**NRC Conference Call (5/15/07)**
**Steam Generator Tube Inspection Discussion Points**
**Oconee Nuclear Station, Unit 2**

Background

- This is the second in-service inspection on the Oconee Unit 2 replacement steam generators (steam generators were replaced in Spring, 2004) - operational cycle length was 1.37 EFPY
- The steam generators are of the once-through design type and were manufactured by Babcock & Wilcox – Canada
- The tubing is thermally treated Alloy 690
- The SG has 15 support plates, the support plates are made of 410 SS, the support openings are of the trifoil broach design, with the exception of some drilled openings at the $14^{th}$ TSP
- The tubes are hydraulically expanded into the tubesheet to a depth of 13 inches
- Widespread tube wear was discovered during the first inspection on the Oconee Unit 1 replacement steam generators; similar but less severe wear was observed on Units 2 and 3
- Both the average and maximum growth rates were reduced for the second inspection on the Oconee Unit 1 and 2 steam generators but there was an increase in the number of wear indications observed.

NRC Generic Questions

1. Discuss any trends in the amount of primary-to-secondary leakage observed during the recently completed operating cycle.

   There has been no primary-to-secondary leakage during the recently completed operating cycle.

2. Discuss whether any secondary side pressure tests were performed during the outage and the associated results.

   No secondary side pressure tests were performed.

3. Discuss any exceptions taken to the industry guidelines.

   No exceptions have been taken to the EPRI PWR Steam Generator Examination Guidelines.

4. For each steam generator, provide a description of the inspections performed including the areas examined, the probes used, and the expansion criteria. Also, discuss the extent of rotating probe inspections performed in the portion of the tube below the expansion transition region.

   A full length bobbin coil inspection was performed on all in-service tubing in both steam generators. A combination X-probe was used for approximately 50% of the inspection, and a standard bobbin probe was used for the remaining 50% of the inspection. Selected indications were further characterized with an array probe. The screening criteria used for array analysis was as follows: (1) all wear indication ≥ 20% TW, (2) new wear indications ≥ 10% TW, and (3) existing wear indications that have grown by ≥ 10% TW. No rotating coil inspections were performed.

5. For each area examined, provide a summary of the number of indications found to date for each degradation mode. For the most significant indications in each area, provide an estimate of the severity of the indication. In particular, address whether tube integrity was maintained during the previous operating cycle. In addition, discuss whether any location exhibited a degradation mode that had not previously been observed at this location in this unit.

   Wear is the only type of degradation that has been observed to date on the Oconee Unit 2 replacement steam generators. This type of degradation was also observed during the previous Unit 2 inspection in October, 2005. Similar wear was identified on all other Oconee Units.

   SG A – The inspection on the 2A steam generator is complete. See Attachment A for a summary of results and comparison to previous Unit 2 inspection results.

   SG B – The inspection on the 2B steam generator is complete. See Attachment A for a summary of results and comparison to previous Unit 2 inspection results.

   A total of one (1) tube was identified with tube wear of ≥ 40% through-wall. See Attachment B for data associated with this indication.

   None of the wear indications detected approach tube integrity limits. The maximum NDE wear depth observed during this inspection was 42% through-wall. This is well below the condition monitoring limit of 73% through-wall.

6. Describe repair/plugging plans.

   One (1) tube was identified for plugging based on a plugging criterion of ≥ 35% through-wall. This tube was stabilized full length.

7. Describe in-situ pressure test and tube pull plans and results.

   No in-situ pressure testing or tube pulls were performed.

8. Provide the schedule for steam generator related activities during the remainder of the current outage.

   The tentative schedule for remaining steam generator related activities is as follows:

   - Remove nozzle dams and install primary manways (Tuesday - Wednesday)

9. Discuss the following regarding loose parts: What inspections are performed to detect loose parts, a description of loose parts identified and their location within the steam generator, if loose parts were removed, tube damage associated with loose parts, and the source or nature of the loose parts.

   No visual inspections were performed for loose parts. No indications of loose parts have been identified via eddy current. Loose parts have not been a historical problem on once-through steam generators.

10. For OTSGs, if you have Babcock& Wilcox welded plugs installed in the steam generators, discuss the actions taken in response to Framatome's notification of the effect of tubesheet hole dilation on the service life of the welded plugs.

    Not applicable.

11. For OTSGs, discuss any actions taken in response to the severed tube issue during the outage (reference NRC IN 2002-02).

    No actions taken. This problem not applicable to the Oconee replacement steam generators.

<u>Attachments</u>

1) Attachment A - Oconee Unit 1 Steam Generator Tube Wear Summary
2) Attachment B - Oconee Unit 1 Tube Wear Indications ≥ 40% TW
3) Tube Wear Elevation Distribution (SG A)
4) Tube Wear Elevation Distribution (SG B)
5) Tubesheet Map (SG A)
6) Tubesheet Map (SG B)
7) Preliminary Operational Assessment Results

# Attachment A

## Oconee Unit 2 EOC 22
## Steam Generator Tube Wear Summary

| | Unit 2 EOC 22 | | Unit 2 EOC 21 | |
|---|---|---|---|---|
| | 2A SG | 2B SG | 2A SG | 2B SG |
| # of wear indications | 2169 | 2493 | 627 | 902 |
| # of tubes with indications | 1587 | 1724 | 495 | 698 |
| % tubes with indications | 10% | 11% | 3% | 4% |
| Average wear depth (all indications) | 8% | 9% | 8% | 8% |
| Average wear depth (new indications) | 7% | 8% | 8% | 8% |
| Maximum wear depth (all indications) | 30% | 42% | 22% | 32% |
| Maximum wear depth (new indications) | 30% | 28% | 22% | 32% |
| # indications ≥ 40% TW | 0 | 1 | 0 | 0 |
| # indications ≥ 30% < 40% TW | 4 | 10 | 0 | 3 |
| # indications ≥ 20% < 30% TW | 27 | 90 | 3 | 8 |
| EFPY per cycle | 1.37 | 1.37 | 1.31 | 1.31 |
| Average growth rate per EFPY | 2% | 2% | 6% | 6% |
| 95/50 growth rate per EFPY | 7% | 8% | 11% | 11% |
| Maximum growth rate per EFPY | 22% | 20% | 17% | 24% |
| # tubes plugged *= tubes pulled | 0 | 1 | 2* | 3 |

# Attachment B

# Oconee Unit 2 EOC 23
# Steam Generator Tube Wear Indications ≥ 40%

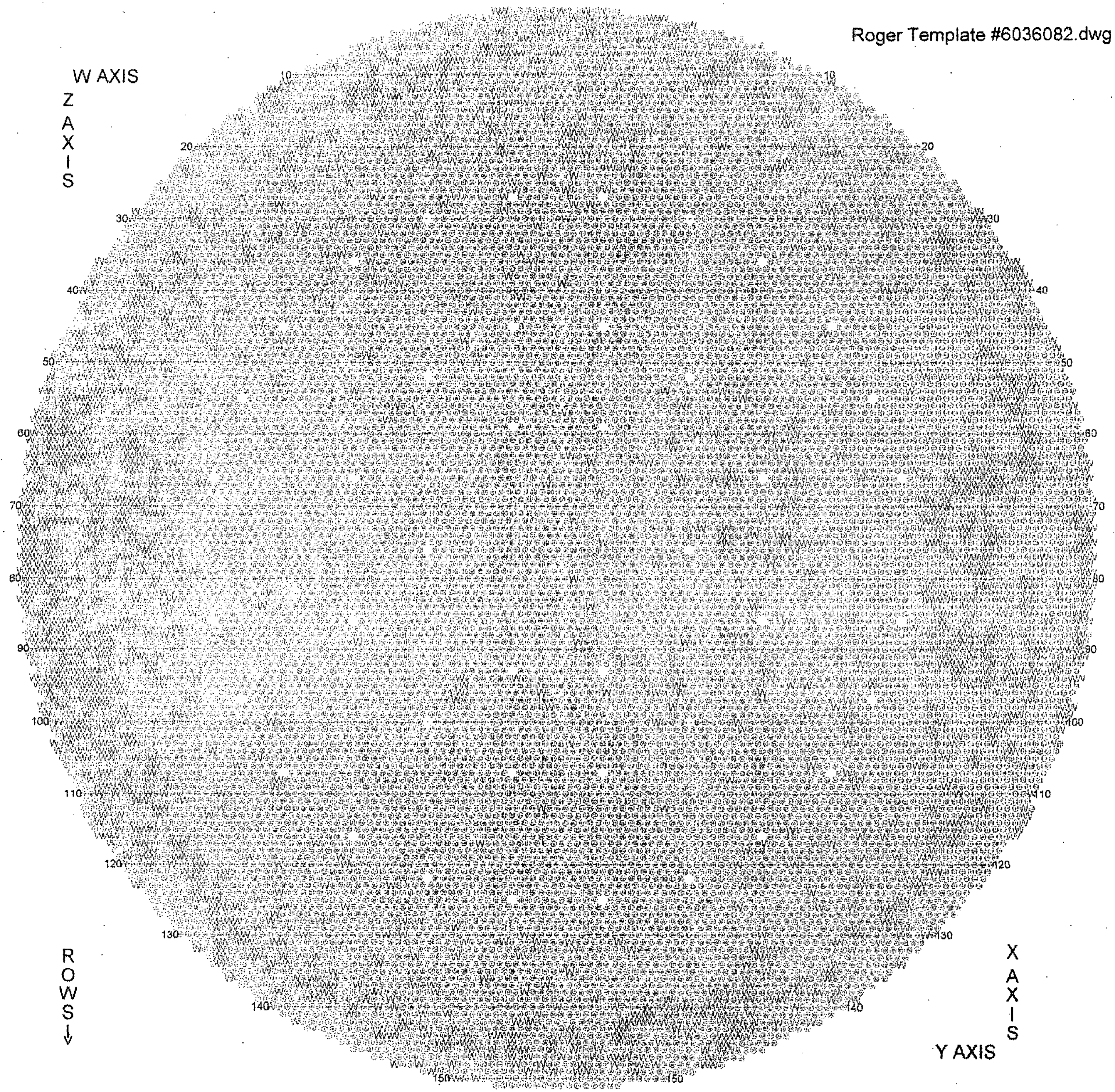
| Oconee Unit 2 Steam Generator A<br>Indications ≥ 40 %TW and Previous History | | | | | | |
|---|---|---|---|---|---|---|
| ROW | COL | 2007 %TW | 2005 %TW | Change %TW | LOCATION | ELEV FROM |
| None | | | | | | |

| Oconee Unit 2 Steam Generator B<br>Indications ≥ 40 %TW and Previous History | | | | | | |
|---|---|---|---|---|---|---|
| ROW | COL | 2007 %TW | 2005 %TW | Change %TW | LOCATION | ELEV FROM |
| 75 | 2 | 42 | 27 | 15 | 2 | |

| | Support | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ONS2 A 2007** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Total |
| %tw<=5 | 3 | 3 | 6 | 9 | 6 | 8 | 45 | 114 | 23 | 25 | 86 | 85 | 74 | 37 | 3 | 527 |
| 5<%tw<=10 | 21 | 20 | 31 | 18 | 22 | 20 | 50 | 78 | 27 | 121 | 236 | 244 | 233 | 102 | 7 | 1230 |
| 10<%tw<=15 | 8 | 10 | 9 | 11 | 3 | 1 | 4 | 2 | 1 | 40 | 45 | 65 | 81 | 26 | 1 | 307 |
| 15<%tw<=20 | 2 | 7 | 1 | 3 | 4 | 2 | | 1 | 1 | 9 | 3 | 4 | 27 | 8 | | 72 |
| 20<%tw<=25 | | 1 | 2 | | 1 | | | | | 4 | | 1 | 5 | 2 | | 16 |
| 25<%tw<=30 | | 4 | 2 | 1 | | | | | | 1 | | | | | 1 | 9 |
| 30<%tw<=35 | | | | | | | | | | | | | | | | 0 |
| 35<%tw<=40 | | | | | | | | | | | | | | | | 0 |
| 40<%tw<=45 | | | | | | | | | | | | | | | | 0 |
| 45<%tw<=50 | | | | | | | | | | | | | | | | 0 |
| 50<%tw<=55 | | | | | | | | | | | | | | | | 0 |
| 55<%tw<=60 | | | | | | | | | | | | | | | | 0 |
| %tw>60 | | | | | | | | | | | | | | | | 0 |
| Total/Support | 34 | 45 | 51 | 42 | 36 | 31 | 99 | 195 | 52 | 200 | 370 | 399 | 420 | 175 | 12 | 2161 |
| | | | | | | | | | | | | | | | Affected Tubes | 1587 |
| | | | | | | | | | | | | | | | Tubes Analysed | Complete |

| | Support | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ONS2 B 2007** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Total |
| %tw<=5 | 6 | 3 | 4 | 3 | 1 | 13 | 64 | 18 | 48 | 60 | 76 | 149 | 36 | 36 | 2 | 519 |
| 5<%tw<=10 | 13 | 12 | 16 | 17 | 5 | 37 | 114 | 21 | 110 | 156 | 162 | 415 | 130 | 150 | 3 | 1361 |
| 10<%tw<=15 | 1 | 1 | 7 | 4 | 1 | 8 | 10 | 2 | 24 | 39 | 48 | 147 | 37 | 40 | 2 | 371 |
| 15<%tw<=20 | 1 | 2 | 2 | 6 | | 4 | 3 | 2 | 7 | 19 | 14 | 66 | 10 | 17 | 1 | 154 |
| 20<%tw<=25 | 1 | 1 | 1 | 2 | | | 1 | | | 18 | 1 | 24 | | 4 | | 53 |
| 25<%tw<=30 | | 1 | 1 | | | | | | | 2 | 3 | 11 | | | | 18 |
| 30<%tw<=35 | | 1 | | | | | | | | 4 | | 1 | | | | 6 |
| 35<%tw<=40 | | | | | | | | | | | | | | | | 0 |
| 40<%tw<=45 | | 1 | | | | | | | | | | | | | | 1 |
| 45<%tw<=50 | | | | | | | | | | | | | | | | 0 |
| 50<%tw<=55 | | | | | | | | | | | | | | | | 0 |
| 55<%tw<=60 | | | | | | | | | | | | | | | | 0 |
| %tw>60 | | | | | | | | | | | | | | | | 0 |
| Total/Support | 22 | 22 | 31 | 32 | 7 | 62 | 192 | 43 | 189 | 298 | 304 | 813 | 213 | 247 | 8 | 2483 |
| | | | | | | | | | | | | | | | Affected Tubes | 1724 |
| | | | | | | | | | | | | | | | Tubes Analysed | Complete |

Roger Template #6036082.dwg




# ONS2 Repl Outage

AREVA - FDMS map module Version 5.0

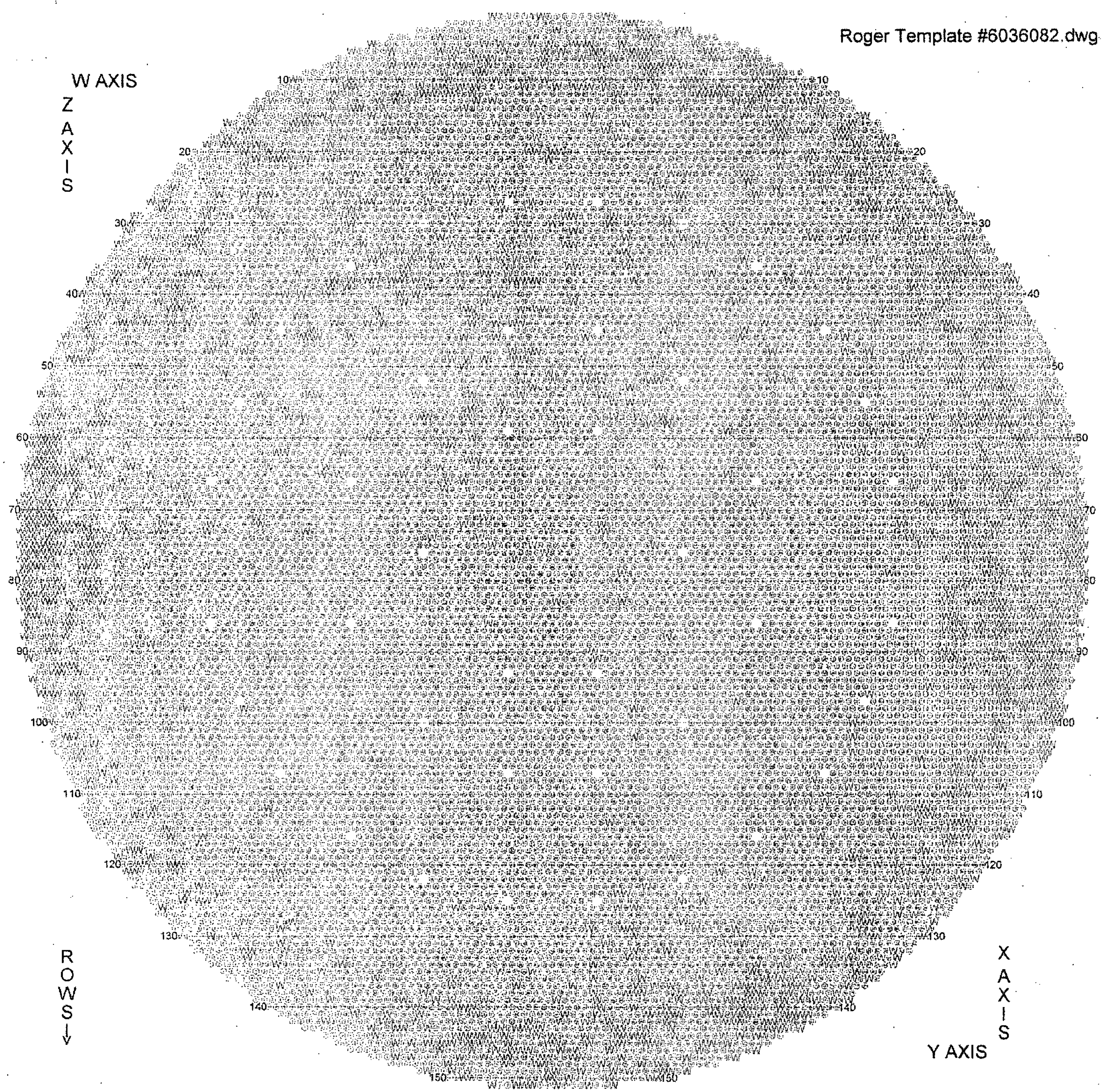
S/G B
PRIMARY FACE
INLET

| | |
|---|---|
| TOTAL TUBES: | 15631 |
| TUBES SELECTED: | 1724 |
| OUT OF SERVICE (#): | NA |

| GROUP | TUBES |
|---|---|
| Wear | 1724 |

SCALE: 0.067445 X

Mon May 14 11:40:56 2007




# ONS2 Repl Outage

AREVA - FDMS map module Version 5.0

S/G A
PRIMARY FACE
INLET

| | |
|---|---|
| TOTAL TUBES: | 15631 |
| TUBES SELECTED: | 1587 |
| OUT OF SERVICE (#): | NA |

| GROUP | TUBES |
|---|---|
| Wear | 1587 |

SCALE: 0.067445 X
Mon May 14 11:37:44 2007

## Operational Assessment Summary

A bounding tapered wear scar geometry with a structural average depth equal to 0.84 times the maximum depth and a structurally effective length of 0.4 inches leads to an allowable end of cycle physical maximum depth of 78.4 %TW. A maximum physical depth of this value insures a minimum burst pressure of 3ΔP, 4050 psi, at 0.95 probability with 50% confidence considering material property and burst equation uncertainty.

Several approaches were evaluated in determining the repair limit. The desired cycle length is 1.392 EFPY but calculations are based on a conservative cycle length of 1.5 EFPY. The most conservative approach is the application of an upper 95th percentile NDE sizing uncertainty to the NDE repair limit and then arithmetically adding a growth allowance base on the worst case growth rate of the current inspection. The selected worst case growth rate is 21.9 %TW/EFPY. This is conservative since it is based on the fresh appearance of a 30 %TW indication rather than growth of a repeat indication. The resulting NDE repair limit is 35 %TW. This is the same as the Unit 1 repair limit. Other techniques led to repair limits substantially larger then the technical specification limit of 40 %TW.

The upper 95th percentile growth rate for repeat indications is relatively low at 8.0 %TW/EFPY in the worst case steam generator. The maximum growth rate of a repeat indication is 16.8 %TW/EFPY. As expected from the Oconee Unit 1 repeat inspection results, there was no correlation between BOC depth and the subsequent growth rate. The depth distribution for indications without a depth call in the first inspection is essentially the same as the depth distribution observed in the first inspection. The observed worst case depth was 42 %TW. This indication had a BOC depth of 27 %TW. The Condition Monitoring limit is 73 %TW thus past cycle structural and leakage integrity is demonstrated.