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1CAN071003

July 29, 2010

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

SUBJECT: Steam Generator Tube Inspection Report – 1R22
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

Dear Sir or Madam:

Entergy Operations, Inc. (Entergy) inspected the Arkansas Nuclear One, Unit 1 (ANO-1) steam generator (SG) tubes during the Spring (March) 2010 refueling outage (1R22) in accordance with ANO-1 Technical Specification (TS) 5.5.9, Steam Generator Program. ANO-1 TS 5.6.7, Steam Generator Tube Inspection Reports, requires the results of the in-service inspection to be submitted to the NRC within 180 days after the initial entry into Mode 4. Attached is the subject inspection report.

The 1R22 inspection performed on both SGs involved an initial full-length bobbin coil examination of specific locations near tie rods. The X-probe used consists of an array of coils for diagnostic testing.

This completes the reporting requirements of the ANO-1 TS for this inspection.

This submittal does not include any new commitments.

If you have any questions or require additional information, please contact me.

Sincerely,

DBB/rwc

Attachments:

1. ANO-1 Steam Generator Inspection Report – 1R22
2. SG "A" Wear Indications – 1R22
3. SG "B" Wear Indications – 1R22

A047
NRR

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Attachment 1 to

1CAN071003

ANO-1 Steam Generator Inspection Report

1R22

ARKANSAS NUCLEAR ONE, UNIT 1
STEAM GENERATOR INSPECTION REPORT – 1R22

1 INTRODUCTION

Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specification (TS) 5.6.7, Steam Generator Tube Inspection Reports, requires Entergy Operations, Inc. (Entergy) to submit a 180-day report to the NRC that outlines the details of the steam generator (SG) tubing inspections that were performed during the reporting period. The report shall include:

1. The scope of inspections performed on each SG.
2. Active degradation mechanisms found.
3. Nondestructive examination techniques utilized for each degradation mechanism.
4. Location, orientation (if linear), and measured sizes (if available) of service induced indications.
5. Number of tubes plugged during the inspection outage for each active degradation mechanism.
6. Total number and percentage of tubes plugged to date.
7. The results of condition monitoring, including the results of tube pulls and in-situ testing.

The operating period for this report includes one refueling inspection outage (1R22), in March 2010, a non In-Service Inspection (ISI). This report details the result of that inspection. The inspection was to determine the extent of bowing of the tie rods and not an ASME Code type inspection. Tube support plate wear was justified for two cycles. The extent of bowing was consistent with predictions made in the previous operational assessment (OA). Also the tubes that contained wear were consistent with the growth rates and estimates predicted in the previous OA. The degradation identified met all performance criteria.

2 DESIGN

The replacement steam generators for ANO-1 are Enhanced Once-Through Steam Generators (EOTSG) manufactured by AREVA. The EOTSG is a straight shell and tube type heat exchanger installed in a vertical position with bottom supports and such emergency supports as required to accommodate normal and accident loads. The tubing consists of Inconel 690 thermally treated tubing that is 5/8" in diameter with a 0.037" wall thickness. The tubes are expanded full-depth hydraulically in the tubesheet. There are 15 tube supports that are constructed of stainless steel (SA 240 type 410) and are a broached trefoil-hole design.

3 REPORT REQUIREMENTS

3.1 The scope of inspections performed on each SG.

Table 3.1.1 lists the inspection scope of 1R22.

Table 3.1.1

1R22 Inspection Scope

SG "A"

Examination Type	Inspections Conducted	% Scope	Extent Tested
Bobbin Initial	650	4	TEC to TEH
X-Probe/Plus Point	41	N/A	N/A

SG "B"

Bobbin Initial	312	2	TEC to TEH
X-Probe/Plus Point	0	N/A	N/A

TEC Tube End Cold

TEH Tube End Hot

3.2 Active degradation mechanisms found.

This was the third ISI following replacement of the SGs. The only mechanisms identified were mechanical wear at tube support plates and tie rod / tube bowing. These are listed in Table 3.2.1.

Table 3.2.1

Indication List for 1R22

SG	Tube Support Wear	Proximity
"A"	63	87
"B"	21	0

Table 3.3.1

Nondestructive examination techniques utilized for each degradation mechanism.

	Site Technique (ETSS)	Site ETSS	Industry Qualification	Damage Mechanism	Demonstrated Applicability	Extended Applicability	Site-Specific Review Deemed Acceptable	
							Detection	Sizing
1	Bobbin	1	96004.1, rev 12 96043.1, rev.1	TSP Wear	Broach TSP	Drill TSP PLP wear Tie rod-to-tube wear Tube-to-tube wear (if similar morphology)	Yes	Yes
2	X-Probe	2	2040X.1, rev.5 2050X.1, rev.4 (X=0-3)	ODSCC, PWSCC	Expansion transitions, freespan, support structures, dents	None	Yes	No

ETSS	Examination Technical Specification Sheet
ODSCC	Outside Diameter Stress Corrosion Cracking
PWSCC	Pure Water Stress Corrosion Cracking
TSP	Tube Support Plate

3.4 Location, orientation (if linear), and measured sizes (if available) of service induced indications.

The only service-induced mechanism is wear at the tube support plates. Due to the large number of indications, these are listed in Attachments 2 and 3 of this submittal for SG "A" and SG "B", respectively. There were no wear indications associated with proximity tubes.

3.5 Number of tubes plugged during the inspection outage for each active degradation mechanism.

There were no tubes plugged in 1R22.

3.6 Total number and percentage of tubes plugged to date.

There are no sleeves installed in either generator. The plugging information is listed in Table 3.6.1.

Table 3.6.1

Cumulative Plugs in Service

SG "A"

Year	Outage	Installed	Cumulative	% Plugged
2005	Fabrication	2	2	< 0.1
2005	Baseline	0	2	< 0.1
2007	1R20	0	2	< 0.1
2008	1R21	8	10	< 0.1
2010	1R22	0	10	< 0.1

SG "B"

Year	Outage	Installed	Cumulative	% Plugged
2005	Fabrication	0	0	0
2005	Baseline	0	0	0
2007	1R20	1	1	< 0.1
2008	1R21	5	6	< 0.1
2010	1R22	0	6	< 0.1

Note – 15597 total tubes so 0.1% = 15 tubes

3.7 The results of condition monitoring, including the results of tube pulls and in-situ testing.

All condition monitoring requirements were met. There were no indications that exceeded performance criteria or in-situ screening limits. There were no tube pulls required.

Proximity is an indicator of tube bowing. The bowing resulted from stay rod bowing due to a compressive load applied during cool down from locking of the tube support plates in the upper shroud. This was originally presented to the NRC in a presentation on August 29, 2007. It was agreed that another inspection would be performed in 1R22 the next refueling outage) to validate the root cause. The amount of bowing did increase slighty from 1R21 to 1R22, but was in the expected range. SG "A" continues to be the only affected generator and only the Z-axis side. The maximum bow is currently at 1.283" of lateral bow and is located in the first span (area between the lower tubesheet and the first tube support plate) and the outer most circle of rods. Contact with adjacent tubes is limited to the first span. The two most dominant locations are on either side of the Z-axis at Rows 64 and 88. The following are depictions of the condition:

Figure 3.7.1 Location Row 64

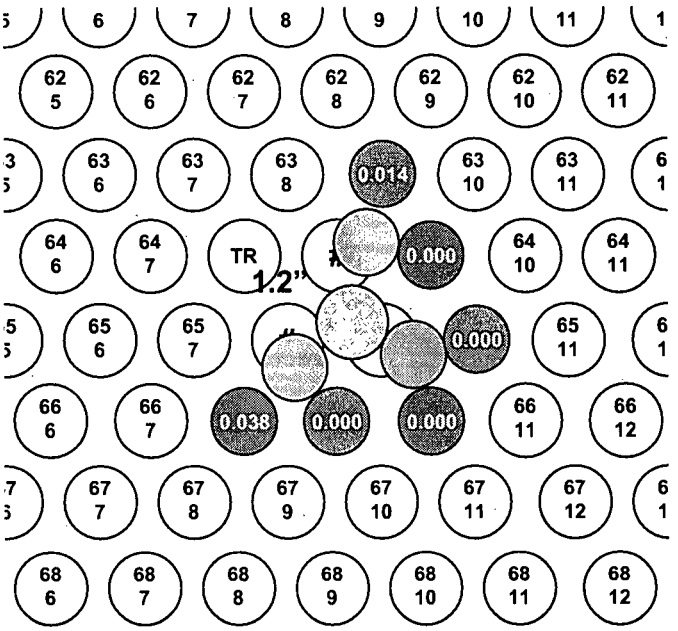
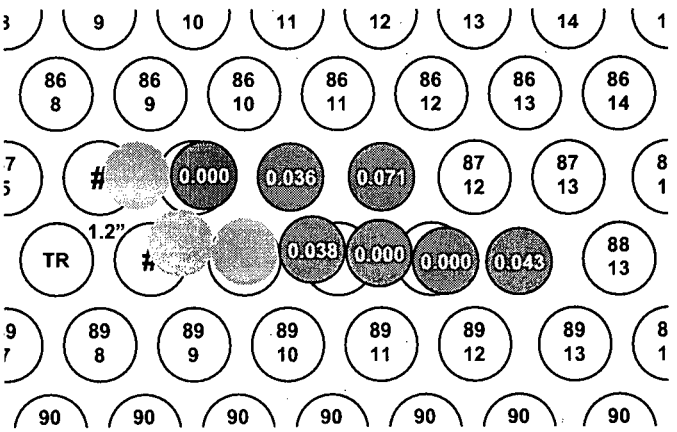


Figure 3.7.2 Location Row 88



As noted in the above figures, the movement of the tie rod is dependent on its location around the periphery. Figure 3.7.1 shows a rod that more directly impacts the rows of tubes. It should be noted that the two tubes in direction of the bow at these two locations were preventatively plugged and stabilized in the previous outage (1R21).

Listed below in Tables,3.7.1 and 3.7.2 is the lateral bowing extents by location for the last three outages.

Table 3.7.1

Outer Most Ring

Tie Rod Location (Z Axis)	Bow at 1R20	Bow at 1R21	Bow at 1R22
1st Span Row 12	None Detected	None Detected	0.180
1st Span Row 24	0.250	0.691	0.891
1st Span Row 42	0.450	0.726	0.979
1st Span Row 64	0.868	1.158	1.283
1st Span Row 88	0.748	1.025	1.241
1st Span Row 110	0.484	0.797	1.039
1st Span Row 128	0.250	0.448	0.559
2nd Span Row 24	None Detected	None Detected	<0.05
2nd Span Row 42	None Detected	<0.14	<0.17
2nd Span Row 64	None Detected	None Detected	Not Determinable
2nd Span Row 88	None Detected	<0.13	Not Determinable
11th Span Row 42	None Detected	None Detected	<0.06
11th Span Row 64	None Detected	None Detected	Not Determinable
11th Span Row 88	None Detected	None Detected	Not Determinable
11th Span Row 110	None Detected	None Detected	<0.08
12th Span Row 42	None Detected	None Detected	<0.05
12th Span Row 64	None Detected	None Detected	Not Determinable
12th Span Row 88	None Detected	None Detected	Not Determinable
13th Span Row 42	None Detected	<0.07	<0.07
13th Span Row 64	None Detected	None Detected	Not Determinable
13th Span Row 88	None Detected	None Detected	Not Determinable
13th Span Row 128	None Detected	None Detected	<0.03
14th Span Row 42	None Detected	<0.14	<0.04
14th Span Row 64	None Detected	<0.13	Not Determinable
14th Span Row 88	None Detected	<0.13	Not Determinable
14th Span Row 110	None Detected	None Detected	<0.08
15th Span Row 24	None Detected	<0.05	<0.04
15th Span Row 42	None Detected	<0.19	<0.16
15th Span Row 64	None Detected	<0.10	Not Determinable
15th Span Row 88	None Detected	<0.15	Not Determinable
15th Span Row 110	None Detected	<0.15	<0.09
15th Span Row 128	None Detected	<0.13	<0.13

Table 3.7.2

Second Outer Most Ring

Tie Rod Location (Z Axis)	Bow at 1R20	Bow at 1R21	Bow at 1R22
1st Span Row 33	None Detected	None Detected	0.022
1st Span Row 47	None Detected	<0.50	0.550
1st Span Row 66	0.357	0.559	0.727
1st Span Row 86	0.25 to 0.32	<0.05	0.670
1st Span Row 105	None Detected	<0.05	0.550
2nd Span Row 47	None Detected	None Detected	<0.09
2nd Span Row 66	None Detected	None Detected	<0.10
2nd Span Row 86	None Detected	None Detected	<0.09
2nd Span Row 105	None Detected	None Detected	<0.05
13th Span Row 86	None Detected	None Detected	<0.03
14th Span Row 86	None Detected	<0.09	<0.06
15th Span Row 86	None Detected	<0.05	<0.04

Tube Support Plate Wear

As noted earlier, two cycle operation was justified for the tube support plate wear damage mechanism. During the 1R22 inspection, tubes that had previous wear indications in the population of tubes tested (around the tie rods and bounding tubes) were sized for wear and a growth rate evaluation was performed. This was compared to the previous cycle OA.

One additional condition that is subject to assessment for both condition monitoring (CM) and OA are the axial loads that result from a postulated Large Break Loss of Coolant Accident (LBLOCA) and its affect on structural and leakage integrity of wear scars. In order to address these conditions, AREVA has performed testing of large depth (90% through wall (TW)) and large circumferential extent (compared to land contact) tapered wear flaws. Tensile testing of these types of flaws was performed and the results indicated that there is very little difference between the ligament pop-through and rupture load for most depths of tapered wear. The test results also clearly show that ligament pop-through will not occur at taper flaw depths up to 90 plus degrees for applied axial loads equivalent to the yield strength of the tube. Therefore, it is concluded that ligament pop-through and leakage of EOTSG Alloy 690 tubing is not a concern for tapered wear flaw depths up to 90% TW when exposed to tube yield strength limiting loads associated with a LBLOCA. Since no wear indications are approaching this severity in either the current inspection, nor with respect to the predicted sizes of wear scars projected out to 1R23, postulated LBLOCA loads have no affect on tube integrity for CM or OA.

For a comparison on growth rates, Figure 3.7.3 list the values for both 1R21 and 1R22. On the upper end of the curve (highest growths) it can be seen that the 1R22 results are much lower than the 1R21 results:

Figure 3.7.3

Comparison of Growth Rates

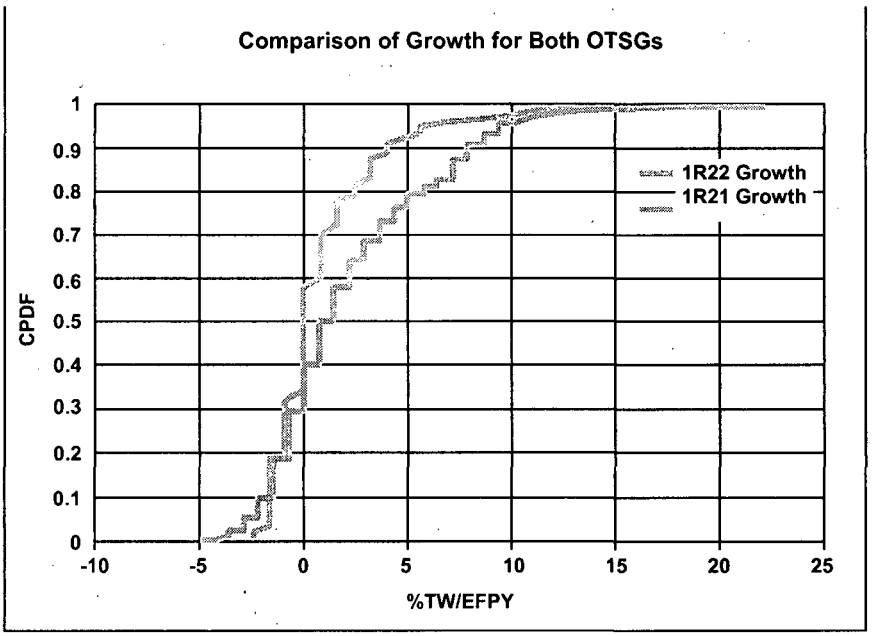


Table 3.7.3

Previous OA Growth Rate Predictions

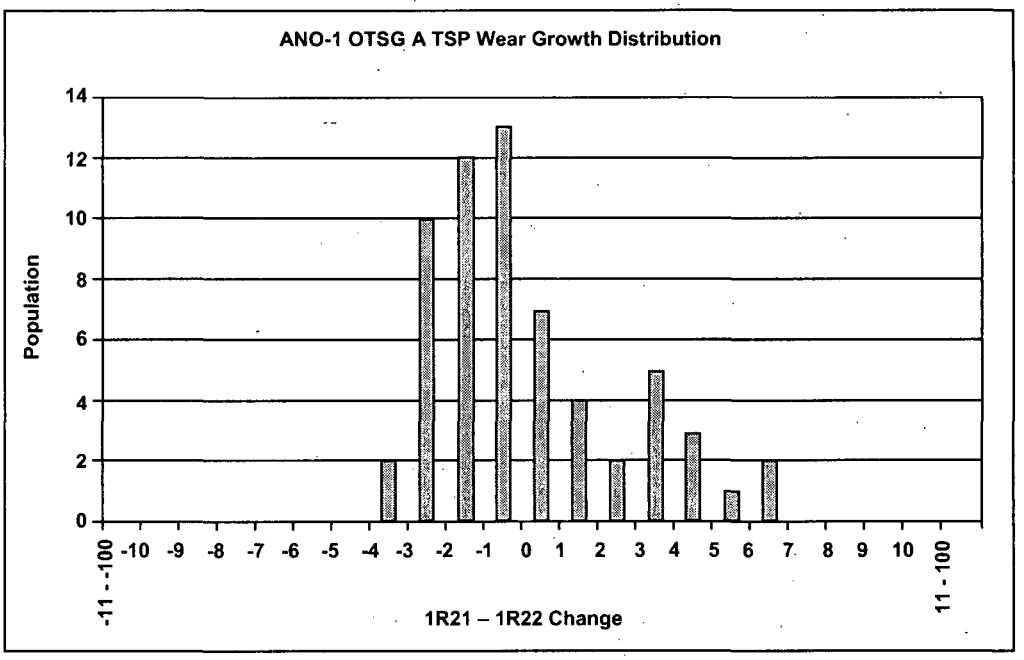
Region	Maximum NDE Depth Returned to Service (% TW)	Corresponding Real Depth (% TW)	Projected Depth Using 95th Growth (% TW)	Margin Using 95th Growth (% TW)	Projected Depth Using Maximum Growth (% TW)
SGA Zone 1	27.00	27.22	52.50	25.50	72.99
SGA Zone 2	6.00	5.17	30.45	47.55	50.94
SGA Zone 3	14.00	13.57	24.19	53.81	30.45
SGB Zone 1	27.00	27.22	48.34	29.66	69.16
SGB Zone 2	0.00	0.00	21.12	56.88	41.94
SGB Zone 3	19.00	18.82	34.46	43.54	43.42

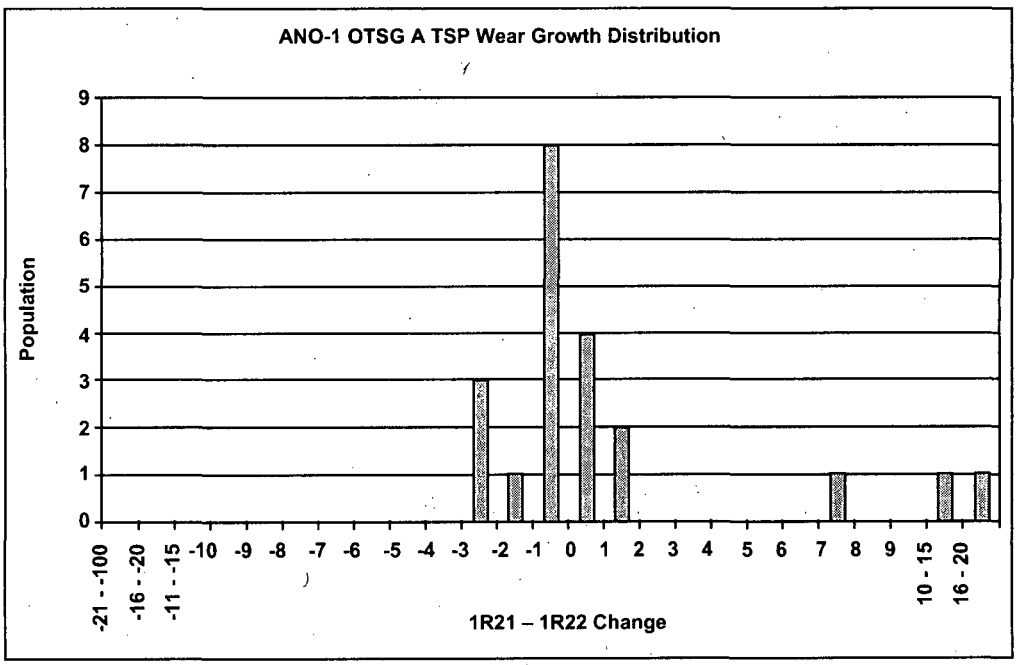
Zone 1 = Radius > 49 Inches, Elevation > TSP 7
Zone 2 = Radius > 49 Inches, Elevation < TSP 8
Zone 3 = Radius ≤ 49 Inches, All Elevations

The 95th Percentile values for growth by zone are (%TW/EFPY):

SGA Zone 1 = 25.28	SGB Zone 1 = 21.12
SGA Zone 2 = 25.28	SGB Zone 2 = 21.12
SGA Zone 3 = 10.62	SGB Zone 3 = 15.64

The largest growths were in Zone 1 of the area adjacent to the aspirating port. The two largest in SGB were new growths that typically run higher than the repeat wear indications. The largest repeat growths were approximately 7% which is well below the predicted 21 – 25% values in the OA.





Attachment 2 to

1CAN071003

SG "A" Wear Indications – 1R22

SG "A" Wear Indications – 1R22

Item #	Row	Column	% TW	Location	Elevation
1	9	31	11	12S	- 0.76
2	11	14	14	10S	- 0.51
3	11	14	3	12S	- 0.54
4	11	15	7	10S	- 0.56
5	11	55	6	09S	0.45
6	12	15	5	10S	0.48
7	12	15	9	10S	- 0.59
8	13	17	9	09S	- 0.59
9	13	57	7	09S	- 0.62
10	23	85	22	10S	- 0.76
11	23	86	32	10S	- 0.87
12	24	38	6	08S	0.48
13	24	83	23	10S	- 0.76
14	25	40	4	08S	0.48
15	25	59	11	08S	- 0.76
16	31	79	4	08S	0.48
17	32	29	5	08S	0.51
18	32	29	8	08S	- 0.54
19	33	29	7	08S	- 0.62
20	33	30	5	08S	0.48
21	33	80	7	08S	-0.76
22	46	22	6	08S	0.48
23	46	23	4	08S	0.51
24	46	23	13	08S	- 0.61
25	47	21	7	08S	- 0.62
26	47	23	7	08S	- 0.59
27	48	22	6	08S	-0.7
28	63	22	5	08S	0.53
29	63	22	10	08S	- 0.61

SG "A" Wear Indications – 1R22 (continued)

Item #	Row	Tube	% TW	TSP	Loc
30	64	22	11	08S	- 0.59
31	65	21	15	08S	- 0.65
32	65	110	9	07S	0.45
33	65	110	9	09S	- 0.64
34	65	110	13	10S	0.28
35	66	21	5	08S	- 0.55
36	66	22	12	08S	- 0.62
37	67	22	8	08S	- 0.65
38	67	23	12	08S	- 0.64
39	68	24	5	08S	0.5
40	84	22	7	08S	0.51
41	84	22	19	08S	- 0.62
42	84	23	15	08S	- 0.59
43	85	23	7	08S	0.52
44	86	22	8	08S	0.52
45	88	22	8	08S	- 0.62
46	104	23	4	08S	- 0.65
47	104	25	8	08S	- 0.65
48	105	24	8	08S	- 0.59
49	106	23	6	08S	0.51
50	106	23	12	08S	- 0.65
51	106	24	5	08S	- 0.59
52	119	30	13	08S	- 0.68
53	120	78	8	08S	- 0.62
54	120	78	13	08S	0.51
55	127	41	7	08S	0.45
56	127	88	6	09S	0.48
57	128	83	13	09S	0.42

SG "A" Wear Indications – 1R22 (continued)

Item #	Row	Tube	% TW	TSP	Loc
58	129	9	18	09S	0.51
59	129	10	5	14S	0.48
60	139	57	11	09S	- 0.59
61	140	16	7	09S	- 0.68
62	141	14	10	09S	0.48
63	141	15	11	09S	0.42

Attachment 3 to

1CAN071003

SG "B" Wear Indications – 1R22

SG "B" Wear Indications – 1R22

Item #	Row	Column	% TW	Location	Elevation
1	11	14	34	10S	- 0.67
2	11	15	27	10S	- 0.7
3	12	15	33	10S	- 0.78
4	23	38	4	08S	0.48
5	23	56	6	08S	0.48
6	25	41	3	08S	- 0.69
7	31	78	9	08S	0.48
8	31	79	4	08S	0.48
9	32	77	6	08S	0.43
10	65	110	9	10S	0.45
11	66	109	6	08S	0.48
12	86	20	4	08S	- 0.74
13	86	20	5	08S	0.48
14	86	109	4	08S	0.5
15	88	122	9	09S	0.42
16	104	99	7	10S	0.47
17	110	106	6	09S	0.42
18	139	57	6	09S	- 0.53
19	140	55	12	13S	0.37
20	141	14	7	12S	0.37
21	141	55	10	11S	- 0.74