUIREMENTS

COMPONENT: Y3

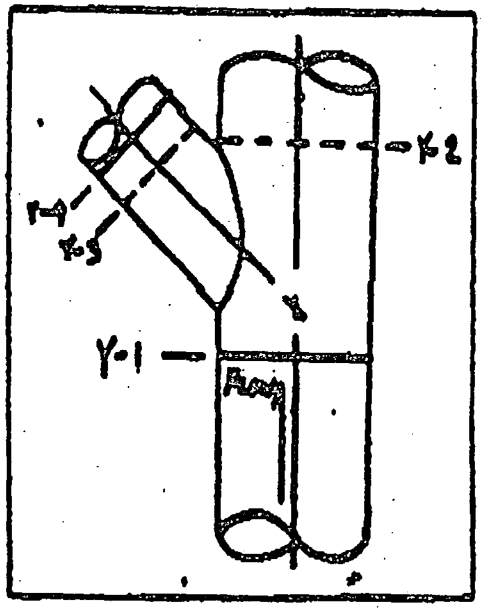
DESCRIPTION: 38" x 24" Wye CONNECTION

LINE 1CB118-38"

NOMINAL WALL THICKNESS (IN.): 1.19 (38) 10.94 (24)

75% OF WALL THICKNESS (IN.): 0.89 (38) 10.70 (24)

MINIMUM WALL THICKNESS (IN.): 0.59 (38) 10.47 (24)



3.1 TEST EQUIPMENT: NORTEC 124D 603C

QA NUMBER: 204829 BY

CALIBRATION DATE: 7-86

DUE DATE: 7-87

NOTE

0° (TDC) is located at the tip of "Y" stamped into pipe.

NOTE

If a measured thickness is less than 75% of nominal wall thickness, examine four additional points located 6 inches upstream, 6 inches downstream, and 6 inches circumferentially on either side, and record in space provided around original point.

RESULTS

LOCATION	0° (TDC)	90° (CW)	180° (CW)	270° (CW)
38" UPST Y-1	1.309	1.323	1.296	1.293
38" DWST Y-2	1.319	1.317	1.317	1.315
24" DWST Y-3	1.048	1.028	1.018	1.022
24" DWST Y-4	1.040	1.027	1.019	1.020

3.2 EXAMINER D. D. Evans, Bradley R. Klein DAS 3/24/87
UT II 3-17-87 UT-II 3-17-87

3.3 EXAMINATION MEETS ACCEPTANCE CRITERIA (YES/NO) DAS 3/24/87

3.4 EXAMINATION COMPLETE DAS 3/24/87

APPROVED

FEB 24 1987

Enclosure 6

BRAIDWOOD STATION

Response to Items 1 - 5 of NRC Bulletin 87-01

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

All of the carbon steel piping systems susceptible to erosion/corrosion are either Class B or Class D piping. All Class B piping was designed and fabricated to the requirements of Article NC-3000 and NC-4000 of the ASME Section III Code. All Class D carbon steel piping systems were designed and fabricated in accordance with ANSI B31.1 which is non-nuclear related.

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

   a. selecting points at which to make thickness measurements

   b. determining how frequently to make thickness measurements

   c. selecting the methods used to make thickness measurements

   d. making replacement/repair decisions

Response

Braidwood has developed inspection surveillances for erosion/corrosion detection on two-phase extraction steam and cross under piping.

a. Thickness measurements are to be taken on piping discontinuities such as tees, elbows, reducers and reducer tees.

b. Thickness measurement inspections are to be performed at every refueling outage.

c. The thickness measurements will be made with a pulse-echo type instrument which has a CRT and/or digital display. A contact type transducer with a minimum diameter of .250" and a minimum frequency of 1 mhz will be used. Visual inspections will be used whenever practical. This method was chosen based on its accuracy and ease of measurement.

d. Predetermined wall thickness values for different piping systems have been established. If any component wall thickness measures less than the acceptable wall thickness values an engineering evaluation will be performed to determine whether a repair or replacement will be made.

3. For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness (Item 2a):

a. piping material (e.g., chromium content)
b. piping configuration (e.g., fittings less than 10 pipe diameters apart)
c. pH of water in the system (e.g., pH less than 10)
d. system temperature (e.g., between 190 and 500°F)
e. fluid bulk velocity (e.g., greater than 10 ft/s)
f. oxygen content in the system (e.g., oxygen content less than 50 ppb)

Response

At the present time Braidwood Station has no approved inspection program for erosion/corrosion on liquid-phase systems. An approved program is being developed by the PWR Engineering Department.

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspections).

   c. Report thickness measurement results and note those that were identified as unacceptable and why.

   d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

There have been no inspections performed to date for erosion/corrosion pipe wall thinning at Braidwood Station.

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Same response as for Dresden Station.