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Ken Peters
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W3F1-2003-0090

December 18, 2003

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Response to Request for Information Related to Review of Refuel 11 Steam Generator Tube Inservice Inspection Report SR-03-001-00
Waterford Steam Electric Station, Unit 3
Docket No. 50-382
License No. NPF-38

REFERENCES:
1. Entergy letter dated April 22, 2002, "15-Day Special Report SR-02-001-00 on the 11th Refueling Steam Generator Tube Inservice Inspection"
2. Entergy letter dated April 10, 2003, "12-Month Special Report SR-03-001-00 on the 11th Refueling Steam Generator Tube Inservice Inspection"

Dear Sir or Madam:

In Reference 1, Entergy Operations, Inc. (Entergy) provided the number of tubes plugged in each Steam Generator (S/G) in refueling outage 11, as specified by Technical Specification (TS) 4.4.4.5.a, within 15 days following completion of S/G tube Inservice Inspection (ISI). In Reference 2, Entergy provided the complete eddy current test results for refueling outage 11, as specified by TS 4.4.4.5.b, within 12 months following the inspection. This report contained the number and extent of tubes inspected, the location and percent of wall-thickness penetration for each indication of an imperfection, and the identification of tubes plugged or sleeved.

On September 16, 2003, the NRC Staff identified the need for additional information to support the review of the 11th Refueling Outage Steam Generator Tube Inservice Inspection. Entergy and members of your staff held a call to clarify the additional information requested. Entergy's response is contained in Attachment 1.

A047

There are no new commitments contained in this letter. If you have any questions or require additional information, please contact our R.L. Williams at (504) 739-6255 or R.C. O'Quinn at (504) 739-6387.

Sincerely,

K. J. Peters
Director, Nuclear Safety Assurance
Waterford Steam Electric Station, Unit 3

KJP/RLW/cbh

Attachments:
1. Response to Request for Additional Information
2. List of SG 31 and SG 32 Flaws Found During RFO 11 Inspection
3. SG Tubesheet Map and Tube Support Naming Convention

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Attachment 1

To

W3F1-2003-0090

Response to Request for Additional Information

Response to Request for Additional Information

REFERENCES:

1. Entergy letter dated April 22, 2002, "15-Day Special Report SR-02-001-00 on the 11th Refueling Steam Generator Tube Inservice Inspection"
2. Entergy letter dated April 10, 2003, "12-Month Special Report SR-03-001-00 on the 11th Refueling Steam Generator Tube Inservice Inspection"
3. Entergy letter dated November 20, 2000, "15-Day Special Report SR-00-003-00 on the 10th Refueling Outage Steam Generator Tube Inservice Inspection"
4. Entergy letter dated November 9, 2001, "12-Month Special Report SR-01-002-00 on the 10th Refueling Outage SG Tube Inservice Inspection"
5. ER-W3-2002-0425-000, "Waterford 3 Operational Assessment for Cycle 12," dated July 16, 2002 includes the Steam Generator Tube Integrity and Condition Monitoring Report for Waterford 3, RF11, SG-SGDA-02-12 Rev.0, dated May 29, 2002
6. Waterford Unit 3 RFO11 Spring 2002 Data Analysis Reference Manual
7. ER-W3-1999-0276-00-00, "S/G Tube Integrity Condition Monitoring Report RF09," dated 3/26/99

Question 1:

In your April 10, 2003 request for review, you indicated that during refueling outage (RFO) 9, one tube was plugged for a circumferential indication at an eggcrate support. Please discuss whether there was a dent / ding at this location, the voltage magnitude (or severity) of the dent ding, how the flaw was detected, the size (length, depth, percent degraded area, voltage) and nature (primary water stress corrosion cracking, outside diameter stress corrosion cracking, etc) of the flaw, and any additional testing performed to assess the integrity of the tube (e.g., ultrasonic testing, in-situ pressure testing).

Response 1:

The letter that contained the information associated with one plugged tube that contained a circumferential indication in RFO 9 is the April 22, 2002 letter (Reference 1) not the April 10, 2003 letter (Reference 2).

The tube that contains a circumferential indication was located in Steam Generator (SG) 32 at a U-bend (row 1 column 43) adjacent to a diagonal "Batwing" support, not an eggcrate support. This tube was generically categorized under the eggcrate support category and should be categorized under indications associated with the diagonal "Batwing" supports. No circumferential crack indications have been identified through RFO 11 at the eggcrate supports. There was no dent or ding identified at this location. However, there was a ding 2.4 inches from the indication with a 30 Volt reading from a bobbin coil.

During RF09, the inspection scope of 20% of each SG's low row U-bends (1 – 3) utilizing Plus Point identified 1 tube in SG 32 that contained a circumferential flaw 3.20" above BW1. As a result, Waterford 3 expanded the scope to 100% (189 Tubes) of rows 1 through 3 in SG 32. The inspection results did not identify any additional flaws, thus closing this expansion scope.

The table shows the results of performing the EPRI Draw (PDA) for the 1 tube identified in SG 32 with circumferential U-bend PWSCC:

Ligament Burst Pressure at Operating Temperature (605°F)

S/G # & (Mode of Degradation)	Tube Number	Location	Flaw Dimension Circ. Extent /// PDA		Ligament Burst Pressure (Psi)
32 (PWSCC)	Row 1//Col. 43	BW1	115°	31.83%	5,645

There was no additional testing performed.

Question 2:

In the letter, you also indicated that 2 tubes were plugged in RFO 11 as a result of free span dings. Please clarify the nature of the eddy current signals at these locations. For example, please discuss the voltage magnitude (or severity) of the ding, whether a flaw was present at these locations, the size (length, depth, percent degraded area, voltage) and nature (primary water stress corrosion cracking, outside diameter stress corrosion cracking, etc) of any flaw at these locations, how the flaw was detected (i.e., rotating probe, bobbin probe), and any additional testing performed to assess the integrity of the tube (e.g., ultrasonic testing, in-situ pressure testing).

Response 2:

The letter referenced in this question is the April 22, 2002 letter (Reference 1), not the April 10, 2003 letter (Reference 2).

The RFO 11 tubes plugged as a result of free span dings were located at SG 31 Row 134 Column 124 and SG 32 Row 1 Column 137. The tubes were not plugged due to flaw identification, but preventatively plugged due to the inability to run a Plus Point coil on the tube wall. The probe lifted off the wall introducing significant noise. Prior to RFO 11 Waterford 3 has not found any cracks associated with dents or dings. The preventatively plugged category was an appropriate response to this condition.

Question 3:

Further, in your letter dated April 22, 2002, you provide the number of tubes with single circumferential indications and single axial indications detected during RFO 11, at the top of the tubesheet for each steam generator. Similar information is provided in Table 3.2 and Tables 1 and 2 of letter dated April 10, 2003. In reviewing these tables, the staff noticed that the total number of tubes did not appear to match from one table to the next. For example, in the letter dated April 22, 2002, 9 tubes were reported as plugged in steam generator 1 for single axial indications at the top of the tubesheet, whereas in Table 3.2 of your letter dated April 10, 2003, 10 tubes were reported as having axial cracks at the top of the tubesheet. In Table 1 of your letter dated April 10, 2003, 11 tubes were identified as having axial cracks at the top of the tubesheet. Please clarify the number of axial and circumferential indications detected at the top of the tubesheet for each steam generator, and identify whether the tubes were plugged. If the tubes were not plugged, discuss your basis for leaving them in service. In addition, please update Tables 1 and 2 of your letter dated April 10, 2003, report to reflect all of the circumferential indications detected during the outage.

Response 3:

Differences Between April 22, 2002 Letter and April 10, 2003, Table 3.2 Letter

The purpose of the April 22, 2002 letter (Reference 1) is to identify the SG and the number of tubes plugged. The tubes are further subdivided into a general location and damage mechanism. Note, in reviewing the historical data contained in this letter, it appears that under Attachment 1, Sixth Refueling heading, a category line that describes the number of 40% Thru-Wall indications was inadvertently dropped from the attachment. This missing information was confirmed through review of an Entergy letter to the NRC dated November 20, 2000 (Reference 3). The missing information has been documented in our corrective action program as Condition Report CR-WF3-2003-3875.

In the April 10, 2003 letter (Reference 2), the purpose of Table 3.2 is to identify the SG and the number of specific degradation mechanisms identified, not the number of tubes plugged. For Top of Tubesheet (TTS) categories, one tube has both a circumferential crack and axial crack (two indications) and another tube has two axial cracks (two indications).

April 10, 2003 Letter, Tables 1 and 2

In reviewing the data contained in Tables 1 & 2, it appears the tables contains a list of previously plugged tubes screened for in-situ pressure testing from the RFO 10 SG inspection that were inadvertently submitted as the RFO 11 inspection results. This condition was confirmed through review of Entergy letter to the NRC dated November 9, 2001 (Reference 4). The missing information has been identified and documented in our corrective action program as Condition Report CR-WF3-2003-3875.

The request to clarify the information contained in Tables 1 and 2 will be provided as part of the response to Question 6 below.

Question 4:

With respect to the inspections at dented/dinged locations, please address the following:

Note, Entergy added identifiers to the NRC question in order to organize the responses.

A. Please discuss your voltage normalization scheme for determining the size of dents/dings and address whether it is consistent with the standard industry approach.

B. Please clarify whether the number of dent/dings reported in Table 3.2 of your letter dated April 10, 2003; include all dents/dings regardless of voltage amplitude or whether it represents all dents/dings above a certain voltage amplitude (e.g., above 2 volts).

C. Please clarify whether the numbers include dents/dings on just the hot-leg or on both legs of the steam generator.

D. Given that degradation may have been detected at dings during the outage (refer to question 2), discuss the basis for the scope of your dent/ding examination. For example, please discuss whether the original scope of the rotating probe examinations at the dent dings was expanded based on the results. The staff notes that both stress and temperature affect a tube's susceptibility to stress corrosion cracking. As a result, a larger dent at a lower temperature may be as severe (from a stress corrosion cracking standpoint) as a smaller dent at a higher temperature (material properties being equal). Discuss how your inspection scope accounted for this.

E. If all dents/dings above a certain threshold were not inspected with a rotating probe, discuss the extent to which the bobbin probe is qualified to inspect dented/dinged regions exceeding a specific voltage threshold (e.g., 5 volts).

F. For the dent/ding examinations, discuss how the tubes that were to be examined was determined. For example, was it a random sample or were all dings above 5 volts examined with a rotating probe and the remaining sample was random?

G. Please clarify the percentages of dings in Table 3.1, given that if the number of dings in Table 3.1 is divided by the total number of dings in Table 3.2, the percentage scope values do not match those reported in Table 3.1.

Response 4:

A. The voltage normalization is consistent with standard industry approach per Westinghouse Analysis Technique Specifications (ANTS) #WTR3-1-02 and #WTR3-2-02: Bobbin 4 Volts on 20% flat bottom and RPC 20 Volts on 100% axial notch, respectively.

B. In Table 3.2, the voltage value criteria used were: (1) ≥ 2 volts for dents and (2) ≥ 3 volts for dings as a calling criteria, as specified in the ANTS WTR3-1-02 for RF0 11.

C. The Dents / Dings are based on full tube examinations by bobbin coil; therefore, it includes both Hot and Cold Legs.

D. During the RF11 examination of dents and dings, there were no cracks identified, therefore no scope expansion was required. The original examination (by Plus Point) was a 20% random sampling of the previously identified and 100% of new dents / dings identified by bobbin coil. The random sample was not biased for sizing or temperature during the examination.

E. Based on the EPRI Eddy current Examination Technique Specification Sheet # 96012.1 Rev. 6 dated February 2001 and Westinghouse document SG-99-03-005, Appendix H Certification of Bobbin Coil Detection Performance in Freespan Dings dated March 1999, the Bobbin Coil is qualified down to 2 Volts for eggcrate dents and 5 Volts for freespan dings, respectively.

   Prior to RFO 11 we have not found any cracks in dents and dings. The 20% sample criteria is based on EPRI TR-107569-V1R5, PWR Steam Generator Examination Guidelines. In the event cracking was identified in dents or dings, scope expansion would have been performed with Plus Point in accordance with Waterford 3's S/G inspection scope as documented in the S/G Degradation Assessment and Repair Criteria for RFO 11.

F. The dent/ding examination criteria for RFO 11 specified that Dings ≥ 5 Volts and Dents ≥ 2 Volts would be examined using Plus Point.

G. The voltage values for Dings of Tables 3.1 and 3.2 are different. Table 3.1 used > 5 Volts and Table 3.2 used ≥ 3 Volts (not marked on table). The ≥ 3 Volt criteria was utilized to identify the population of dings down to that value for future use.

Question 5:

Given the potential for cracks to develop in wear scars, discuss the basis for only inspecting a subset of the wear indications with a rotating probe.

Response 5:

The 20% random sample was chosen because prior to RFO 11 no cracks within wear scars have been identified at Waterford 3. This 20% random sample examination is consistent with section 3.3 of the EPRI TR-107569-V1R5, PWR Steam Generator Examination Guidelines.

Question 6:

Please discuss the screening criteria used in assessing which indications are placed on Tables 1 and 2, and the screening criteria used to determine whether in-situ testing was required.

Please provide a list similar to Tables 1 and 2 of all flaws found during the inspection (axial, circumferential, and volumetric). Wear flaws at tube supports (egg crates, batwings, vertical straps) do not need to be included in this list.

Response 6:

As previously discussed in Entergy's response to Question #3, the results of In-Situ Screening for indications data contained in the Tables 1 & 2 was in error. The tables contain a list of previously plugged tubes screened for in-situ pressure testing from the RFO 10 SG inspection. The screening criteria was in accordance with EPRI Report TR-107620, "In-Situ Pressure Testing Guidelines," and as a result no in-situ tests were required.

Please refer to Attachment 2 for a discussion on the assessment of indications and in-situ screening performed during the RFO 11 inspection. This attachment is an excerpt from the RFO 11 Steam Generator Tube Integrity and Condition Monitoring Report for Waterford 3 (Reference 5).

Question 7:

Please clarify that all crack-like indications were plugged regardless of location.

Response 7:

All tubes with crack-like indications identified during RFO 11 were plugged.

Question 8:

Please discuss the maximum depth observed for the wear indications.

The staff observed that the tube in Row 144 Column 106 of steam generator 2 was reported as having a 40% through-wall indication at Batwing 1. Please discuss whether this tube was plugged. If this tube was plugged, discuss why it wasn't included in your letter dated April 22, 2002. If this tube was not plugged, discuss why it was not plugged.

Please provide a list of all tubes plugged during the outage.

Response 8:

SG 32 tube Row 144 – Column 106 was plugged due to a %Thru-Wall value of 40%.
This tube was included in the April 22, 2002 letter (Reference 1) Attachment 1, under Eleventh Refueling, Indications at Eggcrate, Wear Indications ≥ 40 % thru wall for SG#2. This wear indication was located adjacent to a diagonal "Batwing" support, not an eggcrate support. This tube was generically categorized under the eggcrate support category, as compared to the case with an RFO 9 tube discussed in Entergy's response to Question #1. This tube should also be categorized under indications associated with the diagonal "Batwing" supports.

List of Tubes Plugged During Waterford 3's RF11 Outage

SG1	Row	Column	Row	Column	Row	Column
	63	17	46	58	121	137
	34	24	68	64	2	140
	64	28	64	66	90	154
	71	29	68	88	86	158
	19	33	123	91	4	162
	19	37	32	110	4	164
	45	41	134	124	9	169
	1	47	37	133	7	171
	34	52	27	135		

SG2	Row	Column	Row	Column	Row	Column
	19	31	70	102	1	137
	8	62	144	106	119	139
	20	68	18	116	82	160
	70	74				

Question 9:

Please provide a tubesheet map and your tube support naming convention.

Response 9:

A SG tubesheet map and tube support naming convention is provided in Attachment 3. The tubesheet map is a computer generated map of one-half of SG 32. The tube support naming convention is an excerpt from Waterford 3's Data Analysis Guidelines (Reference 6). Please contact us if you have additional questions regarding readablility.

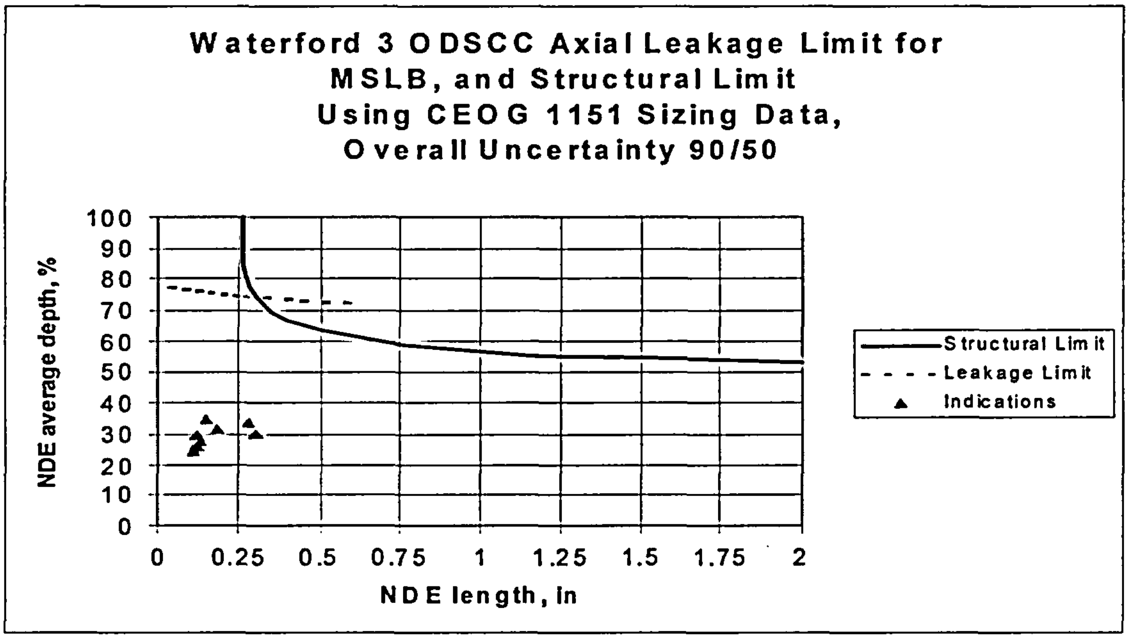
5.0 Assessment of Indications and In Situ Screening

A depth vs. length profile is developed from the Plus Point probe indication data. The profiles of all SAI and SCI indications are shown in Appendix A *(Sizing of Indications Measured by Plus Point in Ref. 5 of Att. 1).* Also shown on each profile is the "equivalent rectangle" which defines the average depth and length which would produce the lowest burst pressure. The average depth and actual NDE measured length are used in the assessment of the indications. This measure of the indication is compared to the structural and leakage limits defined in the degradation assessment, Reference 1 *(SG Degradation Assessment and Repair Criteria for RF11 in Ref. 5 of Att. 1)*, for each degradation type.

5.1 Assessment of Axial ODSCC

The sized indications are shown relative to the structural and leakage limits in Figure 5.1

Figure 5.1



Assessed Indications **OD Axials**

NDE length, inch	Ave. Depth, %	SG	Row	Col	Supt
0.13	27.9	31	63	17	TSH
0.3	30	31	46	58	04H+.5
0.28	33.8	31	64	66	03H+.7
0.18	31.9	31	90	154	TSH
0.12	26.2	31	4	162	TSH
0.12	29.4	31	4	164	TSH
0.15	34.9	31	9	169	TSH
0.11	24.8	31	7	171	TSH

All indications fall well below the structural and leakage limits which assure that the structural and leakage limits are satisfied with significant margin.

Attachment 2

To

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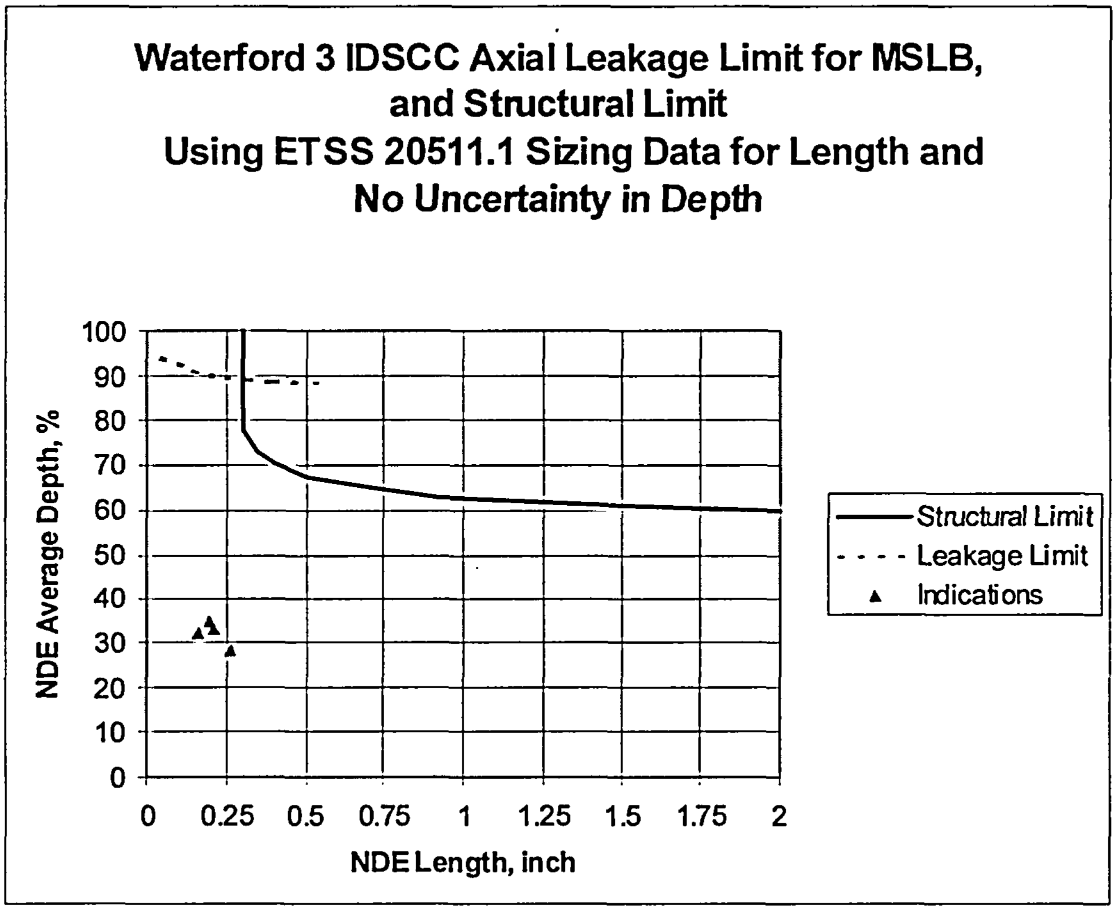
List of SG 31 and SG 32
Flaws Found During RFO 11 Inspection

5.2 Assessment of Axial PWSCC

The sized indications are shown relative to the structural and leakage limits in Figure 5.2.

Figure 5.2



Assessed Indications ID **Axial**

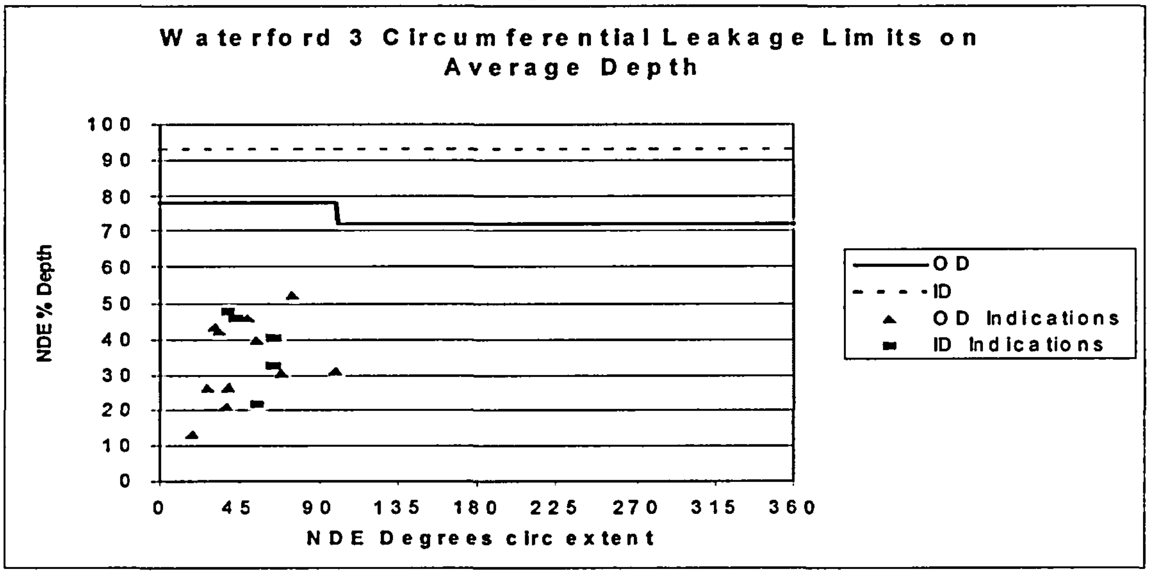
NDE length, inch	Ave. Depth, %	SG	Row	Col	Supt	
0.16	32.1	31	68	64	TSH-1.4	
0.26	28.1	31	~~66~~ *(typo, should be 68)*	88	TSH-1.3	Two indications combined
0.21	33	31	32	110	TSH-1.5	
0.2	34.7	32	70	102	TSH-1.3	

All indications fall well below the structural and leakage limits which assure that the structural and leakage limits are satisfied with significant margin.

5.3 Assessment of Circumferential ODSCC and PWSCC

The tube integrity criteria on burst pressure is defined in terms of percent degraded area of the tube cross section. This limit is specified as a plus point measured PDA = 62% for OD circumferential indications and 77% for ID circumferential indications. The maximum PDA measured is less than 11%. The leakage criterion is defined in terms of average depth. The indications are compared to the leakage criteria in Figure 5.3

Figure 5.3



Assessed Indications

OD

NDE length	Ave. Depth	PDA,%	SG	Row	Col	Supt
18.3	13.1	0.67%	31	34	24	TSH
31	43.3	3.73%	31	64	28	TSH
33.4	42.2	3.92%	31	71	29	TSH
37.1	21.2	2.18%	31	19	37	TSH
99	31.2	8.58%	31	1	47	TSH
74.4	52.1	10.77%	31	123	91	TSH
49.5	45.9	6.31%	31	27	135	TSH
27.1	26.1	1.96%	31	121	137	TSH
38.3	26.4	2.81%	31	86	158	TSH
54.8	39.7	6.04%	32	119	139	TSH
68	30.4	5.74%	32	82	160	TSH

ID

NDE length	Ave. Depth		SG	Row	Col	Supt
54.1	21.8	3.28%	31	19	33	TSH-6.3
42.5	46	5.43%	31	34	52	TSH-0.1
63.8	32.6	5.78%	31	37	133	TSH-2.5
63.4	40.2	7.08%	31	68	64	TSH-6.9
38.8	47.7	5.14%	32	70	74	TSH

All indications fall well below the structural and leakage limits which assure that the structural and leakage limits are satisfied with significant margin.

5.4 Assessment of Wear and Volumetrics

The structural limit for wear indications was established conservatively in the degradation assessment as 38% depth. Also it was established that if an indication exceeded a change of 20% depth the tube should be preventatively plugged. One indication in SG 31 was measured at 38% depth and was plugged. One indication in SG 32 was measured at 40% depth, and one indication was found to have changed by 24% depth. Both of these indications in SG 32 were plugged. The wear rate with the exception of a few tubes as seen in Figures 6.1 and 6.2 essentially zero. Since there were no wear indications greater than 40%, the results indicate that the structural limits are satisfied with significant margin.

Attachment 3

To

W3F1-2003-0090

SG Tubesheet Map and
Tube Support Naming Convention

SG - 32

Waterford RFO12 WTR 3410

X 8916

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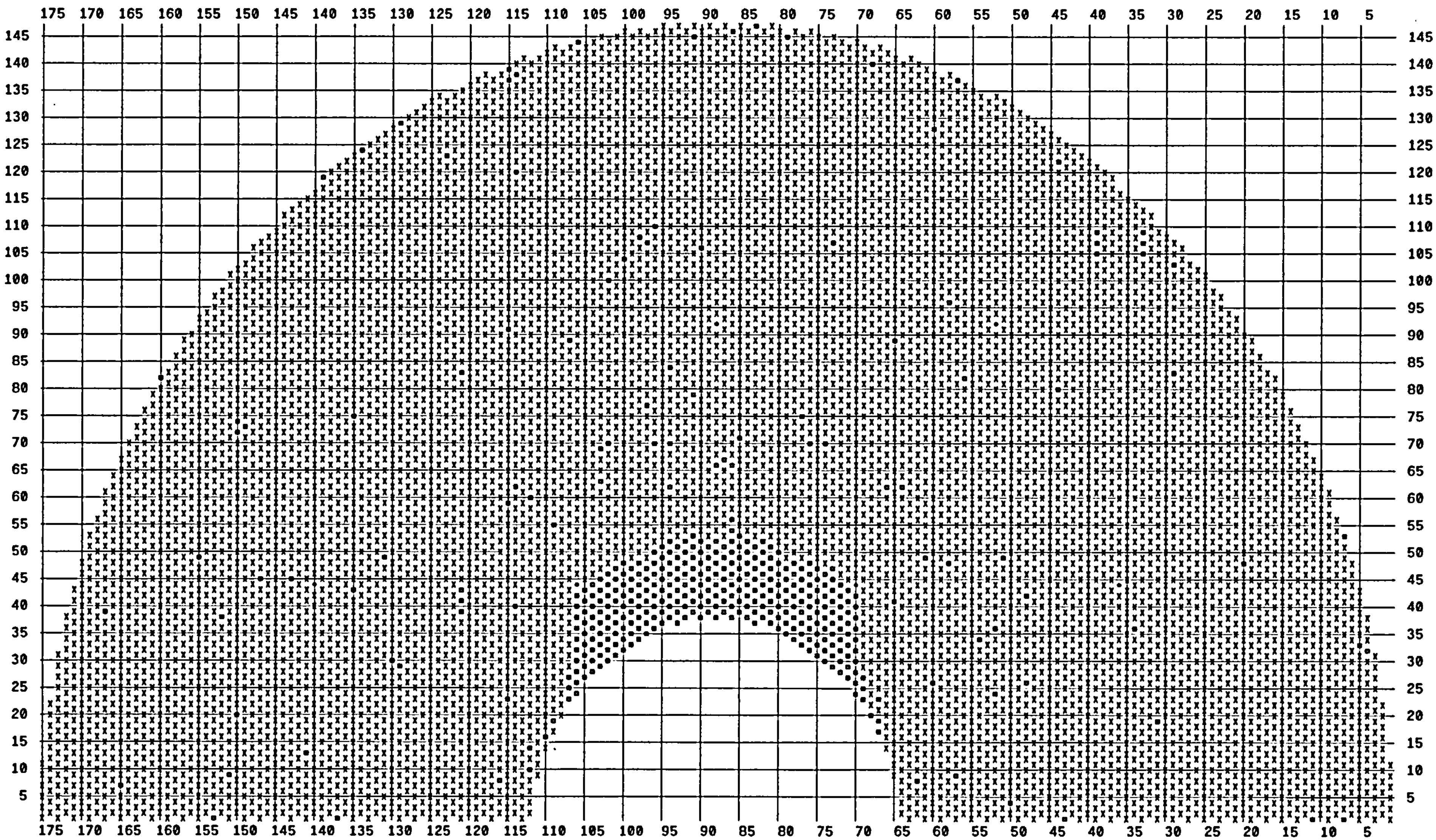

3.2 WATERFORD 3 STEAM GENERATOR DESIGN

3.2.1 WSES 3 The SGs are Combustion Engineering Model 3410 design and all of the supports are egg crates (see fig 3.1 below). The general design of the SGs is shown in Figures 3.1 A & B. The SGs were built by Combustion Engineering and the plant started commercial service in September 1985. There are 2 SGs each having 9350 tubes and are designated as SG31 and SG32. Each steam generator has 147 rows and 175 columns. The tubes are High Temperature Mill Annealed Inconel 600 with dimensions of 0.75" OD x 0.048" nominal wall thickness oriented on a 1" triangular pitch. The longest tubes are in Row 147, and are 949.625" (79.14') long. Supports are carbon steel and include full egg crates (supports 1 to 7), partial egg crates (supports 8 to 10) and batwings (9 total). The batwings include 2 diagonal and 7 vertical straps (Figure 3.1C). Table 3.1 shows information regarding tube support types, location distances and nomenclature.

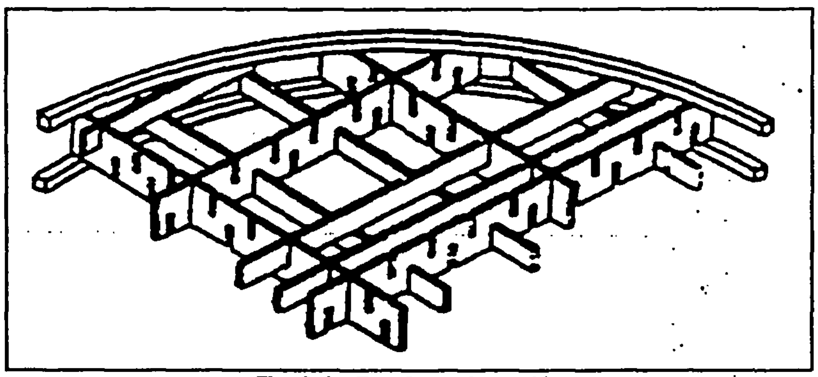

Fig. 3.1 - Egg Crate Assembly

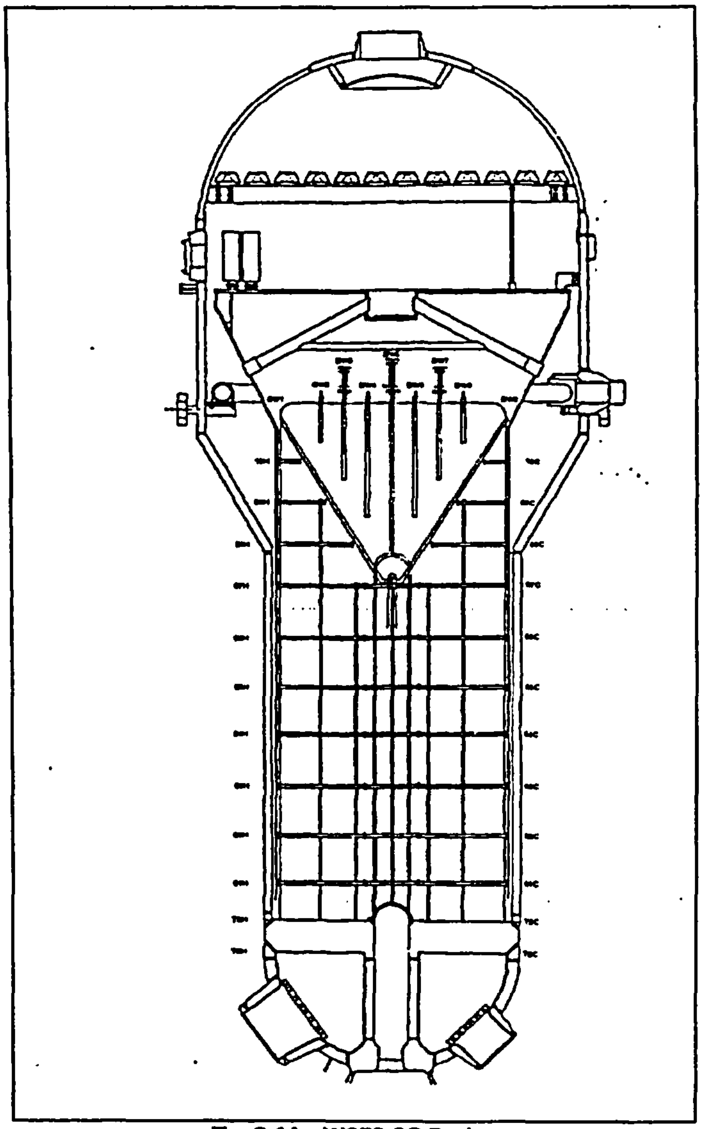

Fig. 3.1A - WSES SG Design

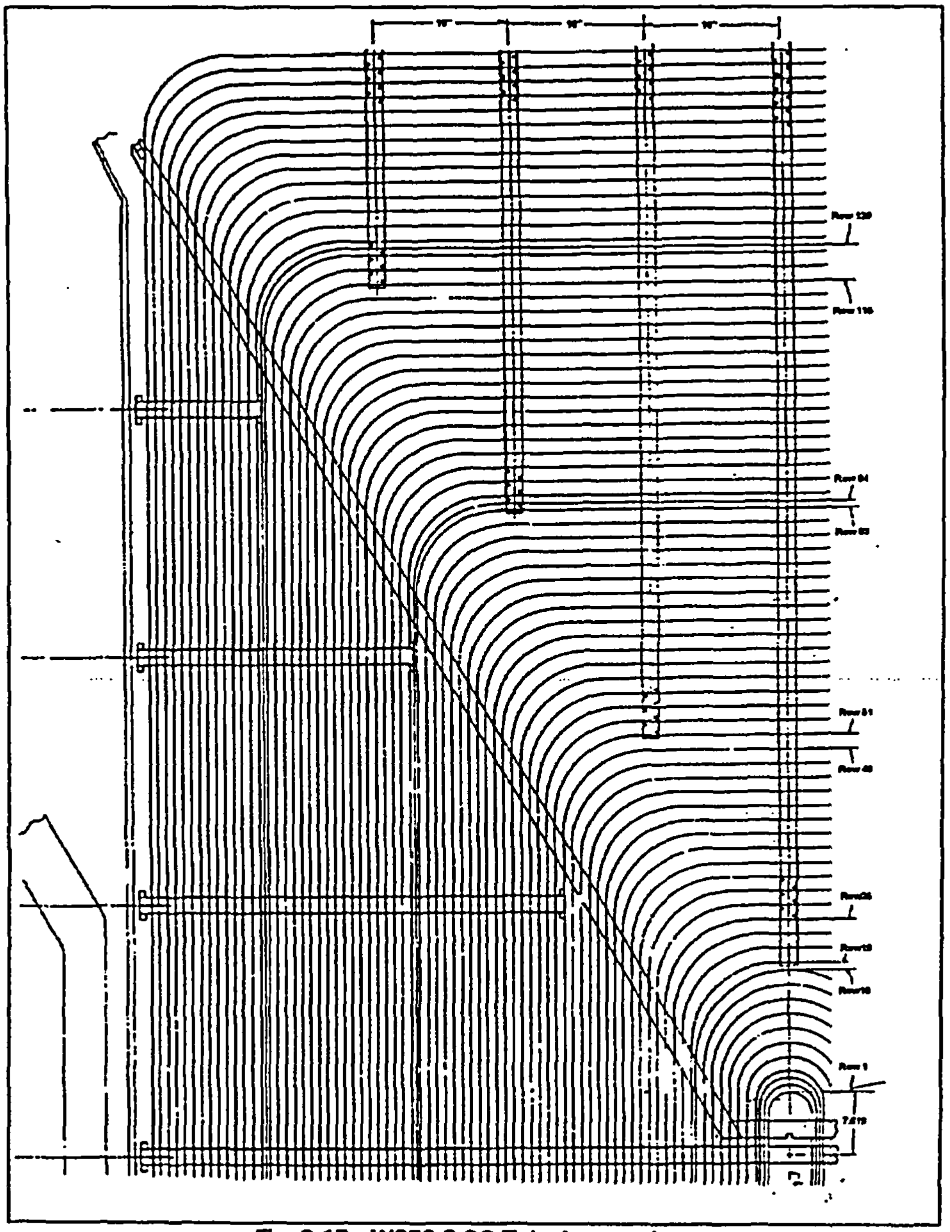

Fig. 3.1B - WSES 3 SG Tube Intersections

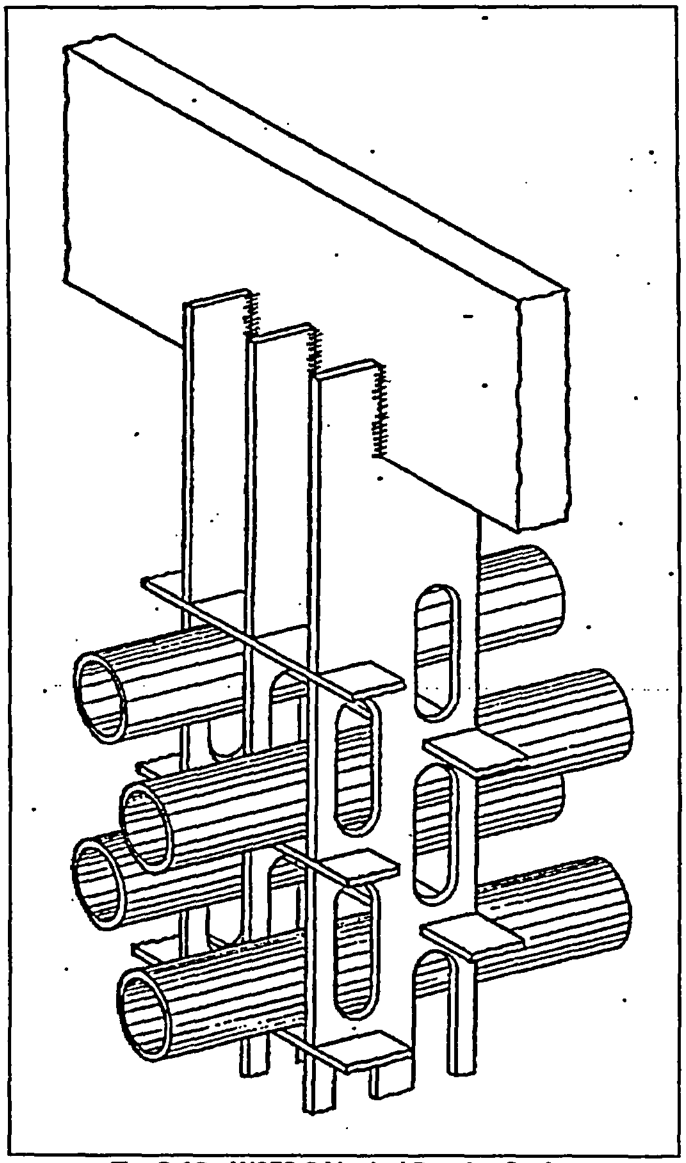

Fig. 3.1C - WSES 3 Vertical Batwing Design

TABLE 3.1
WSES 3 SG LOCATIONS

LOCATION	INCHES FROM TUBE END	CENTER TO CENTER	ACRONYM HOT LEG	ACRONYM COLD LEG
Tube End	0.0"	-	TEH	TEC
Top of Tubesheet	22.75	22.75	TSH	TSC
Center #1 Egg Crate	50.00	27.25	01H	01C
Center #2 Egg Crate	85.00	35.00	02H	02C
Center #3 Egg Crate	121.00	36.00	03H	03C
Center #4 Egg Crate	159.00	38.00	04H	04C
Center #5 Egg Crate	194.00	35.00	05H	05C
Center #6 Egg Crate	230.00	36.00	06H	06C
Center #7 Egg Crate	268.00	38.00	07H	07C
Center #8 Egg Crate	298.75	30.75	08H	08C
Center #9 Egg Crate	329.50	30.75	09H	09C
Center #10 Egg Crate	360.25	30.75	10H	10C

Batwings: BW1(HL), BW2, BW3, BW4, BW5, BW6, BW7, BW8, BW9

Row	Full Length	Straight Length	Radius
1	554.562"	273.344"	2.5"
18	594.000	279.710	11.0
19	597.620	281.590	10.0
147	949.625	393.594	10.0

Table 3.2
SUPPORT STRUCTURE CONTACTS

ROWS	STRUCTURES														
120-147	08H	09H	10H	BW1	BW2	BW3	BW4	BW5	BW6	BW7	BW8	BW9	10C	09C	08C
115-119	08H	09H		BW1	BW2	BW3	BW4	BW5	BW6	BW7	BW8	BW9		09C	08C
84-114	08H	09H		BW1		BW3	BW4	BW5	BW6	BW7		BW9		09C	08C
83	08H			BW1		BW3	BW4	BW5	BW6	BW7		BW9			08C
51-82	08H			BW1			BW4	BW5	BW6			BW9			08C
49-50	08H			BW1				BW5				BW9			08C
19-48				BW1				BW5				BW9			
1-18				BW1								BW9			