Entergy

Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72801
Tel 501 858-5000

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Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
2P99 Steam Generator Tubing Inspection Results

Gentlemen:

The note after Specification 4.4.5.0 of the Arkansas Nuclear One, Unit 2 (ANO-2), Technical Specifications (TSs) requires a report of the 2P99 mid-cycle outage steam generator (SG) tubing inspection results to be submitted to the NRC within 30 days of entering Mode 4. The safety evaluation report for ANO-2 TS Amendment 210 (2CNA119901) also requires the condition monitoring results to be included in the 30 day report. The 2P99 SG condition monitoring and inspection results are attached.

The operational assessment results will be provided within 90 days after entering Mode 4 per 2CNA119901 and NEI 97-06. Additionally, ANO-2 TS 4.4.5.5 requires an annual report on steam generator inspections. These reports will be submitted within their required frequencies at a later date.

Should you have any questions concerning the attached report, please contact me.

Very truly yours,

Jimmy D. Vandergrift
Director, Nuclear Safety

JDV/jjd
attachment

A001 1/1

cc: Mr. Ellis W. Merschoff
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

NRC Senior Resident Inspector
Arkansas Nuclear One
P.O. Box 310
London, AR 72847

Mr. Chris Nolan
NRR Project Manager Region IV/ANO-2
U. S. Nuclear Regulatory Commission
NRR Mail Stop 04-D-03
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

CONDITION MONITORING AND INSPECTION RESULTS ARKANSAS NUCLEAR ONE – UNIT TWO 2P99 MID-CYCLE OUTAGE

1.0 PURPOSE

In accordance with NEI 97-06 and the safety evaluation report for Arkansas Nuclear One, Unit 2 (ANO-2) Technical Specifications Amendment 210 (2CNA119901), an evaluation of the ANO-2 steam generator (SG) tubing inspection results from the 2P99 mid-cycle outage have been compared to the assumptions made in the operational assessment performed after the last inspection (2R13). The purpose of the evaluation is to determine if the operational assessment model inputs are correct or should be modified for the remainder of the operating cycle. Additionally, in-situ testing of the largest flaws observed in the 2P99 inspection was performed to validate the performance criteria used for leakage and burst calculations. Finally, an evaluation based on the results has been performed to determine if the unit can be safely operated for 90 days until a more detailed evaluation can be performed for the remainder of the cycle.

2.0 EVALUATION

The initial step in performing the condition monitoring assessment is to review the outputs from the model used in the previous operational assessment (OA). The 2R13 OA evaluated the following conditions:

1. 01Hot – 03Hot eggcrate axial cracking (half cycle)
2. Remaining eggcrate axial cracking (full cycle)
3. Free span axial cracking (full cycle)
4. Sludge pile axial cracking (full cycle)
5. Circumferential cracking (full cycle)

The OA produced acceptable results to operate to the 2P99 planned mid-cycle outage. The scope of the 2P99 outage inspection focused on the lower eggcrates on the hot leg side of both generators, with additional testing at the top of the tubesheet (TTS) in the "A" SG. The bobbin inspection was conducted from the tube end hot (TEH) to the 07 hot support plate. The TTS examination, while not required during 2P99 by the OA, was performed to minimize the potential for leakage during the last half of the operating cycle. The TTS examination consisted of areas where the largest flaws have developed in the past, and included a total of 503 tubes in two separate areas on the hot leg side of the "A" SG .

2.1 Results of the OA

The following projections were calculated from the OA:

Degradation Mechanism	Conditional Probability of Burst at Postulated SLB (95% Confidence Level)	95/95 Leak Rate at Postulated MSLB (GPM)
Axial ODSCC at Eggcrate hot leg (half cycle)	0.0050	0.0000
Axial ODSCC at Eggcrate cold leg (full cycle)	0.0005	0.0030
Freespan Axial ODSCC hot leg (half cycle)	0.0005	0.0000
Freespan Axial ODSCC cold leg (full cycle)	0.0005	0.0030
Axial at Dented Eggcrates (full cycle)	0.0000	0.0000
Wear at Batwings (full cycle)	0.0000	0.0000
Sludge Pile Axial (full cycle)	0.0003	0.0570
Circumferential ODSCC at Expansion Transitions*	0.0088	0.0460
Leakage due to Hardware (plugs and sleeves)	N/A	0.0022
Total of all Degradation Mechanism	**0.0156**	**0.1112**
NEI 97-06 Limit for 1 Burst	0.05	
SAR Limit for Leakage		1.0000
DG–1074 Guidance	0.01 for 1 or more 0.025 for total degradation	1.0000

Additionally, the following were calculated as outputs from the model:

Flaw Type	Mean # Detected	Mean Max. Depth	POB at 3ΔP
Eggcrate (01-03H)	53	62.5%	9.20%
Other Eggcrates	6	57.5%	2.71%
Free span hot leg	14	50.1%	1.19%
Free span cold leg	6	57.3%	2.28%
Sludge pile	28	74.0%	0.90%
Circumferential	67	65.6%	2.48%

These values are for the worse case SG. The most significant mechanism is axial cracking at the lower eggcrates, which was the reason for the mid-cycle inspection.

The following is a summary of the results from the 2P99 inspection:

2.2 Number of Indications Detected

Mechanism	OA Value	Number Detected Actual Result (2P99)	Bounding Generator
Eggcrate	53	184	SGB
Circumferential	22*	9	SGA
Sludge pile	2*	2	SGA
Free span	14	5	SGA

* Only a 503 tube sample was tested. For a 100% examination the expected values would be 67 for circumferential cracks and 28 for sludge pile axial cracks.

The number of indications detected were conservative relative to the calculated values in the OA, with the exception of the number of eggcrate axial indications. The "B" SG was the dominant generator for axial cracks in the eggcrates. The "A" SG had 49 axial indications in the eggcrates, which is bound by the calculated number in the OA.

2.3 Depth

One of the calculated outputs from the model is depth. This value is the depth averaged over the length of the flaw, similar to the percent degraded area calculated for circumferential indications. The model calculates the average depth for the largest flaw at the end of cycle. The following is a comparison of calculated verses actual average depths for the largest flaws.

Largest Average Depth (% TW)

Mechanism	OA Value	Actual Result (2P99)
Eggcrate	62.5	85.5
Circumferential	65.6*	19.4
Sludge pile	74.0*	47.1

* Value for a full cycle

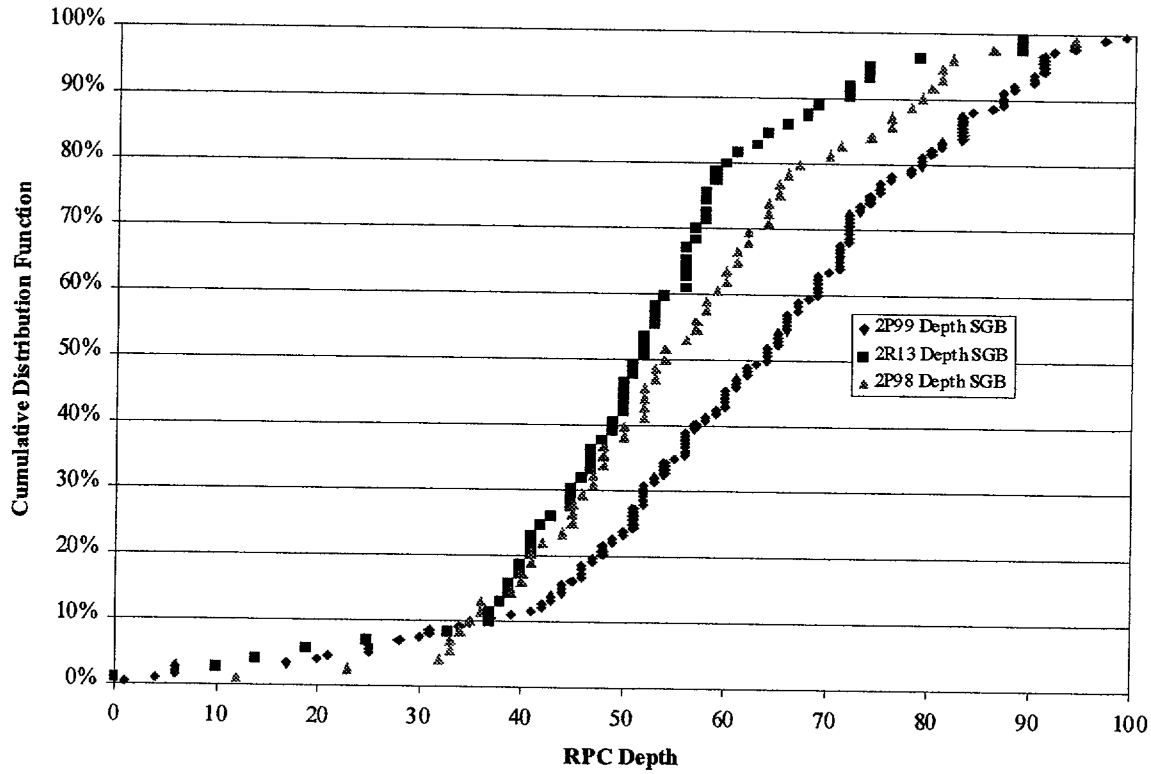
The eggcrate axial indication of the largest flaw was measured at 85.5% average depth. This value was based on use of the 0.115″ pancake coil. The overall depth distribution was also evaluated based on rotating pancake coil (RPC) maximum depth. This is depicted in Figure 1. The overall depth distribution is greater than what was found in the previous two inspections. A change in the growth rate or a change in the probability of detection can cause this difference.

An initial evaluation was performed to determine if the growth rate had increased over that observed previously. The largest indications (greater than 0.5 volts) were sized, with the greatest increase being 20% through wall (TW) while the average was 7.2% TW for 8.3 effective full power months (EFPMs) or 29% TW per effective full power year (EFPY). This value is below 40% TW per EFPY used in the previous OA. A more detailed evaluation of the growth rates is in progress and will be used in the 90 day operational assessment.

The probability of detection (POD) for the deterministic case was modified by assuming a larger beginning of cycle flaw size than previously used. An evaluation of the overall POD is ongoing and will be provided in the 90 day OA.

Figure 1

ANO2 SGB RPC Depth Distribution

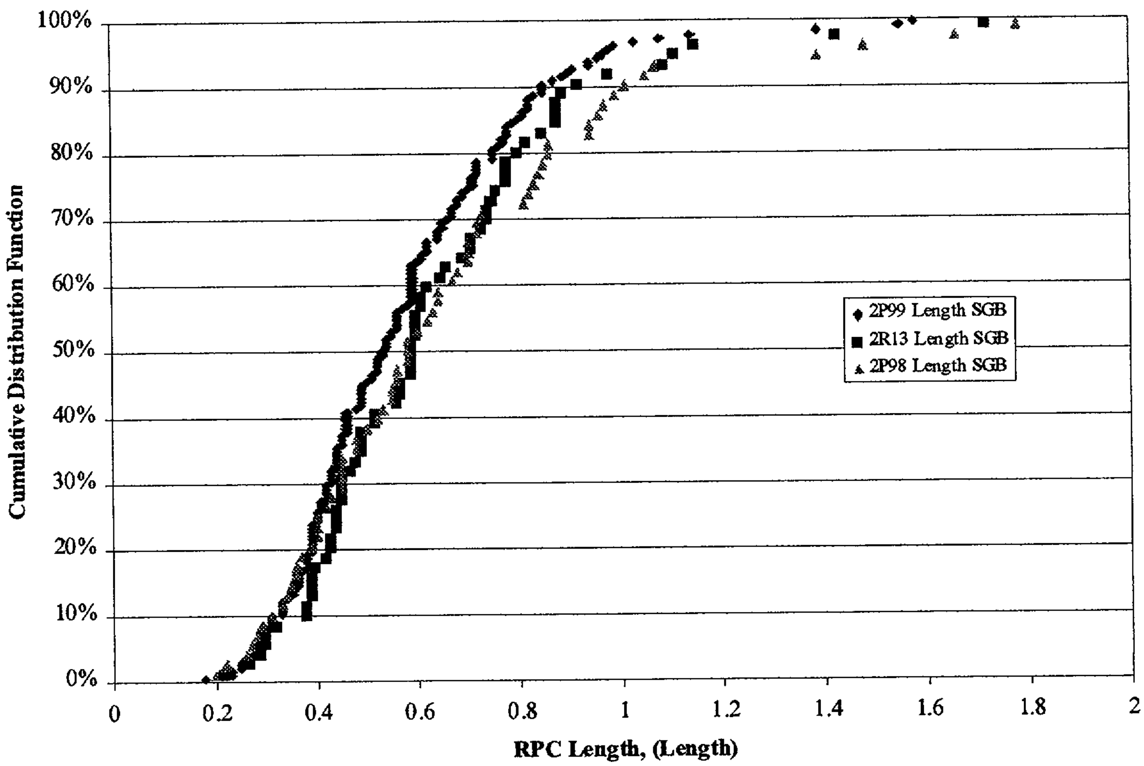


2.4 Length Distribution

The length distribution from the 2P99 inspection results was compared with the previous outages to determine if a change had occurred. Figure 2 depicts the length distributions for the previous three outages. The overall length distribution is still bound by the previous distributions. The average and extreme value lengths are slightly shorter than those measured in previous inspections.

Figure 2

ANO2 SGB RPC Length Distribution



2.5 In-Situ Testing

The performance criteria associated with meeting or exceeding three times the normal operating differential pressure (3ΔP) was demonstrated with in-situ testing. Six tubes were tested in the "B" SG, which bound the "A" SG relative to the screening criteria specified by EPRI. The target values are conservative and were derived by adjusting the actual values for temperature and instrument uncertainties.

	Actual (psig)	Target (psig)
Normal operating	1335	1550
Intermediate	1910	2200
Main steam line break (MSLB)	2485	2850
1.43 X MSLB	3553	4100
3ΔP	4005	4650

The results of the in-situ testing performed during the 2P99 inspection follow:

Tube 23 - 55

PSIG	(GPM)
1587	No leakage
2246	No leakage
2873	No leakage
4186	No leakage
4752	No leakage

Tube 102 - 110

PSIG	(GPM)
1573	No leakage
2246	No leakage
2877	No leakage
4167	No leakage
4715	No leakage

Tube 72 - 72

PSIG	(GPM)	
1568	No leakage	
2232	No leakage	
2882	No leakage (MSLB pressure)	
3737	Leakage detected	3774 psig = 0.02 gpm
3971	Step increase in leakage and pressure drop	
3573	Leakage = 0.560 gpm	
4132	0.920 gpm	
4147*	1.16 gpm	1012 psig = 4.5 gpm)

* Unable to reach the maximum target pressure due to exceeding pump capacity. Value adjusted for leakage and equipment error.

Tube 33 – 71

PSIG	(GPM)
1563	No leakage
2246	No leakage
2896	No leakage
4182	No leakage
4757	No leakage

Tube 36 - 36

PSIG	**(GPM)**
1582	No leakage
2227	No leakage
2896	No leakage
4177	No leakage
4720	No leakage

Tube 53 - 83

PSIG	**(GPM)**	
1587	No leakage	
2236	No leakage	
2659	No leakage	(MSLB pressure)
2910	0.016	
3540	0.044	
4130	0.120	
4580	0.940	
4703	1.160	

It is inconclusive whether Tube 72-72 met the 3ΔP margin criterion due to the inability of the system to reach burst pressure and because of the uncertainties associated with temperature corrections. The tube did surpass design basis accident pressures with no leakage. Further analysis is ongoing and the results will be included in the 90 day OA. Figure 3 is a scatter plot used to assess which tubes should be tested. The assessment consists of evaluating indications based on the EPRI selection criteria and plotting data from previously tested flaws to determine if bounding flaws were previously tested. The data used is for SGB, which bounds SGA. Figure 4 is a similar plot for SGA. Figures 5 and 6 provide supplementary information used to select candidates for in-situ pressure testing. This information, along with a review of the eddy current data to look for the number of cracks, ligaments, series vs. parallel cracks, etc., is used due to the uncertainty associated with depth sizing outer diameter stress corrosion cracking.

Figure 3

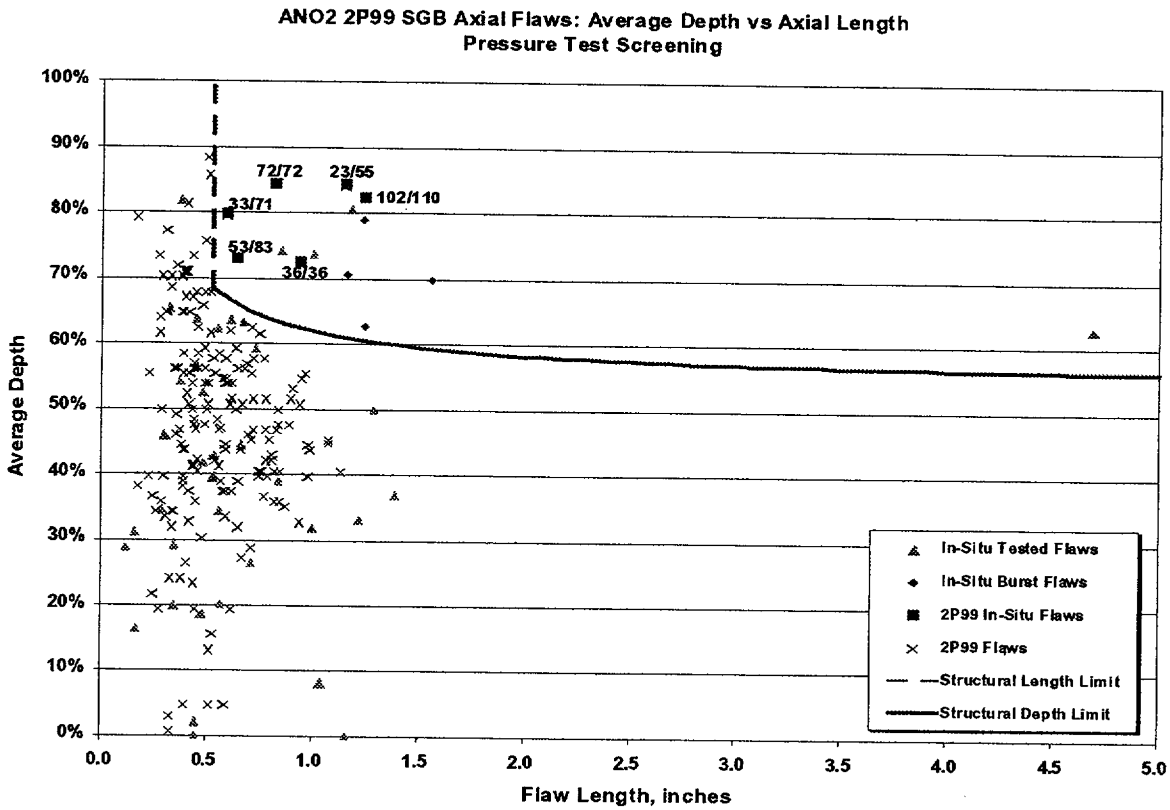

ANO2 2P99 SGB Axial Flaws: Average Depth vs Axial Length
Pressure Test Screening
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Average Depth
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Flaw Length, inches
72/72
23/55
33/71
102/110
53/83
36/36
In-Situ Tested Flaws
In-Situ Burst Flaws
2P99 In-Situ Flaws
2P99 Flaws
Structural Length Limit
Structural Depth Limit

Figure 4

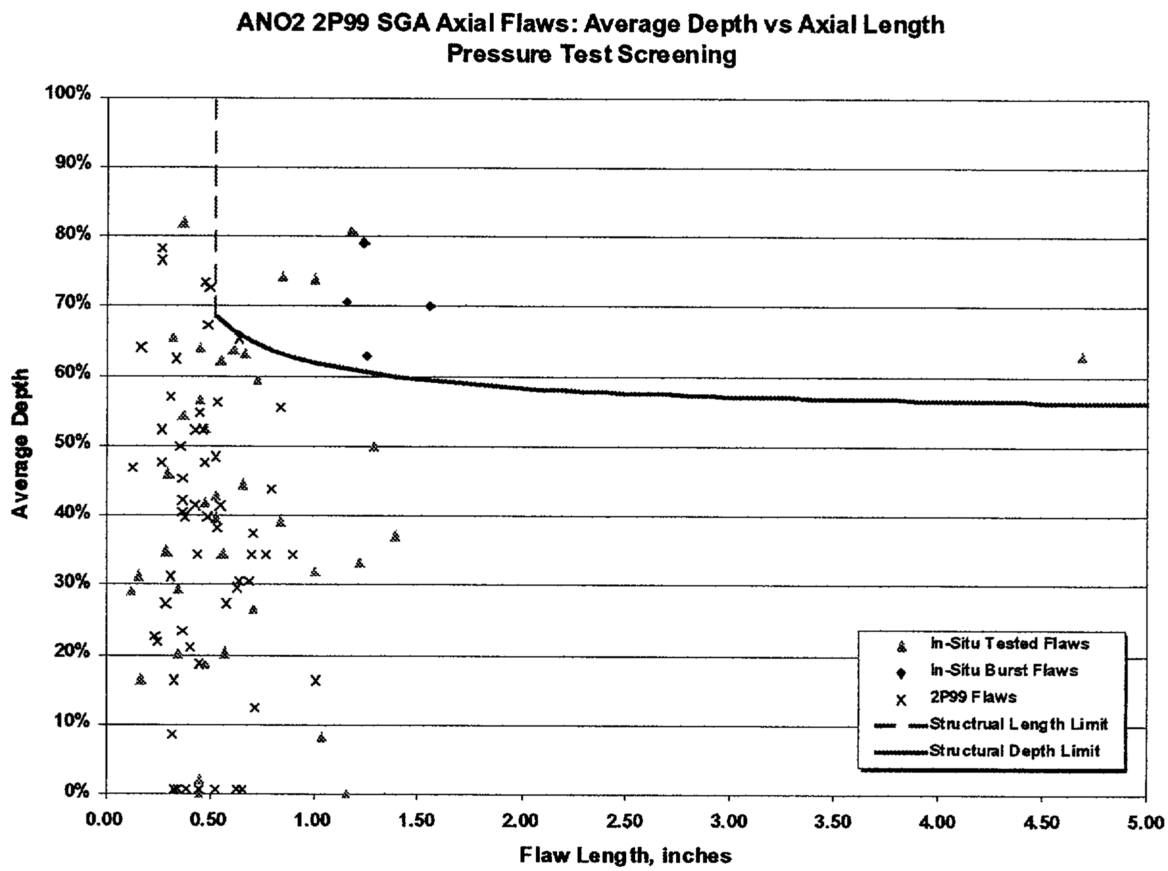

ANO2 2P99 SGA Axial Flaws: Average Depth vs Axial Length
Pressure Test Screening
Average Depth
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
Flaw Length, inches
In-Situ Tested Flaws
In-Situ Burst Flaws
2P99 Flaws
Structrual Length Limit
Structural Depth Limit

Figure 5

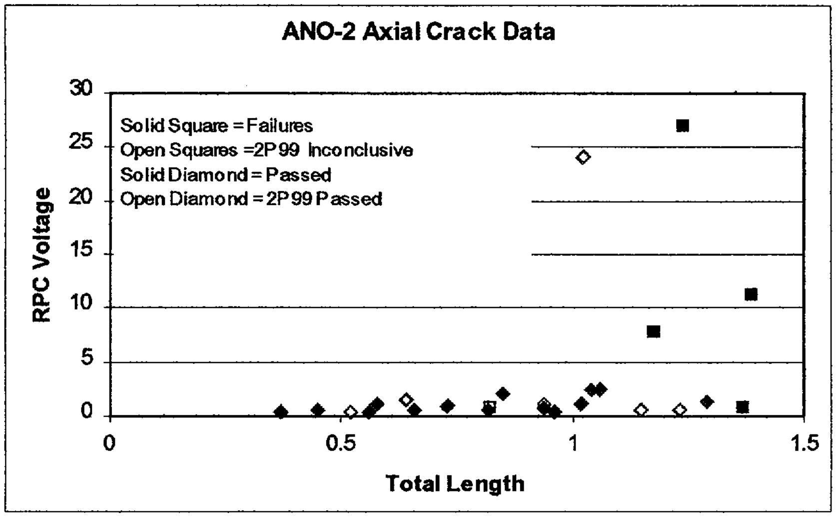
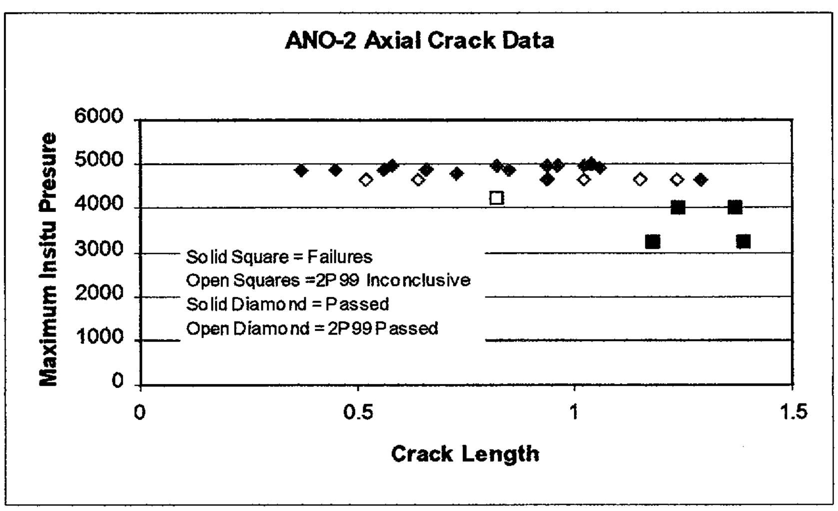


Figure 6

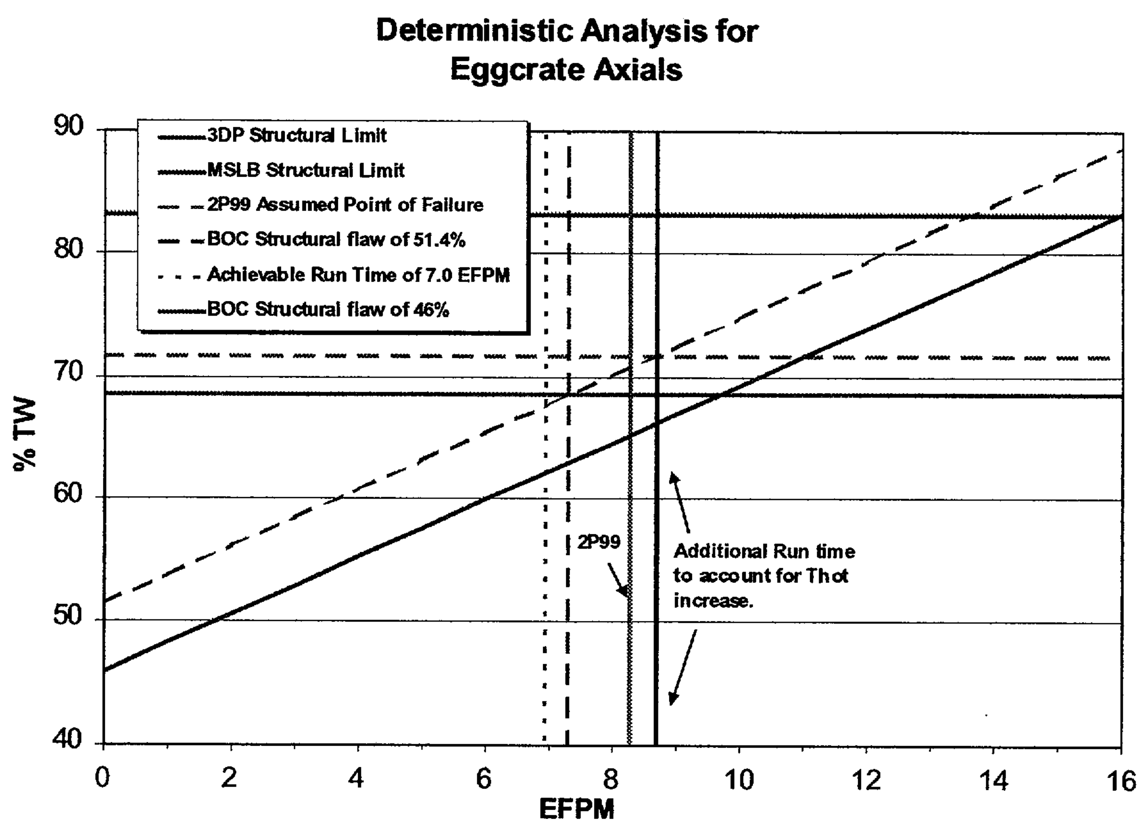


All six tubes met the design basis accident structural and leakage requirements. None of the six tested tubes leaked at or below MSLB pressure. One of the six tubes tested did fail to achieve the target pressure of 4650 psig (72-72). The tube was not pressurized to 4650 psig due to the inability of the pump to maintain a high enough pressure while maintaining an elevated flow rate. Further analysis is ongoing to determine if the flaw met the 3ΔP margin criterion.

2.6 Deterministic Analysis

The OA was based on an operating time of 8.8 EFPM. The actual operating period was 8.3 EFPM. The second half of the operating interval will be slightly longer (1.1 EFPM) and the unit will be operated at approximately 1.0 degree Fahrenheit hotter to maintain 100% power operation. Both of these conditions will be taken in consideration when developing the OA for the remainder of the cycle.

A deterministic evaluation using the worse case identified flaw (72-72) was developed to support initial operation of the plant. Based on conservative growth rates and back calculating a beginning depth, an operating runtime of 7.0 EFPM was determined to be the point at which the worse case flaw would exceed the 3ΔP criterion. The following figure depicts the data:



The beginning of cycle (BOC) depth was determined by assuming that Tube 72-72 burst at the peak pressure achieved (4147 psig) after 8.3 EFPM. Using a 95/95 growth rate of 28% TW/EFPY yields a BOC depth of 51.4% TW. Use of this BOC depth, in turn results in an operating run time of 7.0 EFPM when adjusted for Thot increases.

3.0 SUMMARY

The OA for the last half of the operating cycle will be completed within 90 days of plant startup. The deterministic evaluation performed bounds the 90 day period that will be needed to develop the OA. The plant is considered safe to operate until the detailed operational assessment can be completed.