Entergy

Entergy Operations, Inc.
17265 River Road
Killona, LA 70066
Tel 504 739 6650

W3F1-2003-0089

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Combined Category C-3 and 15-Day Special Report SR-03-002-00 on the 12th Refueling Outage Steam Generator Tube Inservice Inspection

Dear Sir or Madam:

Pursuant to Technical Specifications (TS) 6.9.2, Entergy Operations, Inc. (Entergy) provides the following Special Report (SR) Number SR-03-002-00, Combined Category C-3 and 15-Day Special Report SR-03-002-00 on the 12th Refueling Outage Steam Generator Tube Inservice Inspection, for Waterford Steam Electric Station Unit 3. This Special Report provides the results of the Refuel 12 Steam Generator Tube Inservice Inspection in accordance with TS 4.4.4.5.a and 4.4.4.5.c.

The Waterford 3 Steam Generator (SG) tube inspections were performed during the RF12 scheduled refueling outage that began on October 20, 2003. The inspections performed on both SGs involved a 100% full-length bobbin coil examination of all inservice tubes and a 100% rotating pancake coil (RPC) probe inspection of the hot leg (HL) expansion transition (ET) region. The RPC used consists of a plus-point coil, a 0.115 inch pancake coil, and a 0.080 inch pancake coil. The RPC was also utilized for confirmation of bobbin coil calls. The Plus Point coil was used to test the small radius U-bends, dented eggcrate (EC) intersections and any wear indications that required RPC testing.

In accordance with TS 4.4.4.5.a, the SG tube inspections resulted in plugging 127 tubes in SG 31 and 50 tubes in the SG 32. Sleeves were not utilized to repair these tubes identified during this inspection.

In accordance with TS 4.4.4.5.c, the SG tube inspections resulted in classifying SG 31 Category C-3, due to more than 1% of the inspected tubes require repair. The number of inspected tubes for SG 31 is 8906 and 127 tubes were plugged during this inspection.

Attachments 1 and 2 summarize the results of these inspections.

A047

This letter contains no commitments. If you have any questions concerning the above, please contact R.L. Williams at (504) 739-6255 or Robert O'Quinn at (504) 739-6387.

Very truly yours,

Gautam Sen
Manager, Licensing
Waterford Steam Electric Station, Unit 3

GS/RLW/cbh

Attachments:
1. RF12 Combined Category C-3 and 15-Day Special Report
2. RF12 Steam Generator Plugged Tube Indications

cc: Mr. Thomas P. Gwynn
Acting Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

NRC Senior Resident Inspector
Waterford NPS
P.O. Box 822
Killona, LA 70066-0751

U. S. Nuclear Regulatory Commission
Attn: Mr. N. Kalyanam
Mail Stop 0-7 D1
Washington, DC 20555-0001

Wise, Carter, Child & Caraway
ATTN: J. Smith
P.O. Box 651
Jackson, MS 39205

Winston & Strawn
ATTN: N.S. Reynolds
1400 L Street, NW
Washington, DC 20005-3502

Platts Energy
ATTN: B. Lewis
1200 G. St., N.W. Suite 1000
Washington, DC 20005

Attachment 1

Special Report SR-03-002-00
W3F1-2003-0089

RF12 Combined Category C-3 and 15-Day Special Report

RF12 Combined Category C-3 and 15-Day Special Report

This is the first steam generator inspection that resulted in the steam generators being classified as C-3 (>10% of the tubes inspected are degraded or >1% are defective). Waterford 3 began the outage with 8906 in (SG 31) and 8916 (SG 32) tubes in service. This report documents both the 15 day plugged tube report and C3 report as required by Technical Specifications 4.4.4.5.a and 4.4.4.5.c. There were 127 tubes plugged in SG 31 and 50 plugged in SG 32. Since >1% of the inspected tubes require repair in Steam Generator 31, an eight hour notification was made to the NRC Operations Center at 1152 EST on November 4, 2003. The following is a summary of the historical repairs to date:

Year	Outage	EFPY	SG 31	SG 32
1985	PRE-SER		155	169
1986	RF01	1.01	0	1
1987	RF02	2.08	3	0
1989	RF03	3.31	10	9
1991	RF04	4.55	160	161
1992	RF05	5.83	4	5
1994	RF06	7.15	3	2
1995	RF07	8.52	14	4
1997	RF08	9.90	29	25
1999	RF09	11.02	12	10
2000	RF10	12.37	28	38
2002	RF11	13.70	26	10
2003	RF12	15.00	127	50
Total			**571**	**484**

There were two issues that added to the increased number of defective tubes. The first was an increased extent of the tubesheet inspection. In the previous RF11 outage, the extent into the tubesheet was limited to -5 inches from the top of the tubesheet. During RF12, the extent was increased to -8 inches. To ensure an adequate extent was acquired, the extent was somewhat lower than -8 inches. This resulted in 38 additional indications being identified. This will be discussed in detail later.

The second issue was chemical cleaning on the secondary side of the generator. Due to noise on the eddy current tests, which resulted from the previous chemical cleaning, a second cleaning was performed to remove the copper interference in the support plates. The post cleaning eddy current testing indicated that the support signals were much cleaner and resulted in a better probability of detection (POD). An increase in the total population of eggcrate cracking can be attributed to this issue. In SG 31, 59 total indications were identified as compared to 2 in the previous outage.

Also there were 11 tubes that had copper deposits sufficient enough to degrade the POD. These tubes were removed from service.

1.0 STEAM GENERATOR DESIGN

The Waterford 3 Model 70 (3410 MWT) re-circulating steam generators were designed and fabricated by Nuclear Steam System Supplier Combustion Engineering (CE), Inc. in accordance with ASME Code, Section III NB for Class I vessels. The Waterford 3 steam generators each consist of 9,350 high temperature mill annealed Inconel 600 U-tubes arranged in a one-inch inner diameter triangular pitch pattern representing 103,574 ft² of heat transfer area. The U-tubes are 3/4" O.D. by 0.048" nominal wall thickness explosively expanded the full depth of the tube sheet (CE's Expansion Process) and welded to the primary cladding. The secondary tube bundle support structure consists of carbon steel eggcrates. The secondary supports are arranged in the following order:

- seven full horizontal eggcrate supports
- six horizontal partial eggcrates supports
- two anti-vibration straps (hot and cold batwings)
- seven vertical straps

Waterford 3's primary design inlet (hot leg) temperature is 611°F with an outlet temperature (cold leg) of 553°F. As a result of a 1992 T-Hot reduction, Waterford 3 currently operates with an inlet temperature of 605°F and an outlet temperature of 545°F. This was accomplished at the start of cycle six in an effort to reduce the susceptibility to primary and secondary water stress corrosion cracking induced by hot leg temperatures above 600°F.

2.0 INSPECTION RESULTS

The initial scope and expansions based on number of examinations are listed in Table 2.1:

Table 2.1
Initial Scope and Expansions

Test Type	# Planned	% Scope	Expansion
SG31			
Bobbin	8906	100 %	N/A
RPC ET HL	8906	100 %	N/A
RPC Low Row U-bends (rows 1-2)	120	100 %	N/A
RPC Row 3 -10 U-bends	102	20 %	N/A
Dented/Ding	71	20 %	Yes*

SG32			
Bobbin	8916	100 %	N/A
RPC ET HL	8916	100 %	N/A
RPC Low Row U-bends (rows 1-2)	123	100 %	N/A
RPC Row 3 -10 U-bends	102	20 %	No
Dented/Ding	75	20 %	No

*The dent/ding program in SG31 was expanded due to finding axial cracks in dents at the 01 Hot supports. All dented eggcrates on the hot leg side were tested with the plus point probe.

The bobbin inspections were performed from the cold leg sides of both steam generators. RPC testing was conducted from both hot and cold legs. There were 127 tubes plugged in SG31 and 50 tubes plugged in SG32. Table 2.2 lists the number of "indications" identified by generator during RF12:

Table 2.2
Indications Identified During RF12

Type of Indication at Location	SG31	SG32
Hot Leg Top of Tubesheet Axial Indication (Above TTS)	10	3
Hot Leg Top of Tubesheet Circumferential Indication (Above TTS)	11	2
Hot Leg Tubesheet Axial Indication (Within Tubesheet)	29	7
Hot Leg Tubesheet Circumferential Indication (Within Tubesheet)	39	0
Dent at Support Plate with Axial Indication	2	0
Support Plate (eggcrate) with Axial Indications	59	33
Support Plate (eggcrate) with Circumferential Indications	0	0
Freespan Axial Indications	0	3
Hot Leg Volumetric Indications	1	3
Cold Leg Volumetric Indications	0	0
Low Row U-Bend Indications	0	0
Wear ≥ 39%	0	2
Copper Residual	11	0
Permeability Variation (PVN) or noisy (NSY)	0	6

3.0 EVALUATION OF INSPECTION RESULTS

The inspections were performed with equipment and techniques qualified in accordance with Appendix H of the Electric Power Research Institute (EPRI) PWR Steam Generator Examination Guidelines, Rev. 6. Each mechanism will be discussed individually.

3.1 Top of the Tubesheet Circumferential Cracking

This was the seventh 100% inspection of the top of the tube sheet (TTS) region with a rotating probe. The Plus Point coil was used for detection of both axial and circumferential cracking. The extent of testing was + 3 inches to – 8 inches from the secondary face of the tube sheet. Listed in Table 3.1.1 are the outage,

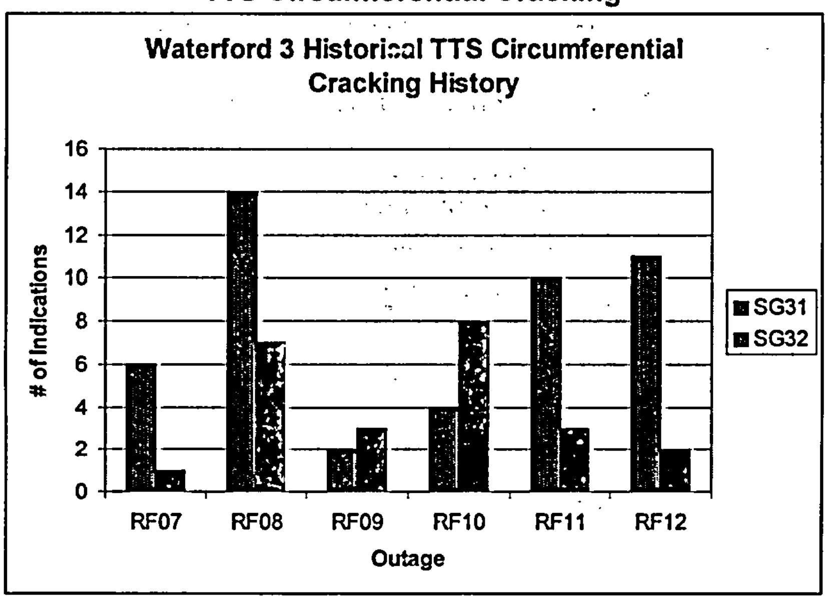
sample size, number of indications, and probe used for the indications identified at the top of the tube sheet.

TABLE 3.1.1
TTS CIRCUMFERENTIAL HISTORY

Outage	Sample	SG31	SG32	Probe
RF06 (1994)	100 %	0	0	Plus Point
RF07 (1995)	100 %	6	1	Plus Point
RF08 (1997)	100 %	14	7	Plus Point
RF09 (1999)	100 %	2	3	Plus Point
RF10 (2000)	100 %	4	8	Plus Point
RF11 (2002)	100 %	10	3	Plus Point
RF12 (2003)	100 %	11	2	Plus Point

The number of circumferential indications found per SG in each inspection is shown in Figure 3.1.1.

Figure 3.1.1
TTS Circumferential Cracking



Screening of the indications was performed for in-situ testing. One indication in SG32 exceeded the criteria for leakage at main steam line break (MSLB) pressure. It did not exceed the criteria for proof testing. The tube was 75-91. Details of the indication is listed in Table 3.1.2:

Table 3.1.2
In-situ Test Candidate

Gen	Row	Line	Location	Circ. Ext.	Max. Depth	PDA
32	75	91	TSH – 0.12	140°	99 %	38.5

Based on CEOG Task 1154, stabilization was performed on all circumferential indications above -3 inches. Several tubes had multiple indications. None of the indications exceed the in-situ selection criteria.

3.3 Axial Cracking at the Top of the Tubesheet

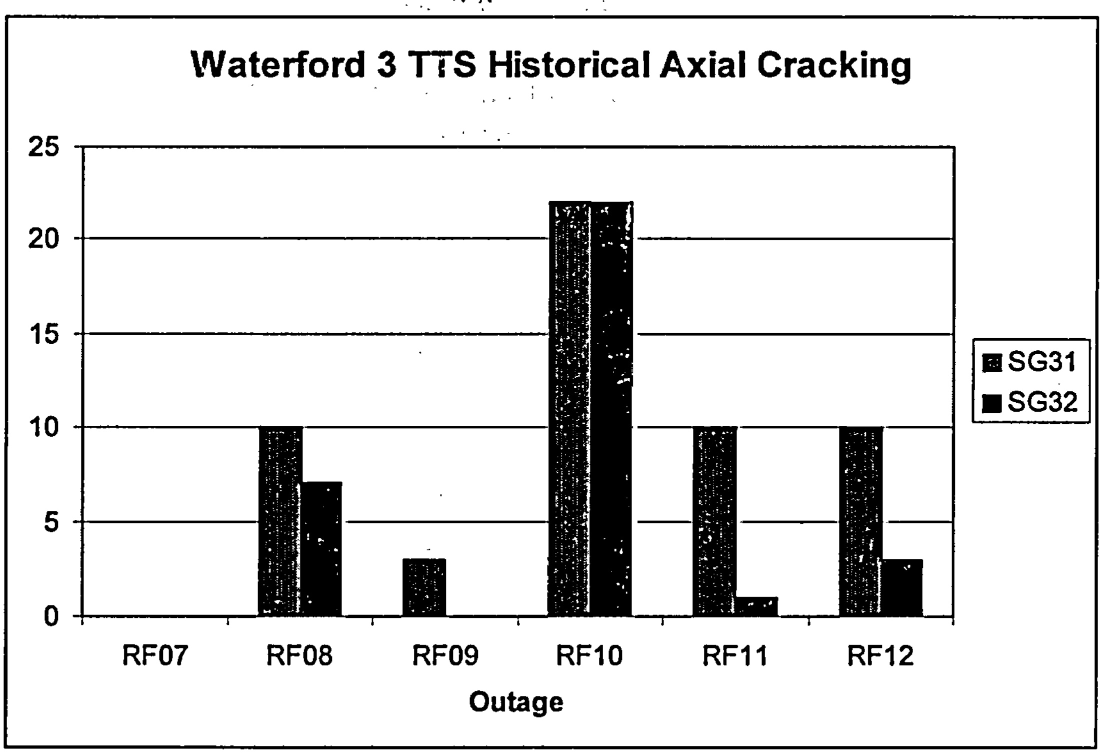
Historically, axial cracking at the top of the tubesheet has been the predominant damage mechanism at Waterford 3, excluding mechanical wear. The historical summary for this mechanism is listed in Table 3.3.1:

Table 3.3.1
Historical Top of the Tubesheet Inspections

Outage	Sample	SG31	SG32	Probe
RF06 (1994)	100 %	0	0	Plus Point
RF07 (1995)	100 %	0	0	Plus Point
RF08 (1997)	100 %	10	7	Plus Point
RF09 (1999)	100 %	3	0	Plus Point
RF10 (2000)	100 %	22	22	Plus Point
RF11 (2002)	100 %	10	1	Plus Point
RF12 (2003)	100 %	10	3	Plus Point

This is displayed graphically below in Figure 3.3.1:

Figure 3.3.1
TTS Axial Cracking



The tube was tested up to normal operating delta pressure (NODP) and MSLB. The actual pressures achieved were 1650 and 2850 psia. No leakage was detected. This was the first circumferential crack in-situ tested at Waterford 3.

3.2 Circumferential Cracking Within the Tubesheet

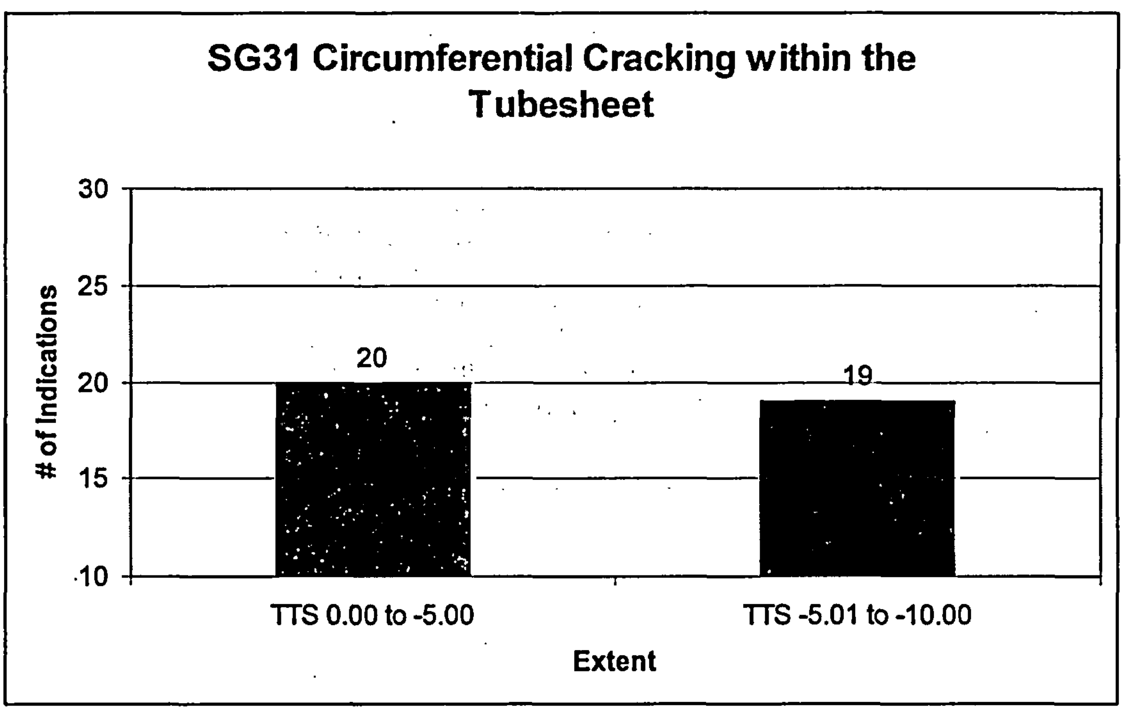
Circumferential cracking within the tubesheet has been identified as primary water stress corrosion cracking (PWSCC) or originating from the inside diameter of the tube. In an attempt to quantify this, the inspection extent was increased this outage to eight inches below the secondary face or top of the tubesheet. The following results were obtained in table 3.2.1:

Table 3.2.1
Circumferential Indications within the Tubesheet

	SG31	SG32
Circumferential Indications within the Tubesheet	39	0

20 of the 39 total circumferential indications were previously identified within the inspected level. Below -5 inches, 19 additional indications were found. There were no circumferential indications identified within the SG32 tubesheet. A breakdown by location of the cracking within the tubesheet is listed in Figure 3.2.2:

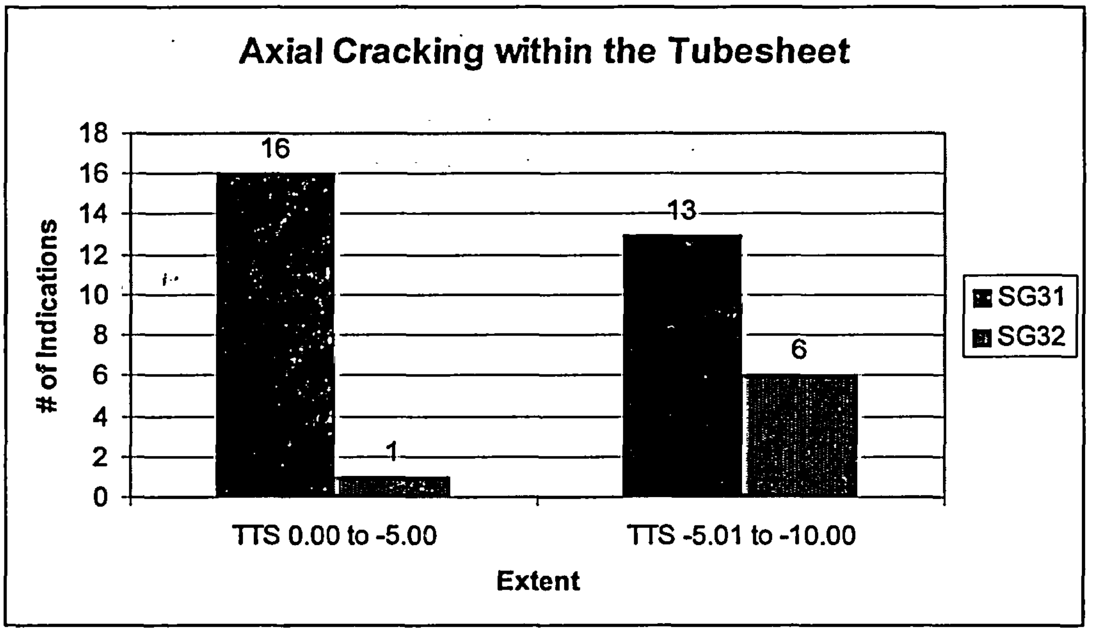
Figure 3.2.2
Circumferential Cracking within the Tubesheet



None of the TTS axial cracks exceeded the in-situ screening criteria for burst or leakage.

There were a total of 29 axial indications in SG31 and 7 indications in SG32 within the tubesheet. As discussed before, the added extent of testing resulted in additional indications being found. 17 of the 36 indications were located in the previously tested extent while the remaining 19 indications were identified below – 5 inches. This data is graphically displayed in Figure 3.3.2:

Figure 3.3.2
Axial Cracking within the Tubesheet



3.4 Freespan Indications

This was the first inspection where freespan indications were identified. One tube was identified with bobbin as having a distorted freespan indication. This tube was adjacent to a stay rod. Plus point identified "lines" of sludge between the tube and the stay rod. The plus point confirmed the presence of three axial cracks. The bobbin data for the tubes around all of the stay rods were re-analyzed for similar indications. No additional indications were identified. The indications were small relative to axial extent and depth. The data associated with the flaws is as follows:

SG	Row	Col	Location	Axial Length
31	42	140	01H + 3.26	0.24
31	42	140	01H + 3.45	0.18
31	42	140	01H + 3.87	0.29

None of the indications met the screening criteria for in-situ testing.

3.5 Axial Cracking (Eggcrate)

Cracking at eggcrates was first detected at Waterford 3 in 1999 (RF09). Based on the examination results of tubes removed during the ANO-2 outages in 1992 and 1996, the eggcrate support flaws at Waterford 3 are classified as axially oriented outside diameter stress corrosion cracking. The cracking can be a single crack or multiple cracks interconnected in the tube within the eggcrate support. As noted in Figure 3.5.1, the largest number of flaws occurs at the hottest support plate (01 Hot) and generally decreases as the temperature decreases. Figure 3.5.2 depicts the number of indications by outage.

Figure 3.5.1
Eggcrate Flaw Distribution

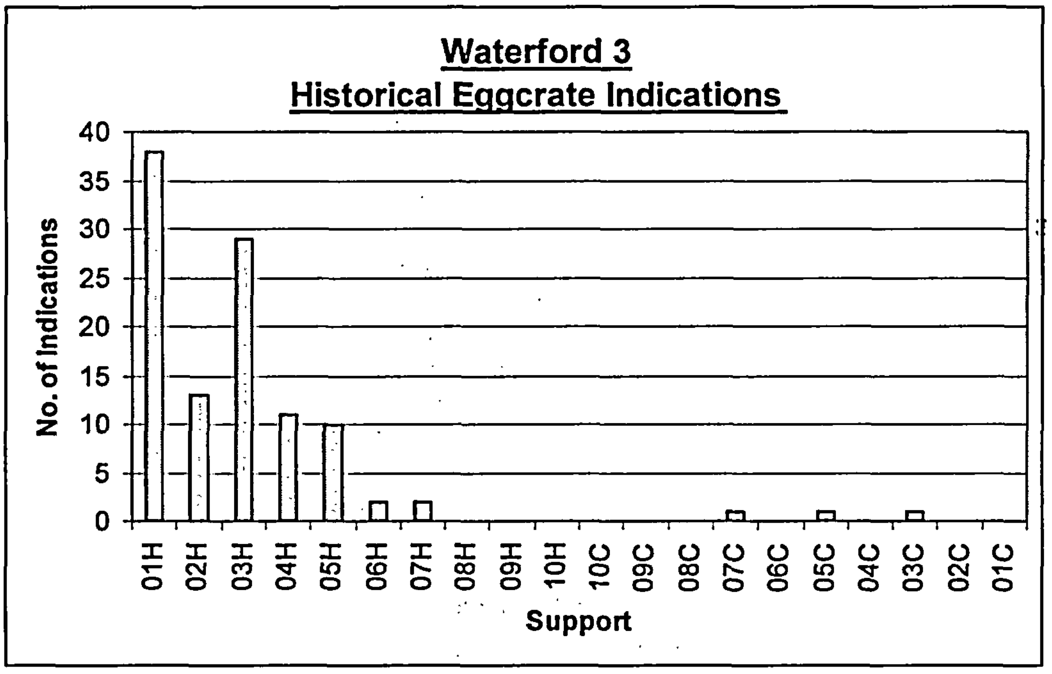
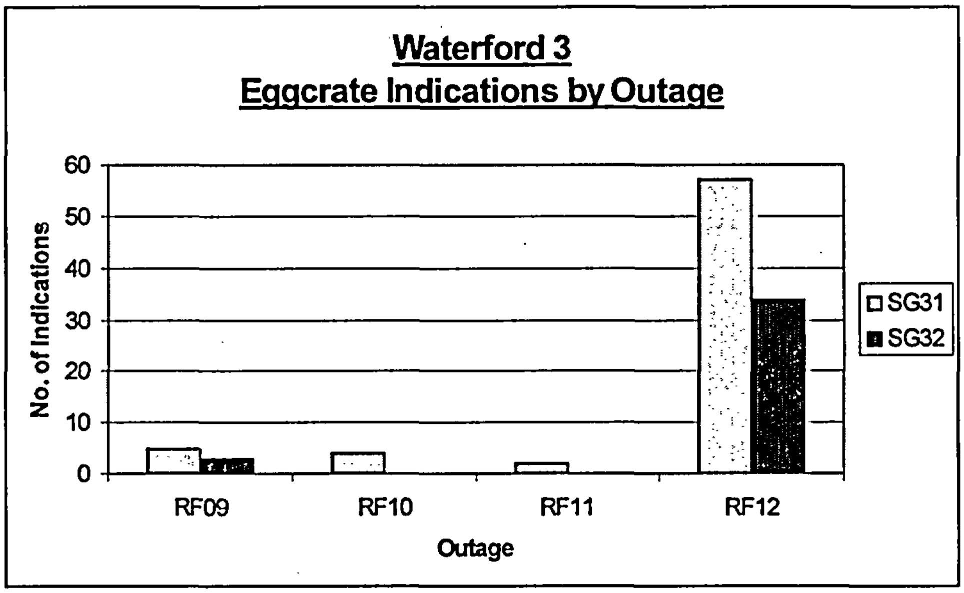


Figure 3.5.2
Eggcrate Axial Flaws by Outage



None of the eggcrate flaws detected during RF12 inspection met the in-situ pressure test criteria. As mentioned previously in this report, the detection capability of the eddy current inspection was enhanced during RF12 due to the chemical cleaning; therefore, an increase in eggcrate indications was not only predicted in the degradation assessment but was also found during the subject outage.

3.6 Dented Eggcrate Axial Indications

The initial inspection program required that in each steam generator 20% of the dented intersections identified with the bobbin coil as having voltages ≥ 2.0 be tested with the +Point coil probe. Included in this sample were all new dented intersections and dented intersections ≥ 2 volts from the previous outage (RF11) results that showed an increase in voltage of 20% in RF12. Of the total population of 403 dents = 2 volts, 248 of these were tested with +Pt RPC with 2 flaw like indications identified in SG 31. The indications identified in SG 31 were both at the 01H eggcrate support and resulted in an expansion of the dent inspection program to all dented intersections on the hot leg side of SG 31. Neither of the indications exceeded the screening criteria for in-situ testing.

4.0 ROOT CAUSE AND CORRECTIVE ACTIONS

Tubing degradation has been previously reported in earlier inspections. The root cause for the degradation is attributed to age and material of the steam generator tubing and the secondary environment. Based on the examination results of the tubes pulled in the ANO2 Fall 1996 outage (2F96), the damage at the eggcrate support is outside diameter stress corrosion cracking (ODSCC). Copper is believed to be a major contributor. In the RF10 refueling outage (2000), a high temperature chemical cleaning was performed to remove copper and residual amounts of lead from the tube bundle. Problems encountered during the cleaning

resulted in the copper being plated out. This not only prompted concerns about crack initiation but also a reduction in probability of detection with eddy current. Therefore, a second chemical cleaning was planned and performed during the RF12 outage. The level of detection was greatly improved from that of the RF11 outage, which resulted in a transient relative to the number of indications identified at the eggcrate supports. The chemical cleaning was expected to be 60-85% effective at removing the copper deposits. Those intersections that contained copper deposits that resulted in significant noise (Bobbin Amplitude >0.53 Vvm & RPC amp >0.5 V; >0.5" length) on the eddy current tests were preventatively removed from service. This accounted for 11 total tubes.

The increased number of indications identified within the tubesheet is due to primary water stress corrosion (PWSCC). This is a common mechanism seen in steam generators of this design. The indications identified in the previously tested zone were consistent with what was expected.

The finding of cracking on the cold leg and in the freespan is also attributed to the better probability of detection following the chemical cleaning. Combustion Engineering steam generators have experienced this mechanism previously.

Molar ratio control was initiated early in plant life. Since that time, minor adjustments have been made to maintain a neutral to slightly acidic environment. The more recent hideout return data indicated that near neutral conditions have been maintained.

CONDITION MONITORING

Results from the RF12 inspection were compared to the operational assessment results. The actual number of detected indications was within the frequency of occurrence predicted by the operational assessment model. Thus, the flaw distribution predicted by the model was reasonable with respect to the actual flaw projections.

In-situ pressure testing was performed on the flaw that exceeded the screening criteria. This flaw (a TTS circumferential) was taken to MSLB pressure with zero leakage.

Both the structural and leakage integrity requirements were met.

CONCLUSIONS

In summary, a comprehensive eddy current examination was performed. Both steam generators were tested 100% full length with the bobbin coil and 100% at the hot leg ET region with RPC, 100% of the small radius U-bends (rows 1-2), 20% of the small radius U-bends (rows 3-10), and 20% of the dented intersections in the eggcrates and freespan.

The top of tubesheet circumferential cracks detected in RF12 exhibited sizes that were bound by previous inspections.

The eggcrate axial cracks identified during RF12 were calculated to burst at pressures well above that identified for structural adequacy in Regulatory Guide 1.121.

Waterford 3 utilizes N-16 monitors for primary-to-secondary leakage detection. TS 3.4.5.2 Reactor Coolant System leakage limits the total primary-to-secondary leakage through all steam generators to 1 gpm and 720 gallons per day through any one steam generator. Abnormal operating procedures are in place in the event that leakage is detected. Other methods for detecting leakage include a condenser off-gas radiation monitor, steam generator blowdown monitors, main steam line radiation monitors, in addition to the utilization of blowdown grab samples. Entergy Operations is sensitive to the potential rapid progression of tube leakage and will take the necessary measures upon detection, should a primary-to-secondary leak occur. Operators routinely train on primary-to-secondary leaks and tube ruptures utilizing the simulator. The primary-to-secondary leakage during the last operating interval was < 1 gallon per day.

Based upon the comprehensive actions performed during RF12 in conjunction with the ability to rapidly detect and respond to any primary-to-secondary leakage, as described above, Waterford 3 is safe to resume plant operation.

An operational assessment will be completed within 90 days following startup.

Attachment 2

Special Report SR-03-002-00
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RF12 Steam Generator Plugged Tube Indications

SG31 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
1	3	1	0.22	SAI	TSH	-0.16
2	5	1	0.16	SAI	TSH	-0.18
3	5	63	0.14	SCI	TSH	-0.02
4	6	22	0.35	SVI	TSH	0.17
5	7	39	0.26	SAI	01H	0.74
6	9	135	0.55	SCI	TSH	-2.05
7	11	15	0.18	SAI	03H	-0.37
8	12	138	0.37	SAI	02H	0.41
9	15	111	0.19	SAI	TSH	0.16
10	15	127	0.5	SAI	01H	0.1
11	16	2	0.11	SAI	TSH	-0.11
12	16	16	0.32	SAI	03H	0.72
13	16	160	0.25	SAI	03H	-0.67
	16	160	0.31	SAI	03H	-0.45
14	17	113	0.47	SAI	01H	0.04
15	17	145	1.4	SAI	TSH	-8.1
	17	145	0.64	SAI	TSH	-7.34
16	18	6	0.14	SCI	TSH	-0.07
17	18	22	0.2	SAI	04H	0.76
18	18	136	0.27	SCI	TSH	-7.69
19	20	14	0.26	SAI	03H	0.76
20	20	126	0.35	MAI	01H	0.03
21	20	146	0.24	SAI	04H	0.58
22	21	15	0.12	SAI	03H	0.66
23	22	42	0.96	SCI	TSH	-6.38
24	22	130	0.11	SAI	01H	0.69
25	26	122	0.2	SAI	01H	0.75
26	27	3	0.43	CUD	01C	0
27	29	59	0.37	SAI	06H	-0.47
28	30	38	0.22	SCI	TSH	-0.11
29	30	62	0.24	SAI	01H	0.81
30	30	122	0.23	SAI	01H	0.67
	30	122	0.47	SCI	TSH	-0.06
31	32	46	0.3	SAI	03H	0.74
32	35	117	0.63	SAI	TSH	-8.58
33	35	119	0.79	SAI	TSH	-2.89
34	36	50	0.51	SCI	TSH	-2.93
	36	50	0.22	SCI	TSH	-2.28
35	37	47	0.56	SCI	TSH	-5.63

SG31 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
36	37	109	0.31	SAI	TSH	-1.17
	37	109	0.33	SAI	TSH	-0.55
37	37	121	0.38	SAI	01H	0.65
38	37	141	1.75	SAI	TSH	-10.08
39	38	56	0.46	SCI	TSH	-4.51
40	38	64	0.42	SAI	TSH	-0.4
	38	64	0.23	SCI	TSH	-8.86
	38	64	0.27	SCI	TSH	-3.31
41	38	108	0.14	SAI	TSH	0.28
42	38	118	0.42	SCI	TSH	-4.5
	38	118	0.56	SCI	TSH	-4.09
43	38	120	0.54	SCI	TSH	-1.92
44	38	130	0.28	SAI	01H	-0.88
	38	130	0.17	SAI	01H	-0.48
	38	130	0.39	SCI	TSH	-7.33
44	38	130	0.34	SCI	TSH	-2.93
45	39	55	0.3	SCI	TSH	-3.33
46	41	49	1.26	SCI	TSH	-10.17
47	42	48	2.29	SCI	TSH	-8.83
48	42	136	0.48	SAI	02H	0.34
	42	136	0.49	SAI	02H	0.67
49	43	61	0.28	SCI	TSH	-2.44
	43	61	0.36	SCI	TSH	-1.98
50	43	125	0.21	SAI	01H	-0.84
	43	125	0.52	SAI	03H	0.24
	43	125	0.17	SAI	04H	0.63
51	44	18	0.3	SAI	02H	-0.83
52	44	46	0.74	SAI	TSH	-6.3
53	44	120	0.47	SCI	TSH	-8.95
	44	120	0.65	SCI	TSH	-7.25
	44	120	1.24	SCI	TSH	-6.77
54	45	129	0.14	SAI	01H	0.58
55	46	56	0.34	SCI	TSH	-6.98
56	46	116	0.52	SAI	TSH	-6.91
	46	116	0.56	SAI	TSH	-2.53
	46	116	0.66	SCI	TSH	-1.54
57	47	29	0.18	SAI	05H	0.68

SG31 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
58	47	57	0.19	SAI	01H	-0.41
	47	57	0.35	SAI	05H	0.69
	47	57	0.84	SAI	06H	0.03
	47	57	0.52	SCI	TSH	-3.42
59	47	109	0.32	SAI	TSH	-1.2
60	48	54	0.16	SAI	05H	0.92
61	48	56	0.39	SCI	TSH	-2.32
	48	56	0.64	SCI	TSH	-0.81
62	49	55	0.1	SAI	01H	-0.93
63	49	121	0.27	SAI	03H	0.56
64	50	68	0.27	SAI	05H	0.56
65	51	127	0.17	SAI	01H	-0.74
66	53	105	0.51	SAI	TSH	-2.03
	53	105	0.12	SAI	TSH	-1.32
	53	105	0.32	SAI	TSH	-0.94
67	55	115	0.19	SAI	01H	0.77
68	57	87	0.6	SAI	TSH	-3.18
69	57	89	0.46	SAI	TSH	-1.53
70	58	50	0.34	SAI	02H	-0.96
71	58	82	0.38	SAI	03H	-1.03
72	58	106	0.28	SCI	TSH	0.08
73	58	108	0.63	SCI	TSH	-8.7
74	59	89	0.48	SAI	TSH	-1.05
75	60	40	0.06	SCI	TSH	-0.11
76	61	81	0.34	SAI	TSH	-2.01
77	63	89	0.24	SAI	03H	0.6
78	63	97	0.4	SAI	01H	-0.63
79	66	76	0.4	SAI	05H	0.68
80	66	92	0.47	SAI	01H	0.19
81	67	119	0.2	SAI	TSH	-0.13
82	68	90	0.6	SAI	TSH	-1.13
83	68	96	0.73	SAI	TSH	-1.47
	68	96	0.49	SCI	TSH	-2.39
84	68	118	0.45	SCI	TSH	-7.65
	68	118	0.23	SCI	TSH	-6.83
85	68	132	0.53	SCI	TSH	-3.78
86	69	69	0.22	SAI	TSH	0.22
87	70	142	0.37	SAI	03H	0.84
88	72	74	0.41	SAI	03H	0.66
	72	74	0.18	SAI	04H	0.69

SG31 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
89	72	88	0.73	SAI	TSH	-1.06
	72	88	0.36	SCI	TSH	-7.89
90	72	118	0.12	SAI	TSH	-0.12
91	72	120	0.43	SCI	TSH	-8.92
92	73	97	0.37	SAI	03H	-0.15
93	74	70	0.29	SCI	TSH	-7.96
94	74	118	0.46	SAI	TSH	-6.51
95	75	55	0.44	SAI	TSH	-7.75
96	76	30	0.45	SAI	02H	0.71
97	76	160	0.21	SAI	02H	0.79
98	78	50	0.24	SAI	01H	0.6
99	79	15	0.53	CUD	02H	0.03
100	82	26	0.23	SCI	TSH	0.17
101	82	106	0.17	SAI	TSH	-0.18
102	84	106	1.06	SCI	TSH	-9.1
	84	106	1.2	SCI	TSH	-8.6
	84	106	0.43	SCI	TSH	-7.94
103	86	96	0.48	SCI	TSH	-3.78
104	87	105	0.48	SAI	TSH	-12.68
	87	105	4.02	SAI	TSH	-11.04
	87	105	3.44	SAI	TSH	-9.86
105	88	122	0.21	SAI	02H	0.72
106	89	105	0.15	SAI	TSH	-0.22
107	90	78	0.7	MAI	03H	-0.45
	90	78	0.33	SAI	03H	0.66
108	90	90	0.15	SCI	TSH	-0.02
109	98	24	0.48	CUD	01H	0
	98	24	0.47	CUD	01C	0
110	99	79	1.97	SAI	TSH	-8.41
111	99	103	0.47	SAI	TSH	-8.9
112	100	124	0.14	SAI	01H	0.78
113	101	151	1.13	CUD	01H	0
114	111	83	0.18	SAI	03H	0.5
115	125	133	0.64	CUD	01H	0.62
116	127	113	0.29	SCI	TSH	-0.05
117	128	92	0.15	SCI	TSH	-0.01
118	128	114	0.2	SCI	TSH	-0.06
119	129	129	0.87	CUD	02H	0
120	132	112	15.16	PVN	03H	1.19
121	133	123	0.4	CUD	01C	0

SG31 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
122	138	58	0.98	CUD	01H	0
123	139	61	0.6	CUD	01C	0
124	140	62	0.73	CUD	01H	0
125	141	63	0.66	CUD	01H	0
126	142	94	0.21	SAI	01H	0.87
127	142	106	0.31	SAI	01H	0.4

Legend:

TSH – Tubesheet Hot
SAI – Single Axial Indication
MAI – Multiple Axial Indication
SCI – Single Circumferential Indication
MCI – Multiple Circumferential Indication
SVI – Single Volumetric Indication
MVI – Multiple Volumetric Indication
CUD – Copper Deposit
PVN – Permeability Variation

SG32 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
1	1	155	0.12	SVI	TSH	0.47
2	4	126	0.24	SAI	01H	-0.25
3	6	162	0.2	SAI	TSH	-23.46
4	9	51	0.19	SAI	05C	0.69
5	10	20	0.16	SAI	01H	-0.88
6	10	24	0.15	SAI	02H	-0.79
	10	24	0.09	SAI	02H	-0.68
	10	24	0.5	SAI	05H	0.78
7	10	160	0.31	SAI	03H	-0.37
	10	160	0.23	SAI	03H	-0.16
8	11	29	0.14	SAI	05H	0.76
9	12	14	0.29	SAI	03H	0.82
10	12	156	0.3	SAI	03H	-0.99
11	15	113	0.33	SAI	07H	0.58
12	16	18	0.17	SAI	03C	-0.87
13	16	160	0.11	SAI	02H	0.66
14	16	166	0.56	SAI	03H	-0.88
15	19	27	8.14	NSY	02H	16.74
16	19	33	4.88	NSY	07H	7.41
17	19	35	10.59	NSY	05C	19.46
18	19	37	0.35	SAI	TSH	-12.9
	19	37	0.33	SAI	TSH	-10.59
	19	37	0.29	SAI	TSH	-14.13
19	21	123	0.76	SAI	TSH	-4.84
20	21	129	0.25	SAI	02H	0.65
21	25	117	0.2	SVI	TSH	3.38
22	27	33	0.59	SAI	03H	0.8
23	27	39	0.3	SAI	01H	0.4
24	29	35	3.88	NSY	04H	27.23
	29	35	0.26	SAI	03H	0.53
25	29	51	0.49	SCI	TSH	-0.26
26	34	130	0.19	SAI	01H	0.5
27	37	51	0.13	SAI	TSH	0.65
28	42	140	0.24	SAI	01H	3.13
	42	140	0.22	SAI	01H	3.45
	42	140	0.43	SAI	01H	3.66
29	45	35	3.87	NSY	BW1	23.76
30	48	6	0.15	SAI	TSH	0.02
31	53	101	0.37	SAI	01H	0.3
32	54	88	1.86	PCT	BW9	1.97

SG32 Plugged Tube Indications

TUBE #	ROW	COL	VOLTS	IND	LOCN	INCH1
33	56	88	1.7	PCT	BW9	1.7
34	58	50	0.35	SAI	03H	-0.4
35	65	111	0.5	SAI	02H	0
	65	111	0.21	SAI	03H	0.9
36	73	67	0.12	SAI	TSH	-0.01
37	75	91	1.81	SCI	TSH	-0.12
38	75	113	0.22	SAI	04H	0.68
39	78	120	0.27	SAI	04H	0.65
40	83	119	0.32	SAI	03H	-0.36
41	89	39	0.26	SAI	03H	0.85
42	90	52		PTP		
43	91	53	0.27	SAI	04H	0.54
44	93	23	0.23	SAI	01H	0.2
45	107	65	0.8	SAI	TSH	-6.82
46	107	93	1.08	SAI	TSH	-7.61
47	108	92	0.21	SAI	01H	0.6
48	117	109	0.3	SAI	01H	0.54
49	122	110	0.12	SAI	01H	0.55
50	135	57	0.55	SVI	BW9	-4.65

Legend:

TSH – Tubesheet Hot
BW – Bat Wing
SAI – Single Axial Indication
MAI – Multiple Axial Indication
SCI – Single Circumferential Indication
MCI – Multiple Circumferential Indication
SVI – Single Volumetric Indication
MVI – Multiple Volumetric Indication
PTP – Preventative Tube Plug
PCT – Percent Through Wall
NSY – Noisy Tube