ENTERGY

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

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

Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Special Report: Steam Generator Tube Surveillance - Category C-3 Results

Gentlemen:

Steam generator tubing inservice inspections of the Arkansas Nuclear One, Unit 2 (ANO-2), steam generators (SGs) were performed during the twelfth refueling outage (2R12). The inspections performed on both SGs were a 100% full length bobbin coil examination, with the exception of the tube area below the sleeves (20% of the tubes were examined with the bobbin coil below the sleeves). Also performed in 2R12 were a 100% rotating pancake coil probe (RPC) inspection in the hot leg (HL) expansion transition (ET) region, a 20% RPC inspection of the cold leg ET region bounded by the sludge pile, a 100% inspection of existing installed Babcock & Wilcox (B&W) kinetic sleeves using a Plus Point probe, a 20% inspection (plus 28 previously identified indications) of installed Combustion Engineering (CE) tungsten inert gas (TIG) welded sleeves (later expanded to 100% on the "B" SG) utilizing a Plus Point probe, a 40% inspection of row 1 small radius U-bends using RPC, and a 20% RPC inspection of tubes at HL drilled tube support plate (DTSP) locations (later expanded to 100% in the "B" SG). The RPC used consists of a 0.115 inch pancake coil with both axially-oriented and circumferentially-oriented coils. The bobbin coil inspection was performed to meet the requirements of ANO-2 Technical Specification (TS) 4.4.5.2. The RPC inspection was utilized in regions of interest and for confirmation of bobbin coil calls.

The results of these inspections revealed 327 defective tubes in the "A" SG (SGA) and 362 defective tubes in the "B" SG (SGB). Consequently, both the SGs fall within the criteria of Category C-3 (more than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective), as defined in ANO-2 TS 4.4.5.2. Tables 1 and 2 summarize the results of these inspections. ANO-2 TSs 4.4.5.5.c and 6.9.2.j require that a

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Special Report be submitted prior to resumption of plant operation for inspections that fall into Category C-3. This submittal provides the required report. Additionally, ANO-2 TS 4.4.5.5.a requires that a plugged tube report be submitted within 15 days of each inservice inspection of SG tubes. This submittal also includes the information required for that report.

PLANT DESCRIPTION

ANO-2 is a Combustion Engineering (CE) Model 2815 designed plant that began commercial operation in March, 1980. The plant has two recirculating SGs, each having 8411 high temperature mill annealed Inconel Alloy 600 tubes with a 0.75" outer diameter and a 0.048" wall thickness. The tubes were full depth explosively expanded into the tubesheet. The tube supports in the lower part of the SG are eggcrate (EC) type which consists of an array of intersecting one inch wide and two inch wide flat carbon steel plates at each support elevation. There are seven full EC support plates, two partial EC support plates, two partial drilled support plates, and five strap supports for the horizontal run of the tubing, called batwings (BW). The BW supports consist of two diagonal and three vertical straps. Two tube sleeve types, B&W kinetic and CE TIG-welded, are currently installed in the SGs.

INSPECTION RESULTS

Below is a breakdown of the initial scope and expansions:

Test Type	# Planned	% Scope	Expansion
SGA			
Bobbin	7594	100	No
Bobbin Below Sleeves	153	20	No
RPC ET HL	6802	100	No
RPC ET CL	1742	20	No
B&W Sleeve	354	100	No
TIG Sleeve	131*	20	No
U-bends (row 1)	28	40	No
DTSP	728	20	No
SGB			
Bobbin	7700	100	No
Bobbin Below Sleeves	71	20	No
RPC ET HL	7476	100	No
RPC ET CL	1742	20	No
B&W Sleeve	49	100	No
TIG Sleeve	44*	20	Yes
TIG Expansion	130	100	No
U-bends (row 1)	25	40	No
DTSP	698	20	Yes
DTSP Expansion	722	20	No

* Includes 20% plus the previous indications

The expansion in the TIG welded sleeves in SGB were due to an indication in the weld zone that was not previously identified during 2R11, but was identified based on re-analysis. All TIG sleeves in SGA not previously tested were re-analyzed for indications that may not have been previously identified. Eighteen tubes were found to have possible weld zone indications (WZIs) and were tested with the Plus Point coil during 2R12. The expansion in the DTSPs in SGB was due to one volumetric indication. Revision 4 of the EPRI Guidelines states that a noncrack-like indication requires an expansion of 20% in the same generator. No indications were identified in the expansion.

The inspections were performed from the hot and cold leg sides of both SGs. In SGA, 327 tubes were found to have indications requiring repair, due to either exhibiting flaw-like distorted support indications (DSIs), non-quantifiable indications (NQIs), volumetric indications or containing circumferential indications in the ET region or sleeve weld zone. All DSIs and NQIs confirmed by the RPC as crack-like were repaired and are detailed in the attached Table 1. In SGB, 362 tubes were found to have indications requiring repair, due to either exhibiting flaw-like DSIs, NQIs, or containing circumferential indications in the ET region or sleeve weld zone. All DSIs and NQIs confirmed by the RPC as crack-like were repaired and are detailed in the attached Table 2. The number of tubes repaired, based upon flaw location, is provided in Table 3.

The ET region indications were primarily circumferential cracks with some axial cracking present in a few tubes. The eggcrate indications were predominantly axial cracks based upon RPC characterization and observations from previously pulled tubes. Sludge pile indications are generally considered to be axial and/or volumetric in nature. The BW flaws detected consisted mostly of wear attributed to flow induced vibration across the horizontal portion of the tubing at the upper support structure. The inservice tubes containing both types of previously installed sleeves revealed indications in the parent tubes. The indication in the DTSP was volumetric. No indications were found in the 40% examination of the small radius U-bends performed in row 1.

EVALUATION OF INSPECTION RESULTS

Several enhancements were incorporated during 2R12 to improve the data and enhance the detection and disposition of indications. The first change was the use of a larger diameter bobbin probe. Previously the 0.580 bobbin was used. The 0.600 bobbin, which is Appendix H qualified, was utilized. The second change was incorporating more representative examples of eggcrate flaws in the training and testing material. Due to interferences from the support plate, sludge and the influence of copper, analysis of the eggcrates is difficult. Special emphasis was placed on analysis in this area of the generator. The third change was the use of an Entergy oversight team that consisted of Level III analysts from Entergy, Palo Verde and Zetec. The team was responsible for screening the data for repairable indications that were dispositioned by the resolution team as not requiring repair. Additionally, the team reviewed approximately 10% of tubes classified as no detectable degradation (NDD). Other enhancements include: 1) tertiary computer data screening (CDS); 2) resolution analyst training; 3) analyst performance tracking; and 4) independent resolution analysis.

CIRCUMFERENTIAL CRACKING

This was the eighth inspection of the ET region with either a pancake or a Plus Point probe. Listed below is the history, sample size, number of indications, and probe used:

OUTAGE	% HL SAMPLE	# HL CRACKS	DETECTION PROBE
2F92 (3/92)	100	469	0.080 RPC
2R9 (9/92)	100	25	0.080 RPC
2P93 (5/93)	100*	48	0.080 RPC
2R10 (3/94)	100	170	0.115 RPC
2P95 (1/95)	100*	283	0.115 RPC
2R11 (9/95)	100	702	+ POINT
2F96 (11/96)	100	26	0.115 RPC
2R12 (5/97)	100	119	0.115 RPC

* 100% of the sludge pile

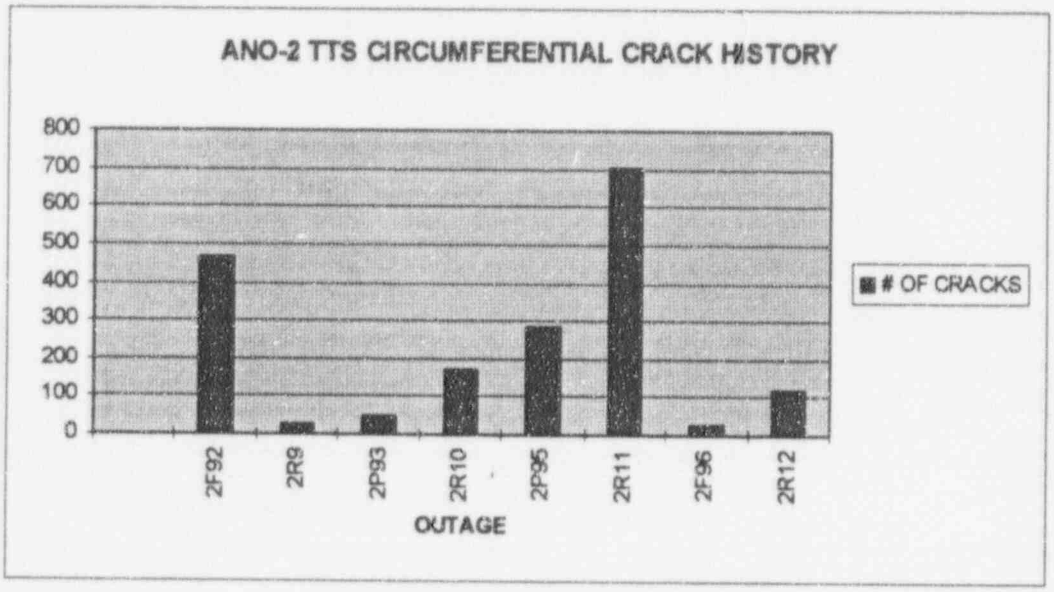

Figure 1

The 0.115" pancake coil has demonstrated on numerous occasions at ANO-2, its ability to detect circumferential cracking. In-situ pressure tests performed during the last several outages have demonstrated the RPC's ability to detect cracks at an early stage, such that they do not become structurally significant between examination periods. The 0.115" has been very successful in finding circumferential indications at the expansion transition and is Appendix H qualified for detection. To date, the repair criterion for all circumferential indications at the ET is to repair upon detection.

Based on documented burst testing data, all circumferential cracks identified in 2R12 would exhibit burst pressures significantly above RG 1.121 limit, with most being near that of a virgin tube. To further assess the structural significance of the flaws, in-situ pressure tests were conducted. The two largest ET region circumferential cracks were selected for testing. The pressure test device utilizes two expandable bladders approximately 6.0" apart, allowing the chamber between the bladders to be pressurized. The device is designed to allow movement of the region between the bladders such that the axial load that would be applied to the U-bend of the tube during normal operation and postulated accident conditions is simulated for circumferential cracking.

The two tubes selected for in-situ pressure testing were the largest circumferential flaws identified during 2R12. Both tubes were pressurized to 4800 psig with no indication of leakage.

AXIAL CRACKING (EGGCRATE)

Cracking at eggcrates was first detected at ANO-2 in 1991. Based on the examination results of tubes removed during outages in 1992 and 1996, the eggcrate support flaws are classified as axially oriented outside diameter stress corrosion cracking. The cracking can be single cracks or multiple cracks interconnected in the tube within the eggcrate support. As noted in Figure 2, the largest number of indications are associated with the hottest support plate and decrease as the temperature decreases.

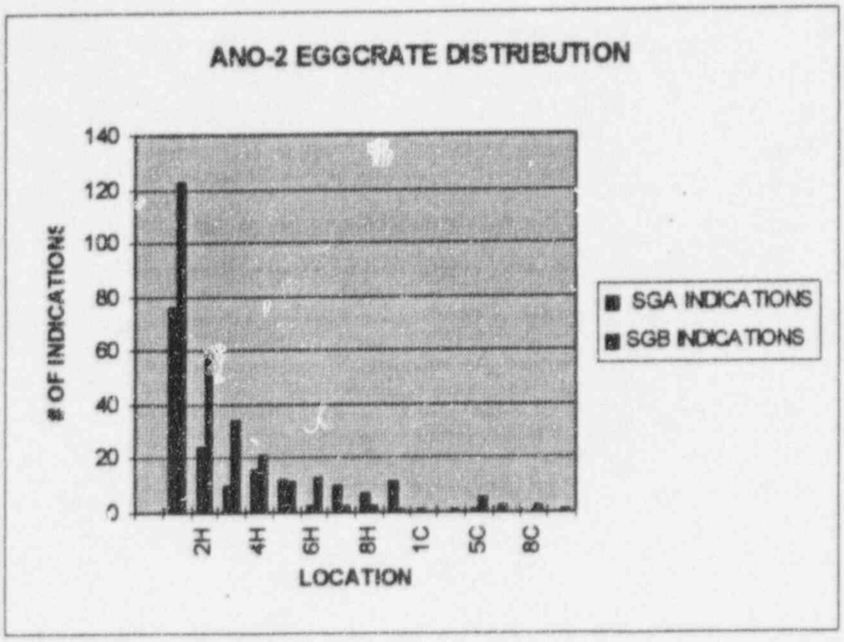

Figure 2 (2R12)

Prior to 2R12, a qualified bobbin sizing methodology was used to leave eggcrate indications in service. Approximately 280 indications were left in service in the November 1996 forced outage (2F96). Prior to 2R12 it was decided that all eggcrate indications that were confirmed by RPC would be removed from service. The only indications that were sized and left in service were wear indications at the batwings.

Six of the largest eggcrate flaws (1 in SGA and 5 in SGB) were in-situ pressure tested. The criteria for choosing the candidates included several parameters, i.e., signal amplitude and depth as measured by bobbin and RPC, as well as RPC length measurements. All indications passed the peak accident pressure with zero leakage, as well as the RG 1.121 limit of three times the normal differential operating pressure (3ΔP) without bursting. For ANO-2, that pressure is equal to 4576 psig. The following tubes were in-situ pressure tested:

ANO-2 IN-SITU TEST RESULTS FOR 2R12

SG	Date	Tube R/L	Target P (psig)	Pressure (psig)	Flaw Type	Leakage	Leakage (gpm)
A	6/1/97	R82L118	1600	1600	01H AXIAL	NO	
			2850	2850		NO	
			4800	4700		YES	0.15
			4800*	5000		BURST	
B	5/31/97	R9L117	1600	1600	01H AXIAL	NO	
			2850	2900		NO	
			4800	4900		NO	
B	5/31/97	R11L129	1600	1650	01H AXIAL	NO	
			2850	2900		NO	
			4800	4850		NO	
B	5/31/97	R34L70	1600	1650	01H AXIAL	NO	
			2850	2850		NO	
			4800	4850		NO	
B	5/31/97	R23L65	1600	1650	02H AXIAL	NO	
			2850	2850		NO	
			4800	4850		NO	
B	5/31/97	R37L67	1600	1650	01H AXIAL	NO	
			2850	2850		NO	
			4800	4650		BURST	

* Sealing bladder in place over the flaw.

The leakage values shown above are as-measured and have not been compensated for temperature. When temperature compensated, the indicated leakage would be less. The target pressure of 4800 psig was chosen to ensure the RG margin value was obtained.

FREE-SPAN INDICATIONS

Several freespan indications were identified during the bobbin coil inspection as NQIs and were subsequently examined using the RPC. Most of the confirmed indications were volumetric and not axial cracks. All indications were bounded by the flaws first identified during 2R11. SGA contained 38 and SGB contained four indications. All were repaired by mechanical plugging.

SELECTION PROCESS FOR IN-SITU CANDIDATES

Several parameters were considered in the choice of the "largest" flaws for testing, so as to bound the remaining flaws. Not only were the ECT parameters considered, but also the morphology of the flaw. Such things as depth, overall length, length of throughwall extent, and presence of ligaments were also considered. Below is the listing of candidates and the associated ECT parameters:

CIRCUMFERENTIAL

GEN.	ROW	COL.	IND.	LENGTH (in)	ARC (deg)	RPC VOLTS	RPC PHASE ANGLE
A	**15**	**25**	**SCI**	**1.98**	**307**	**1.20**	**53**
A	**52**	**50**	**MCI**	**2.02**	**313**	**1.06**	**100**

EGGCRATE AXIAL

GEN.	ROW	COL.	IND.	LOCATION	LENGTH (in)	BOBBIN VOLTS	BOBBIN PHASE ANGLE	RPC DEPTH
A	46	98	MAI	01H-.98	1.94	0.76	70	53%
A	38	108	MAI	02H-1.03	1.65	0.40	64	61%
A	49	103	MAI	01H-.87	1.22	0.56	74	47%
A	**82**	**118**	**MAI**	**01H-.48**	**1.36**	**0.97**	**50**	**83%**
A	38	142	SAI	01H-.09	0.89	1.34	59	67%
B	**23**	**65**	**MAI**	**02H-.96**	**1.89**	**0.35**	**74**	**67%**
B	68	66	SAI	03H-.90	1.67	0.21	60	58%
B	**37**	**67**	**SAI**	**01H-.85**	**1.86**	**0.25**	**55**	**62%**
B	**34**	**70**	**MAI**	**01H-.36**	**1.34**	**0.30**	**81**	**50%**
B	82	90	MAI	02H-.99	1.14	0.24	64	51%
B	65	99	SAI	01H+.22	1.26	0.37	66	59%
B	43	105	MAI	01H-.54	1.43	0.17	92	48%
B	**9**	**117**	**SAI**	**01H-.09**	**0.97**	**1.13**	**42**	**95%**
B	**11**	**129**	**SAI**	**01H-.14**	**0.76**	**1.51**	**43**	**90%**

SCI - Single circumferential indication
MCI - Multiple circumferential indication
SAI - Single axial indication
MAI - Multiple axial indication

The entries listed above in bold represent those tubes that were chosen for testing. For the eggcrates, it should be noted that the parameters of the tubes tested bound parameters of the other candidate tubes, e.g., bobbin amplitude, depth and phase angle. The actual terrain maps from the RPC analysis were also used to determine morphology.

Tube 37/67 had the most susceptible condition with two deep sections connected by a ligament. This tube did burst at 4650 psig and exhibited zero leakage at main steam line break (MSLB) conditions.

ROOT CAUSE

Based on the examination results of the tubes pulled in the Spring 1992 forced outage (2F92) and the Fall 1996 forced outage (2F96), the damage at both the eggcrate support plates and the ET region is stress corrosion cracking (SCC). Sulfur was believed to be a major contributor. In addition, lead was found in the cracks of the 1992 tubes and in the tube deposits for both the 1992 and 1996 tubes. Minor intergranular attack occurs with the SCC.

CONCLUSIONS

In summary, a comprehensive eddy current examination was performed with an enhanced analysis process. Both SGs were tested 100% full length with the bobbin coil, 100% at the hot leg ET region with RPC, 20% of the cold leg ET in the sludge pile region, 100% of the existing B&W kinetic installed sleeves, all TIG weld sleeves with a previous WZI or GEO indication and 20% of the remaining sleeves, 40% inspection of row 1 small radius U-bends, and an expanded inspection in SGB for TIG sleeves and DTSP.

The 119 circumferential cracks detected in 2R12 exhibited a size that was bounded by previous inspections. The increased number is primarily attributed to increased analyst sensitivity and the review of the oversight team. These cracks would be expected to exhibit burst pressures well above that required by RG 1.121. The in-situ pressure tests of the largest flaws demonstrated that the flaw strengths exceeded 3ΔP with zero leakage.

The increased number of repaired eggcrate axial cracks during 2R12 is attributed to the program enhancements and the decision to remove all crack-like indications. These cracks would be expected to exhibit burst pressures at or above that required for structural adequacy as defined in RG 1.121. The largest crack was successfully in-situ pressure tested in excess of 3ΔP. Free span indications were identified this outage and are readily identified by bobbin coil. Structurally, the largest of these flaws would be expected to burst at pressures well above that required by RG 1.121 as demonstrated by previous in-situ pressure testing and analytical evaluations.

The indications in the TIG welded sleeves were all installation induced. Nine service induced indications in SGA in the B&W kinetic sleeves were found and repaired.

ANO-2 utilizes N-16 monitors for primary-to-secondary leakage detection, and has an administrative leakage limit of 0.1 GPM (144 GPD). Abnormal operating procedures are in place for both Operations and Chemistry in the event that leakage is detected. Other leakage monitors include condenser off-gas radiation monitor, steam generator blowdown monitor, 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. Operations routinely trains on primary-to-secondary leaks and tube ruptures utilizing the simulator. Entergy Operation's aggressive response to tube leakage was demonstrated last Fall, when ANO-2 was shutdown due to primary-to-secondary leakage of 50 GPD (well below the ANO-2 TS limit of 0.5 GPM through any one SG).

Based upon the comprehensive actions performed during 2R12 in conjunction with the ability to rapidly detect and respond to any primary-to-secondary leakage, as described above, Entergy Operations believes ANO-2 is safe to resume plant operation.

Based upon the results of the 2R12 and previous inspections, Entergy Operations plans to conduct a midcycle inspection during the upcoming cycle of operation. The date of this inspection will be determined based upon further evaluation of 2R12 inspection data.

Should you have any questions regarding this submittal, please contact me.

Very truly yours,

for Dwight C. Mims
Director, Nuclear Safety

DCM/jjd

attachment

cc: U. S. Nuclear Regulatory Commission
Document Control Desk
Mail Station OP1-17
Washington, DC 20555

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

Mr. George Kalman
NRR Project Manager Region IV/ANO-1 & 2
U. S. Nuclear Regulatory Commission
NRR Mail Stop 13-H-3
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
1	20	2	Sludge Pile Axial
2	23	5	TTS Circ
3	16	10	EC VOL
4	14	14	EC Axial
5	8	16	EC Axial
6	41	23	TTS Circ
7	15	25	TTS Circ
8	58	28	EC Axial
9	9	29	EC VOL
10	58	30	EC Axial
11	96	30	BW VOL
12	13	31	TTS Circ
13	20	32	TTS Circ
14	9	33	EC VOL
15	19	33	TTS Circ
16	24	34	TTS Circ
17	34	34	EC Axial/TTS VOL
18	38	34	TTS VOL
19	74	34	TTS Circ
20	15	35	TTS Circ
21	45	35	TTS VOL
22	20	36	EC Axial
23	33	37	TTS Circ
24	52	38	TTS VOL
25	58	38	EC Axial
26	66	38	BW VOL
27	70	38	Sludge Pile VOL
28	78	38	TTS Circ
29	45	39	TTS Circ
30	46	40	TTS VOL
31	7	41	TTS Circ
32	58	42	TTS VOL
33	86	42	Freespan/PTP
34	65	43	TIG Sleeve (WZI)/BW Axial
35	89	43	TTS VOL
36	20	44	EC Axial
37	50	44	EC Axial
38	98	44	Freespan/PTP
39	5	45	Freespan Axial
40	37	45	EC Axial
41	43	45	TTS VOL

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
42	53	45	TTS VOL
43	87	45	TTS Circ
44	91	45	PTP
45	30	46	TTS Circ
46	98	46	EC VOL
47	3	47	Freespan Axial
48	21	47	EC Axial
49	33	47	EC VOL
50	30	48	EC VOL
51	32	48	EC VOL
52	11	49	Freespan Axial
53	35	49	TTS Circ
54	47	49	PTP
55	63	49	TTS Circ
56	38	50	EC Axial
57	52	50	TTS Circ
58	58	50	EC Axial
59	90	50	EC Axial
60	11	51	PTP
61	15	51	EC Axial
62	51	51	EC VOL
63	95	51	TTS Circ
64	28	52	PTP
65	36	52	PTP
66	58	52	TTS Circ
67	5	53	TTS Circ/TTS Axial/Sleeve
68	21	53	PTP
69	52	54	PTP
70	96	54	TTS Circ
71	71	55	EC VOL
72	97	55	TTS Circ
73	129	55	EC VOL
74	14	56	EC Axial
75	40	56	EC VOL
76	90	56	TTS VOL
77	102	56	TTS Circ
78	51	57	EC VOL
79	89	57	TTS VOL
80	91	57	TTS Axial
81	101	57	TTS VOL
82	30	58	EC Axial

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
83	46	58	PTP
84	58	58	EC Axial
85	5	59	EC Axial
86	27	59	EC Axial
87	16	60	EC Axial
88	48	60	EC Axial
89	72	60	EC Axial
90	15	61	Sludge Pile VOL
91	29	61	EC VOL
92	30	62	EC Axial
93	34	62	EC Axial
94	60	62	TIG Sleeve (WZI)
95	66	62	Freespan Axial
96	86	62	EC Axial
97	35	63	EC Axial
98	67	63	TTS Circ
99	81	63	EC Axial
100	48	64	PTP
101	50	64	Sludge Pile Axial
102	70	64	Freespan VOL
103	39	65	EC VOL
104	48	66	TTS Axial
105	62	66	Sludge Pile Axial
106	78	66	TTS VOL
107	41	67	EC VOL
108	53	67	PTP
109	65	67	TIG Sleeve (WZI)
110	111	67	Freespan
111	84	68	Freespan
112	101	69	Freespan
113	117	69	TTS Circ
114	30	70	EC Axial
115	44	70	Freespan Axial
116	66	70	TTS Circ
117	45	71	TTS Circ
118	47	71	EC Axial
119	57	71	EC Axial
120	112	72	TTS Circ
121	41	73	EC Axial
122	53	73	EC VOL
123	61	73	Freespan Axial

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
124	115	73	TTS Circ
125	34	74	Freespan Axial
126	110	74	Sludge Pile MMI
127	87	75	TTS VOL
128	99	75	TTS Circ
129	40	76	EC Axial
130	48	76	EC VOL
131	64	76	Freespan Axial
132	93	77	EC Axial
133	107	77	TTS Circ
134	58	78	EC Axial
135	74	78	TTS Circ
136	106	78	Freespan
137	108	80	PTP
138	65	81	TTS Circ
139	111	81	TTS Circ
140	42	82	EC Axial
141	86	84	EC Axial
142	47	85	EC Axial
143	49	85	EC Axial
144	53	85	EC Axial
145	111	85	TTS Circ
146	62	86	EC VOL
147	78	86	Freespan
148	88	86	EC Axial
149	124	86	Freespan VOL
150	73	87	Freespan Axial
151	81	87	TTS Circ / Sludge Pile Axial
152	40	88	EC Axial
153	82	88	Sludge Pile Axial
154	94	88	EC VOL
155	41	89	EC Axial/EC VOL
156	49	89	EC Axial
157	51	89	EC Axial
158	55	89	Freespan VOL
159	109	89	TTS Circ
160	62	90	EC Axial
161	94	90	EC VOL
162	98	90	TIG Sleeve (WZI)
163	51	91	Freespan Axial
164	40	92	EC Axial

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
165	46	92	EC Axial
166	60	92	EC Axial
167	78	92	EC Axial
168	116	92	EC Axial
169	47	93	EC Axial
170	49	93	Freespan Axial
171	61	93	EC Axial
172	69	93	TTS Circ / TTS Axial
173	101	93	PTP
174	113	93	PTP
175	115	93	TTS Circ
176	46	94	EC Axial
177	52	94	Freespan Axial
178	86	94	EC VOL
179	100	94	EC VOL
180	47	95	EC Axial
181	55	95	EC Axial/Freespan Axial
182	59	95	EC Axial
183	71	95	TIG Sleeve (WZI)
184	75	95	EC Axial
185	91	95	TTS VOL
186	95	95	EC VOL
187	42	96	EC VOL
188	46	96	Freespan Axial
189	64	96	EC VOL
190	106	96	Sludge Pile Circ
191	122	96	EC VOL
192	46	98	EC Axial
193	56	98	EC Axial
194	66	98	EC Axial/Freespan Axial
195	116	98	TTS Circ
196	122	98	Freespan Axial
197	69	99	Freespan Axial
198	87	99	Freespan VOL
199	89	99	Freespan VOL
200	52	100	EC Axial
201	35	101	Freespan Axial
202	37	101	Freespan Axial
203	125	101	EC VOL
204	32	102	EC Axial
205	49	103	EC Axial

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
206	59	103	EC VOL
207	69	103	TTS Circ
208	79	103	EC VOL/Freespan VOL
209	91	103	VOL in DTSP
210	103	103	VOL in DTSP
211	127	103	EC Axial
212	28	104	EC Axial
213	64	104	EC VOL
214	66	104	TTS Circ
215	57	105	EC VOL
216	89	105	Freespan Ax/Freespan VOL
217	119	105	VOL in DTSP
218	24	106	Sludge Pile Axial
219	30	106	Sludge Pile Axial
220	66	106	PTP
221	102	106	Sludge Pile Circ
222	71	107	EC Axial
223	101	107	PTP
224	103	107	PTP
225	113	107	TIG Sleeve (WZI)
226	10	108	EC Axial
227	12	108	Freespan Axial
228	34	108	TTS VOL/EC Axial
229	38	108	EC Axial
230	55	109	EC Axial
231	50	110	EC Axial
232	68	110	EC VOL
233	96	110	EC VOL
234	19	111	TTS Axial
235	33	111	TTS Circ
236	45	111	TTS Circ
237	47	111	EC Axial
238	59	111	TTS Circ
239	2	112	TTS Circ
240	28	112	PTP
241	30	112	PTP
242	60	112	TTS Circ
243	70	112	TTS VOL
244	17	113	TTS VOL
245	19	113	EC Axial
246	47	113	BW Axial

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
247	24	114	PTP
248	40	114	Freespan Axial
249	54	114	EC Axial
250	70	114	EC Axial
251	63	115	TTS VOL
252	65	115	EC VOL
253	81	115	Freespan VOL
254	101	115	TIG Sleeve (WZI)
255	60	116	EC Axial
256	70	116	EC Axial
257	72	116	EC Axial
258	76	116	EC Axial
259	51	117	EC Axial
260	57	117	EC VOL
261	113	117	VOL in DTSP
262	40	118	EC Axial
263	46	118	EC Axial
264	66	118	EC VOL
265	68	118	TTS VOL
266	82	118	EC Axial
267	96	118	Sludge Pile Axial/ Circ
268	120	118	EC VOL
269	13	119	EC Axial
270	37	119	TTS Circ
271	67	119	EC Axial
272	106	120	Freespan VOL
273	45	121	PTP
274	97	121	Sleeve Circ
275	8	122	Freespan Axial
276	10	122	EC Axial
277	62	122	EC VOL
278	73	123	TTS VOL
279	24	124	TTS Circ
280	48	124	EC Axial
281	7	125	EC Axial
282	41	125	TTS Circ/EC Axial
283	65	125	EC Axial
284	91	125	EC Axial
285	26	126	TTS Circ
286	34	126	TTS Circ
287	44	126	EC VOL

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
288	50	126	EC Axial
289	9	127	PTP
290	31	127	PTP
291	35	127	Sludge Pile Circ / Axial
292	51	127	EC Axial
293	10	128	TIG Sleeve (WZI)
294	52	128	EC Axial
295	66	128	EC Axial
296	96	128	EC VOL
297	9	129	TIG Sleeve (WZI)
298	13	129	TTS VOL
299	29	129	PTP
300	47	129	EC Axial/VOL
301	63	129	EC Axial
302	38	130	EC Axial
303	68	130	EC Axial
304	7	131	EC Axial
305	87	131	EC Axial
306	101	131	Freespan Axial
307	28	132	EC Axial
308	60	132	EC Axial
309	70	132	EC Axial
310	78	132	EC VOL
311	10	134	EC Axial/VOL
312	18	134	EC Axial/VOL
313	38	134	EC Axial
314	46	134	EC VOL
315	19	135	TTS Circ
316	61	135	EC VOL
317	63	135	TTS Circ
318	16	136	TTS Circ
319	18	136	TTS Circ
320	50	136	TTS Circ
321	45	137	TTS Circ
322	2	138	EC Axial
323	10	138	EC Axial
324	12	138	TTS VOL
325	26	138	EC Axial
326	28	138	EC Axial
327	62	138	Sleeve Circ
328	84	138	EC Axial

TABLE 1 (SGA PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
329	42	140	TTS Circ
330	74	140	Freespan Axial
331	24	142	TTS Circ
332	30	142	EC Axial
333	38	142	EC Axial
334	27	143	EC Axial
335	71	143	EC Axial
336	12	144	TTS Circ
337	62	144	BW VOL
338	17	145	TTS Circ
339	14	146	TIG Sleeve (WZI)
340	17	147	EC VOL
341	23	147	TTS Circ
342	8	148	TTS Circ
343	29	149	EC Axial
344	15	151	EC Axial
345	19	153	EC Axial
346	16	154	TTS Circ
347	38	154	EC Axial
348	11	155	EC Axial
349	19	163	EC VOL
350	18	166	EC Axial

Legend:

BW - Batwing Stabilizer
DTSP - Drilled Tube Support Plate (Partial)
EC - Egg Crate Support
MMI - Mixed Mode Indication
PTP - Preventative Tube Plug
TTS - Top of Tube Sheet
VOL - Volumetric Indication
WZI - Weld Zone Indication (Sleeve)

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
1	60	26	BW Axial
2	71	43	BW Axial
3	25	57	BW Axial
4	59	115	BW Axial
5	40	140	BW Axial
6	38	150	BW Axial
7	24	6	BW VOL
8	35	13	BW VOL
9	27	15	BW VOL
10	69	21	BW VOL
11	24	22	BW VOL
12	20	24	BW VOL
13	29	29	BW VOL
14	65	111	BW VOL
15	54	112	BW VOL
16	41	117	BW VOL
17	59	117	BW VOL
18	63	149	BW VOL
19	40	150	BW VOL
20	63	151	BW VOL
21	31	7	BW VOL/Axial
22	24	14	BW VOL/Axial
23	25	9	BW VOL/Wear
24	135	81	BW VOL/Wear
25	107	39	DTSP Axial
26	110	40	DTSP Axial
27	7	17	EC Axial
28	11	19	EC Axial
29	8	22	EC Axial
30	20	22	EC Axial
31	1	25	EC Axial
32	30	26	EC Axial
33	12	28	EC Axial
34	79	31	EC Axial
35	30	32	EC Axial
36	36	32	EC Axial
37	7	33	EC Axial
38	22	34	EC Axial
39	78	34	EC Axial
40	63	35	EC Axial
41	76	36	EC Axial

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
42	34	38	EC Axial
43	36	40	EC Axial
44	52	40	EC Axial
45	97	41	EC Axial
46	62	42	EC Axial
47	74	42	EC Axial
48	61	43	EC Axial
49	75	43	EC Axial
50	27	45	EC Axial
51	69	45	EC Axial
52	20	48	EC Axial
53	74	48	EC Axial
54	75	49	EC Axial
55	79	49	EC Axial
56	34	50	EC Axial
57	74	50	EC Axial
58	63	51	EC Axial
59	65	51	EC Axial
60	73	51	EC Axial
61	76	52	EC Axial
62	7	53	EC Axial
63	15	53	EC Axial
64	73	53	EC Axial
65	79	53	EC Axial
66	60	54	EC Axial
67	66	54	EC Axial
68	7	55	EC Axial
69	9	55	EC Axial
70	27	55	EC Axial
71	67	55	EC Axial
72	16	56	EC Axial
73	30	56	EC Axial
74	60	56	EC Axial
75	7	57	EC Axial
76	95	57	EC Axial
77	44	58	EC Axial
78	62	58	EC Axial
79	68	58	EC Axial
80	11	59	EC Axial
81	25	59	EC Axial
82	12	60	EC Axial

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
83	68	60	EC Axial
84	23	61	EC Axial
85	38	62	EC Axial
86	54	62	EC Axial
87	98	62	EC Axial
88	22	64	EC Axial
89	60	64	EC Axial
90	23	65	EC Axial
91	30	66	EC Axial
92	68	66	EC Axial
93	98	66	EC Axial
94	37	67	EC Axial
95	108	68	EC Axial
96	85	69	EC Axial
97	34	70	EC Axial
98	46	70	EC Axial
99	62	70	EC Axial
100	70	70	EC Axial
101	100	70	EC Axial
102	35	71	EC Axial
103	37	71	EC Axial
104	75	71	EC Axial
105	79	71	EC Axial
106	34	72	EC Axial
107	36	72	EC Axial
108	38	72	EC Axial
109	84	72	EC Axial
110	45	73	EC Axial
111	63	73	EC Axial
112	107	73	EC Axial
113	101	75	EC Axial
114	36	76	EC Axial
115	60	76	EC Axial
116	73	77	EC Axial
117	44	78	EC Axial
118	74	78	EC Axial
119	61	79	EC Axial
120	79	79	EC Axial
121	93	79	EC Axial
122	92	80	EC Axial
123	124	82	EC Axial

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
124	69	83	EC Axial
125	58	84	EC Axial
126	84	84	EC Axial
127	86	84	EC Axial
128	43	85	EC Axial
129	46	86	EC Axial
130	86	86	EC Axial
131	44	88	EC Axial
132	92	88	EC Axial
133	133	89	EC Axial
134	92	90	EC Axial
135	53	91	EC Axial
136	55	91	EC Axial
137	73	93	EC Axial
138	52	96	EC Axial
139	74	96	EC Axial
140	43	97	EC Axial
141	36	98	EC Axial
142	41	99	EC Axial
143	65	99	EC Axial
144	48	100	EC Axial
145	106	100	EC Axial
146	24	102	EC Axial
147	50	102	EC Axial
148	80	102	EC Axial
149	82	102	EC Axial
150	33	103	EC Axial
151	24	104	EC Axial
152	32	104	EC Axial
153	50	104	EC Axial
154	58	104	EC Axial
155	60	104	EC Axial
156	64	104	EC Axial
157	76	104	EC Axial
158	43	105	EC Axial
159	51	105	EC Axial
160	9	107	EC Axial
161	23	107	EC Axial
162	22	108	EC Axial
163	104	108	EC Axial
164	1	109	EC Axial

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
165	7	109	EC Axial
166	19	109	EC Axial
167	75	109	EC Axial
168	16	110	EC Axial
169	34	110	EC Axial
170	52	110	EC Axial
171	9	111	EC Axial
172	13	111	EC Axial
173	27	111	EC Axial
174	12	112	EC Axial
175	44	112	EC Axial
176	58	112	EC Axial
177	17	113	EC Axial
178	62	114	EC Axial
179	14	116	EC Axial
180	32	116	EC Axial
181	62	116	EC Axial
182	68	116	EC Axial
183	128	116	EC Axial
184	5	117	EC Axial
185	9	117	EC Axial
186	19	117	EC Axial
187	43	117	EC Axial
188	12	118	EC Axial
189	14	118	EC Axial
190	62	118	EC Axial
191	98	118	EC Axial
192	120	118	EC Axial
193	5	119	EC Axial
194	15	119	EC Axial
195	31	119	EC Axial
196	14	120	EC Axial
197	20	120	EC Axial
198	44	120	EC Axial
199	60	120	EC Axial
200	62	120	EC Axial
201	88	120	EC Axial
202	13	121	EC Axial
203	8	122	EC Axial
204	24	122	EC Axial
205	58	122	EC Axial

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
206	62	122	EC Axial
207	76	122	EC Axial
208	9	123	EC Axial
209	11	123	EC Axial
210	8	124	EC Axial
211	24	124	EC Axial
212	64	124	EC Axial
213	24	126	EC Axial
214	102	126	EC Axial
215	3	127	EC Axial
216	25	127	EC Axial
217	43	127	EC Axial
218	16	128	EC Axial
219	26	128	EC Axial
220	36	128	EC Axial
221	5	129	EC Axial
222	11	129	EC Axial
223	15	129	EC Axial
224	59	129	EC Axial
225	16	130	EC Axial
226	38	130	EC Axial
227	62	130	EC Axial
228	32	132	EC Axial
229	1	133	EC Axial
230	14	134	EC Axial
231	16	134	EC Axial
232	30	134	EC Axial
233	20	136	EC Axial
234	61	137	EC Axial
235	105	137	EC Axial
236	12	140	EC Axial
237	27	141	EC Axial
238	10	142	EC Axial
239	26	142	EC Axial
240	38	142	EC Axial
241	27	143	EC Axial
242	47	143	EC Axial
243	12	144	EC Axial
244	56	144	EC Axial
245	9	145	EC Axial
246	8	146	EC Axial

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
247	1	147	EC Axial
248	19	147	EC Axial
249	33	147	EC Axial
250	20	148	EC Axial
251	9	149	EC Axial
252	34	150	EC Axial
253	10	162	EC Axial
254	42	6	EC VOL
255	49	51	EC VOL
256	30	52	EC VOL
257	17	57	EC VOL
258	36	60	EC VOL
259	79	63	EC VOL
260	25	65	EC VOL
261	34	68	EC VOL
262	81	69	EC VOL
263	32	72	EC VOL
264	98	72	EC VOL
265	51	73	EC VOL
266	85	77	EC VOL
267	122	84	EC VOL
268	77	85	EC VOL
269	48	102	EC VOL
270	89	111	EC VOL
271	32	112	EC VOL
272	102	118	EC VOL
273	83	27	Freespan Axial
274	138	96	Freespan Axial
275	69	17	Freespan VOL
276	66	56	Freespan VOL
277	121	49	PTP
278	42	56	PTP
279	130	56	PTP
280	72	138	PTP
281	70	74	Sludge Pile Axial
282	76	96	Sludge Pile Axial
283	50	100	Sludge Pile Axial
284	46	114	Sludge Pile Axial
285	14	130	Sludge Pile Axial
286	96	72	Sludge Pile Circ
287	75	151	Sludge Pile VOL

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
288	76	152	Sludge Pile VOL
289	28	42	TIG Sleeve (WZI)
290	53	43	TIG Sleeve (WZI)
291	80	44	TIG Sleeve (WZI)
292	100	56	TIG Sleeve (WZI)
293	109	73	TIG Sleeve (WZI)
294	100	78	TIG Sleeve (WZI)
295	107	81	TIG Sleeve (WZI)
296	90	124	TIG Sleeve (WZI)
297	26	146	TIG Sleeve (WZI)
298	26	148	TIG Sleeve (WZI)
299	120	42	TTS Axial
300	129	53	TTS Axial
301	68	74	TTS Axial
302	73	95	TTS Axial
303	125	101	TTS Axial
304	42	106	TTS Axial
305	18	112	TTS Axial
306	66	76	TTS Axial / EC VOL
307	14	20	TTS Circ
308	19	21	TTS Circ
309	33	25	TTS Circ
310	62	38	TTS Circ
311	77	39	TTS Circ
312	72	40	TTS Circ
313	81	41	TTS Circ
314	95	41	TTS Circ
315	56	42	TTS Circ
316	88	48	TTS Circ
317	57	49	TTS Circ
318	91	51	TTS Circ
319	25	53	TTS Circ
320	83	53	TTS Circ
321	98	56	TTS Circ
322	72	58	TTS Circ
323	99	59	TTS Circ
324	47	65	TTS Circ
325	106	66	TTS Circ
326	108	66	TTS Circ
327	84	70	TTS Circ
328	116	70	TTS Circ

TABLE 2 (SGB PLUG LIST FOR 2R12)

No.	Row	Line	Reason for Plug
329	105	71	TTS Circ
330	109	71	TTS Circ
331	81	75	TTS Circ
332	91	75	TTS Circ
333	99	91	TTS Circ
334	102	92	TTS Circ
335	37	93	TTS Circ
336	79	97	TTS Circ
337	93	97	TTS Circ
338	86	100	TTS Circ
339	109	101	TTS Circ
340	112	102	TTS Circ
341	111	105	TTS Circ
342	100	108	TTS Circ
343	87	117	TTS Circ
344	57	123	TTS Circ
345	95	123	TTS Circ
346	56	124	TTS Circ
347	58	124	TTS Circ
348	4	128	TTS Circ
349	13	129	TTS Circ
350	12	134	TTS Circ
351	15	135	TTS Circ
352	42	136	TTS Circ
353	20	138	TTS Circ
354	15	141	TTS Circ
355	16	146	TTS Circ
356	27	147	TTS Circ
357	15	149	TTS Circ
358	68	120	TTS Circ/EC Axial
359	11	131	TTS Circ/EC Axial
360	87	73	TTS VOL
361	88	110	TTS VOL
362	89	117	TTS VOL
363	64	70	TTS/EC Axial
364	82	90	TTS/EC Axial
365	138	76	VOL in DTSP
366	136	96	VOL in DTSP

TABLE 2 (SGB PLUG LIST FOR 2R12)

Legend:

BW - Batwing Stabilizer
DTSP - Drilled Tube Support Plate (Partial)
EC - Egg Crate Support
MMI - Mixed Mode Indication
PTP - Preventative Tube Plug
TTS - Top of Tube Sheet
VOL - Volumetric Indication
WZI - Weld Zone Indication (Sleeve)

TABLE 3

2R12 TUBES REPAIRED BASED ON FLAW LOCATION

LOCATION	SGA	SGB
Hot Leg ET Region (circumferential)	66	53
Sludge Pile	31	21
Cold Leg ET Region (circumferential)	0	0
EC Support Plate	166	246
BW Support	4	24
Drilled Support Plate	4	4
Sleeved Tubes (Kinetic)	9	0
(TIG)	9	10
Free-Span	38	4
Tube Sheet Below Sleeves	0	0
Miscellaneous	23	4
Total	350	366