Omaha Public Power District

444 South 16th Street Mall
Omaha NE 68102-2247

July 30, 2003
LIC-03-0100

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

References:
1. Docket No. 50-285
2. Letter from OPPD (R. T. Ridenoure) to NRC (Document Control Desk) dated July 1, 2002, Fort Calhoun Station (FCS) Steam Generator Tube Plugging Report - 2002 Refueling Outage (LIC-02-0083)
3. Letter from OPPD (R. T. Ridenoure) to NRC (Document Control Desk) dated December 3, 2002, Fort Calhoun Station (FCS) Steam Generator Eddy Current Test Report - 2002 Refueling Outage (LIC-02-0139)
4. Letter from NRC (A. B. Wang) to OPPD dated September 17, 2002, Stream Generator Inspection Phone Call Summary (TAC No. MB4961) (NRC-02-143)
5. Letter from NRC (A. B. Wang) to OPPD (R. T. Ridenoure) dated May 9, 2003, Request for Additional Information - Ft. Calhoun Station Steam Generator Report (TAC No. MB6954) (NRC-03-098)

SUBJECT: Response to Request for Additional Information - Ft. Calhoun Station Steam Generator Report (TAC No. MB6954)

The Attachment provides Omaha Public Power District's (OPPD) response to the NRC's request for additional information presented in Reference 5, Request for Additional Information - Ft. Calhoun Station Steam Generator Report.

If you have any questions or require additional information, please contact Dr. R. L. Jaworski of the FCS Licensing staff at (402) 533-6833.

Sincerely,

R. T. Ridenoure
Division Manager
Nuclear Operations

RTR/rrl

A001

Attachment: Response to NRC Request for Additional Information - Ft. Calhoun Station Steam Generator Report

c: T. P. Gwynn, Acting Regional Administrator, NRC Region IV
A. B. Wang, NRC Project Manager
J. G. Kramer, NRC Senior Resident Inspector

Response to NRC Request for Additional Information
Ft. Calhoun Station Steam Generator Report

NRC Question 1:

1. It is the NRC's understanding that the reporting criteria at Fort Calhoun for dents was established at 3 volts and that motorized rotating probe coil (MRPC) inspections were performed at various dented locations in the steam generator. With respect to dented locations:

NRC Question 1.a:

(a) Please discuss the basis for the selection of 3 volts as the screening criteria for identifying dents rather than some lower threshold such as 2 volts. Probe wobble can mask dents. The issue is at what point do dents and/or probe wobble signals need to be further investigated with rotating probes to ensure an effective inspection. The licensee may want to review the lessons learned from the Comanche Peak Special Inspection (Adams Accession No. ML030090566) in which probe wobble masked a dent and, in turn, resulted in a flaw not being reported. This discussion should include a discussion of outer diameter stress corrosion cracking (ODSCC) and primary water stress corrosion cracking (PWSCC).

OPPD Response:

Due to the support denting that occurred in the initial few cycles of operation downsized bobbin probes are used for the examination. A 0.560 inch diameter probe has been used for approximately 97% of the tubes which provides a fill factor of 73%. Because the diameter of the probe is reduced there is inherently more probe wobble which produces a horizontal signal response that can mask small amplitude dents. The 3 volt reporting threshold was selected in 1998 as that level at which a dent could be reliably differentiated from probe wobble.

The bobbin probe is qualified to detect both axial ODSCC and axial PWSCC in low level dents. The technique for axial ODSCC was developed by Westinghouse and is qualified for detection in dents up to 5.0 volts. The technique for axial PWSCC is an industry technique (ETSS 96012) and is qualified for detection in up to 2.0 volt dents. The Fort Calhoun Station data analysis procedure used in the last examination require that the analyst review all dent signals for distortions which may indicate the presence of a flaw. This type of indication is identified as DDI if the indication is located at a support structure and DNI if the indication is located in the free-span section of tubing. All DDI and DNI calls from the bobbin coil are subsequently examined with the plus point coil to determine whether a flaw is actually present.

For the September 2003 examination Fort Calhoun plans on testing 100% of the open tubes with a .560" diameter bobbin probe. Those tubes which have historically been restricted to this diameter probe (approximately 3%) will be tested from both tube ends with the area of restriction re-tested with a plus point coil.

Examination results from the last several inspections have shown that axial ODSCC is not preferentially located at dented supports. The issue with dents is that the dent signal could mask a flaw signal; it is not that dents are particularly more susceptible to flaws, or that dents with increased voltage signals are more susceptible to flaws than dents with smaller voltage signals. With respect to PWSCC, Fort Calhoun has had a single flaw reported at a dented support. This was detected during the programmed 20% plus point sample of dents.

We are currently in the process of revising the Fort Calhoun Station data analysis procedure in preparation for the fall inspection. Lessons learned from Comanche Peak will be incorporated and TXU has provided their ECT data for our site specific analysis training.

NRC Question 1.b:

(b) Please clarify the number, location, and magnitude of the dents including whether the dent is at a drilled hole tube support, an eggcrate support, or some other support structure. Also, if possible, determine whether the dents at drilled hole locations can be separated from the dents at eggcrate locations.

OPPD Response:

Table 1 is excerpted from the 2002 inspection report. Support elevations 1 through 7 are eggcrate design with a cutout area comprised of a drilled plate segment.

Table 1

2002 Dent Distribution >= 3.00 V						
Structure	**Number**	**% Open Tubes**	**Average Voltage**	**Number**	**% Open Tubes**	**Average Voltage**
	Steam Generator "A"			**Steam Generator "B"**		
H1	186	3.89%	22.31	151	3.16%	15.62
H2	129	2.69%	10.45	705	14.76%	13.47
H3	288	6.02%	7.72	659	13.79%	9.82
H4	599	12.51%	10.60	1138	23.82%	10.30
H5	527	11.01%	8.28	1014	21.22%	10.29
H6	1097	22.92%	14.97	1425	29.82%	12.51
H7	379	7.92%	14.16	522	10.93%	11.42
H8	729	15.23%	35.72	486	10.17%	31.68
DBH	7	0.15%	7.51	9	0.19%	21.00
V1	487	10.17%	45.86	466	9.75%	45.82
V2	551	11.51%	22.96	455	9.52%	17.93
V3	134	2.80%	22.00	213	4.46%	20.94
DBC	5	0.10%	5.49	8	0.17%	16.27
C8	538	11.24%	38.16	477	9.98%	40.59
C7	76	1.59%	27.30	193	4.04%	29.58
C6	44	0.92%	20.05	199	4.16%	36.54
C5	29	0.61%	12.29	27	0.57%	11.49
C4	6	0.13%	8.16	32	0.67%	14.23
C3	5	0.10%	8.05	30	0.63%	16.24
C2	2	0.04%	9.53	3	0.06%	6.87
C1	2	0.04%	3.14	1	0.02%	4.06
Totals	**5820**			**8213**		
All Dents measured with channel P1 - 2.75v on 20% FBHs						

All Dent calculations in this table assume the largest dent is used at each location and each is within plus or minus three inches of the given structure.

Table 2 lists only the horizontal supports with cutout areas and separates drilled plates versus eggcrate structure

Table 2

2002 Dent Distribution >= 3.00 Volts By Structure Type										
	Number in TSP	Average Voltage	Number in EC	Average Voltage	Total	Number In TSP	Average Voltage	Number in EC	Average Voltage	Total
Structure	Steam Generator "A"					Steam Generator "B"				
H1	130	32.42	56	6.76	186	64	25.55	87	7.55	151
H2	12	40.85	117	7.19	129	54	51.06	651	10.02	705
H3	5	4.74	283	7.24	288	66	25.17	593	7.97	659
H4	68	30.81	531	7.54	599	193	16.61	945	8.60	1138
H5	44	14.90	483	7.22	527	175	20.15	839	7.92	1014
H6	220	30.95	877	10.59	1097	181	18.02	1244	11.38	1425
H7	171	18.77	208	9.34	379	185	14.22	337	9.48	522
C7	70	30.02	6	8.60	76	184	30.44	9	7.13	193
C6	38	22.14	6	11.20	44	191	38.89	8	5.95	199
C5	29	14.80	0	N/A	29	25	12.46	2	6.54	27
C4	4	10.23	2	3.86	6	30	14.59	2	3.79	32
C3	4	8.44	1	3.00	5	27	16.94	3	4.02	30
C2	1	17.37	1	5.38	2	3	6.87	0	N/A	3
C1	0	N/A	2	3.59	2	1	4.06	0	N/A	1
Totals	2063		2573		4636	2339		4723		7062

NRC Question 1.c:

(c) For each flaw detected during the outage, indicate the magnitude of the dent at that location and indicate whether the flaw (1) was initially found during the bobbin screening, (2) was only identified with the MRPC, (3) was identified during the initial bobbin screening and confirmed by MRPC, or (4) was only identified with the bobbin after the MRPC results were available.

OPPD Response:

Tables 3 and 4 provide the requested information under the column titled Detection Class with the classification numbers listed as in the question above. There were no indications in classification number 1 as all suspect flaw indications by bobbin are subject to confirmation with MRPC.

Table 3

OPPD Ft Calhoun Station
Spring 2002 Outage

S/G A Plug List

	Row	Line	2002 MRPC Call	2001 MRPC/ Change	2002 Bobbin Dent	Detection Class	Plus Point Max %	"Avg." Depth
1	3	68	TBP Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
2	3	82	TBP Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
3	9	28	SAI HTS + 0.38	No Change	N/A	2	27	21
4	9	96	SCI HTS + 0.18	Yes	N/A	2	55	N/A
5	10	91	SCI HTS + 0.07	No Change	N/A	2	53	N/A
6	11	90	SCI HTS + 0.11	No Change	N/A	2	61	N/A
7	11	94	SAI HTS + 0.39	No Change	N/A	2	32	28
8	12	55	SAI HTS + 0.26	No Change	N/A	2	27	20
9	12	63	SAI HTS + 0.21	No Change	N/A	2	28	20
10	12	91	SAI HTS + 0.22	No Change	N/A	2	26	20
11	12	95	SAI HTS + 0.60	No Change	No Dent	2	29	24
12	15	68	TBP Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
13	15	70	SAI HTS + 0.21	No Change	N/A	2	28	24
14	15	82	TBP Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
15	24	107	SAI HTS + 0.64	No Change	No Dent	2	30	24
16	25	52	SAI HTS + 0.99	No Change	No Dent	2	25	20
17	26	55	SAI HTS + 1.19	Yes	No Dent	4	27	23
18	31	66	SAI H1 + 0.41	No Change	4.81V DNT	2	45	38
19	67	54	SAI H2 +0.99	No Test	No Dent	2	33	28
20	69	56	SAI H2 +1.16	No Change	No Dent	2	26	21
21	70	79	SAI H1 + 0.77	No Test	No Dent	3	52	47
22	73	58	SAI H2 + 0.12	No Test	No Dent	2	30	27
			SAI H4 + 0.14	No Change	8.31V DNT	2	43	38
23	80	59	SAI H1 + 1.29	No Test	No Dent	3	50	46
			SAI H1 + 1.25	No Test	No Dent	3	33	28
24	80	65	TBP Not testable at V1 with RPC	N/A	N/A	N/A	N/A	N/A
25	81	58	SAI H1 + 1.29	No Test	No Dent	2	31	25
26	88	77	TBP Not testable at V1 with RPC	N/A	N/A	N/A	N/A	N/A
27	90	49	SAI H1 + 0.98	No Change	No Dent	2	27	24
28	90	69	SAI H4 - 0.21	No Test	No Dent	2	32	29
29	92	79	SAI H3 - 1.05	No Test	No Dent	2	36	32
30	94	47	SAI H3 - 0.19	No Change	No Dent	2	31	26
31	94	81	SAI H1 + 0.41	No Test	No Dent	2	33	27

32	95	84	SCI	H1 + 0.20	No Test	22.09V DNT	2	35	35
33	96	47	SAI	H1 + 0.24	No Test	No Dent	2	44	35
34	96	57	SAI	H6 +19.10	No Change	N/A	2	27	23
35	98	45	SAI	H3 + 0.14	No Test	No Dent	3	33	28
36	98	69	SAI	H7 + 13.56	No Change	N/A	2	33	24
37	99	46	SAI	H3 +0.06	No Test	No Dent	2	26	24
38	99	48	SAI	H3 - 0.07	No Test	No Dent	2	33	30
39	99	50	SAI	H1 + 0.04	No Test	No Dent	4	42	36
40	99	80	SAI	H1 - 0.22	No Test	No Dent	2	31	27
41	101	56	SAI	H2 - 0.03	No Test	No Dent	2	25	23
42	101	62	SCI	H7 + 0.21	Yes	3.67V DNT	2	47	31
43	101	66	SAI	H2 + 0.16	No Test	No Dent	2	35	29
44	103	62	SAI	H7 + 7.55	No Test	N/A	3	40	31

Table 4

OPPD Ft Calhoun Station
Spring 2002 Outage

S/G B Plug List

	Row	Line	2002 MRPC Call		2001 MRPC/ Change	2002 Bobbin Dent	Detection Class	Plus Point Max %	"Avg." Depth
1	3	68	TBP	Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
2	3	82	TBP	Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
3	10	33	SAI	HTS + 0.92	No Change	No Dent	2	37	29
4	15	68	TBP	Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
5	15	82	TBP	Flexi FlatRail	N/A	N/A	N/A	N/A	N/A
6	19	46	SAI	HTS + 0.97	No Change	No Dent	2	28	23
7	19	60	SAI	HTS + 1.28	No Change	No Dent	4	33	24
8	20	59	SAI	HTS + 0.82	No Change	No Dent	4	38	36
9	20	61	SAI	HTS + 0.54	No Change	No Dent	2	38	32
10	22	61	SAI	HTS + 1.01	No Change	No Dent	2	25	20
			SAI	HTS + 1.19	No Change	No Dent	2	23	18
11	28	83	SAI	H2 - 0.06	No Test	No Dent	2	47	39
12	31	116	SAI	H2 + 0.40	No Test	31.48V DNT	2	36	30
13	38	79	SAI	H2 + 0.83	No Test	6.89V DNT	2	38	30
14	49	66	SAI	H1 - 0.64	No Test	No Dent	3	35	34
15	59	22	TBP	Noisy Tube	N/A	N/A	N/A	N/A	N/A
16	68	41	SAI	H2 + 0.38	No Test	10.81V DNT	2	44	40
17	71	84	SAI	H2 - 0.15	No Test	8.03V DNT	2	44	35
18	74	39	SAI	H8 - 0.07	No Test	No Dent	2	35	33
19	77	64	SAI	H4 - 0.15	No Test	No Dent	2	38	32
			SAI	H3 + 0.13	No Test	4.40V DNT	2	29	26
#	78	59	SAI	H4 + 0.09	No Test	No Dent	3	66	55
21	78	63	SCI	H7 + 0.25	Yes 96	2.30V DNT	2	33	N/A

22	79	74	SVI	H6 + 3.19	No Change	No Dent	2	48	N/A
23	80	35	SCI	H8 - 0.17	No Change	No Dent	2	9	N/A
34	81	72	SAI	H7 - 0.17	No Change	No Dent	2	37	31
25	82	69	SCI	H7 + 0.28	No Change	4.77V DNT	2	31	N/A
26	83	74	SCI	H5 + 1.33	No Test	5.09V DNT	2	32	N/A
27	84	55	SAI	H6 + 19.73	Yes	No Dent	2	30	27
28	84	59	SAI	H6 + 21.26	Yes	No Dent	3	35	29
29	85	66	SAI	H7 + 0.69	No Change	No Dent	2	31	28
30	88	57	SAI	H6 + 0.73	No Change	No Dent	2	29	26
31	88	67	SAI	H4 + 2.00	No Test	No Dent	2	36	30
			SAI	H6 + 1.73	No Change	No Dent	3	29	27
32	89	66	SAI	H6 + 0.76	No Change	No Dent	2	28	24
33	91	48	SAI	H1 - 0.18	No Change	No Dent	2	29	25
34	91	58	SAI	H1 + 0.11	No Test	No Dent	3	42	35
35	91	70	SAI	H1 - 0.06	No Change	No Dent	2	37	30
			SAI	H8 + 2.34	No Change	No Dent	3	35	28
36	95	74	SAI	H1 + 0.06	No Test	No Dent	2	25	23
			SAI	H6 + 1.22	No Change	3.19V DNT	2	33	28
37	97	54	SAI	H5 + 36.02	No Test	No Dent	2	26	22
38	99	56	SAI	H1 + 0.22	No Test	No Dent	2	41	38
39	100	59	SAI	H2 + 0.26	No Change	No Dent	2	30	27
40	101	52	SAI	H3 + 0.06	No Test	No Dent	2	31	27
41	101	60	SAI	H1 + 0.03	No Test	No Dent	2	34	30
42	101	70	SAI	H8 + 9.21	No Test	No Dent	3	41	31
43	103	58	SAI	H4 + 0.01	No Test	No Dent	2	35	29
44	103	70	SAI	H3 + 0.19	No Test	No Dent	2	36	32

NRC Question 1.d:

(d) For those dents not at drilled hole tube supports (since all dents at drilled tube supports were examined by MRPC), it appears that 20% of these locations on the hot-leg were originally scheduled to be examined by MRPC (and was subsequently expanded to included 100% of the dents at the first two hot-leg tube supports). Please clarify whether the "hot-leg" includes the hot-leg diagonal bar and the vertical supports (V1, V2, and V3). Please discuss the inspection results for these dents. If any flaws were identified, discuss the size of the flaw and the size of the dent at this location.

OPPD Response:

The 2002 examination included 20% of the dents at the hot leg horizontal supports, diagonal bar and V1. The planned inspection scope of the 2003 examination includes all the hot leg support dents.

NRC Question 1.e:

(e) Regarding the expansion of the MRPC inspection to include all hot-leg dents at the first two hot-leg tube supports, please clarify why the expansion was limited to this region. 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). Your response should reflect both ODSCC and PWSCC.

OPPD Response:

The licensee has taken the position that magnitude of the dent does not necessarily equate to severity. However, there is still an issue that a more severe dent at a higher elevation with a lower temperature may crack earlier than a lower location. As a result, once cracking is observed, some assessment of not only the temperature but also the severity of the dent/ding should be performed. The staff noted that although the population of flaws may follow a trend, this does not ensure there are not exceptions (i.e., the experience at Westinghouse plants where flaws are detected at higher tube supports in one outage and then at lower tube supports in subsequent outages).

There is ample data from the other retired C-E design steam generators, that ODSCC at supports is thermally stratified. Also, for those SCC indications at FCS that are located at H1 or above, approximately 25% are coincident with a bobbin dent response. There is no evidence that dented locations are any more susceptible than non-dented locations. There is no industry data which shows a correlation between bobbin coil dent voltage versus presence of SCC.

NRC Question 1.f:

(f) It is the NRC staff's understanding that dent sizes at Fort Calhoun range up to 100 volts in magnitude. Discuss whether the bobbin probe is qualified to inspect dents with that magnitude. Discuss the extent to which the bobbin probe is qualified to inspect dented regions exceeding a specific voltage threshold (e.g., 5 volts).

OPPD Response:

The bobbin probe is qualified to detect both axial ODSCC and axial PWSCC in low level dents. The technique for axial ODSCC was developed by Westinghouse and is qualified for detection in dents up to 5.0 volts. The technique for axial PWSCC is an industry technique (ETSS 96012) and is qualified for detection in up to 2.0 volt dents.

NRC Question 2:

2. For locations with dings, please provide information similar to what was provided for the dented locations. For example: (1) clarify the screening criteria (e.g., 3 volts), (2) provide a summary of the number, location, and severity of all dings, (3) provide a list of all flaws associated with dings along with the amplitude of the ding, (4) provide the basis for any expansion of the inspection, etc.

OPPD Response:

The Fort Calhoun Station analysis procedure labels all dent indications as DNT whether they are at structures or in the free-span section of tubing. The threshold value for reporting a dent in the free-span section of tubing is also 3.0 volts. Table 5 provides a summary of free-span dent signals observed during the last inspection. Approximately twenty percent of the hot leg free-span dents were also tested with a plus point coil. No flaws have been detected to date at free-span dent locations.

Table 5

FREESPAN DENTS (+ OR - 3 IN SUPPORT MEASUREMENT)

	SG A	AVERAGE DENT	SG B	AVERAGE DENT
HTS-H1	8	5.65	9	5.03
H1-H2	2	6.53	5	4.38
H2-H3	3	7.55	6	7.82
H3-H4	1	3.73	9	6.35
H4-H5	6	4.11	10	7.15
H5-H6	6	7.68	13	5.23
H6-H7	38	7.18	24	10.42
H7-H8	16	8.1	23	13.49
H8- DBH	6	7.31	15	9.01
DBH-V1	11	10.12	12	11.36
V1-V2	9	52.78	37	12.57
V2-V3	17	6.8	29	8.08
V3-DBC	11	12.42	8	18.1
C8-DBC	0		0	
C7-C8	9	13.81	24	8.39
C6-C7	48	7	80	9.51
C5-C6	2	16.14	5	6.85
C4-C5	5	12.46	6	5.47
C3-C4	3	5.1	5	8.41
C2-C3	3	10.62	5	6.36
C1-C2	9	4.89	5	5.57
CTS-C1	7	5.61	8	5.09

NRC Question 3:

3. Please clarify what is meant by the term "previous less than zero indications." This term was used in bullet 4 on page 3 of the December 3, 2002 submittal.

OPPD Response:

The first use of the plus point probe in 1996 resulted in approximately 50 tubes with LTZ (Less Than Zero) indications. The LTZ classification was assigned when the rotating plus point coil terrain map indicated an axial ridge-like indication which could be interpreted as a crack, yet the depth estimate was zero percent with the indication phase angle typically 20 to 30 degrees outside the defect plane. The majority of these indications were transparent to the bobbin coil. Tubes with LTZ indications were identified for future tracking but were not considered to represent a repairable condition. In 1998 two tubes with LTZ indications were removed for metallographic examination. The post-removal ECT showed that the indications had disappeared and the laboratory examination did not reveal the presence of any degradation. Therefore, the origin of the LTZ indications is assumed to be deposits on the O.D. of the tube.

NRC Question 4:

4. With respect to the MRPC examinations performed from DBH to H5 in the critical area and the MRPC examinations performed in the 90-degree bends outside the critical area, discuss the results from the examination. If flaws were identified, indicate whether the flaw was initially found during the bobbin screening (or whether the flaw was only identified with the bobbin after the MRPC results were available, or whether the flaw was only identifiable from the MRPC data). If flaws were identified, discuss whether the scope of the inspection was expanded. If not, discuss why not.

OPPD Response:

Tables 3 and 4 provide this information for all of the flaws detected in the last examination and figures 1 and 2 are tubesheet maps with the locations of flawed tubes and their proximity to the critical area. ODSCC indications were identified in the critical area which were only detected by the MRPC probe. However none of these flaws were challenging from a leakage or structural integrity perspective (the deepest was estimated at 40% TW based on plus point amplitude sizing). In addition, no degradation of the type defining the CA were observed in the buffer zone and additional program expansion was not required per the EPRI PWR Steam Generator Examination Guidelines, Revision 5.

NRC Question 5:

5. Discuss the technical basis for the critical area (superposition of partial drilled hole tube support plate locations) discussed in question 4.

OPPD Response:

Fort Calhoun steam generators have partial drilled hole tube support plates (patch plates) at support elevations 1 through 8. Patch plates were installed during manufacturing as a convenience for access to the steam generator internals during and after installation of the eggcrates. Elevations 1 through 7 patch plates are a part of the full bundle support comprised mainly of an eggcrate support structure with patch plates on the hot and cold leg sides. Patch plates alternate in two wedge shape configurations at elevations 1 through 6. The even-numbered plates 2, 4, and 6 are asymmetrical wedges and the odd-numbered plates 1, 3, and 5 are symmetrical wedges. Patch plates at elevations 7 and 8 are of a different shape. Plate 7 is a symmetrical wedge with sides extending beyond the symmetrical shape of the odd-numbered plates. Plate 8 is the largest plate and is a partial disk with edges extending beyond the other plates but does not cover the farthest point into the tube bundle of the even numbered plates wedge shape. The critical area for the freespan between patch plates is defined radially as the minimum area of the superimposed shape of all of the hot leg side patch plates resembling the silhouette of a simple house shape when observed from the mid-point of hot leg side of the tube bundle. The critical area for the freespan between patch plates is defined axially as the beginning above H5 to DBH.

The critical area boundary has been defined on the basis of axial ODSCC experience in the Fort Calhoun Station steam generators patch plate region and the sludge deposition area in the lower flow patch plate region. Flow is restricted in this region due to deposit accumulation in the drilled support flow holes. Axial ODSCC was first detected by bobbin coil in the patch plate region in 1999 and confirmed by +Point. Freespan degradation is axially oriented stress corrosion cracking because hoop stresses in the tube exceed axially oriented stresses. Circumferential cracking is not expected to occur in the freespan in any tube bundle region and has not been observed. Bobbin probe techniques can detect freespan axial cracking including in the presence of deposits. The +Point probe techniques can detect axial cracking at a smaller flaw size than the bobbin probe and also detects circumferential cracking. The bobbin probe POD was adequate but it was conservatively decided that +Point would be used in the most susceptible part of the patch plate region (i.e., the critical area) to enhance the probability of detection of axial cracking and to provide a basis for growth rate determination in subsequent inspections for use in operational assessments.

The critical area radial boundary is surrounded by a two row buffer zone of tubes that is sampled at 20% of the total population to ensure that the critical area encompasses the region of most likely tube degradation. The axial buffer is not necessary below the CA in that all tubes intersections at H1 and the top of the tubesheet are inspected. In the event of degradation detection in the buffer zone, the inspection is expanded until the critical area is redefined and encompasses the targeted degradation type. In the last examination no freespan axial ODSCC was detected in the radial buffer zone providing a confirmation that the target degradation type is encompassed within the critical area.

NRC Question 6:

6. On page 6 of the December 3, 2002, submittal, it was indicated that historical data reviews were performed for the single axial indications and that of the 74 indications identified, 33 indications showed no change and 3 showed change. Please clarify how the 74 indications were detected during the 2002 outage (by bobbin, by MRPC only, by bobbin only after MRPC identification, etc.). Please discuss whether the "change" referred to is a change in the bobbin coil data and/or the MRPC data.

   From above, 33 indications were identified and confirmed as flaws by MRPC in 2002. In evaluating the previous data (presumably bobbin data) for these indications, there was no change in the signals from the prior inspection. Given there was no change in the bobbin data and flaws are known to exist at these locations, discuss why it was appropriate to use historical comparisons of the bobbin data as a basis for not MRPC inspecting other bobbin indications identified in 2002. That is, if in 2002 a bobbin indication is identified and a historical comparison is made to the 2001 bobbin data and there is no change (regardless of the results of previous MRPC examinations), wouldn't the results from the evaluation of the 74 indications discussed above indicate that there is a potential for a flaw to be present. Were any of the flaws that were identified in 2002 and that exhibited "no change" since the 2001 data, inspected by MRPC in 2002?

   At locations where the bobbin shows no change and for which a previous MRPC examination did not confirm a flaw (i.e., non-relevant indications), please discuss whether any random MRPC examinations have been performed to confirm the adequacy of the screening criteria for determining when an MRPC examination should be performed? The NRC staff understands that the "change" refers not only to change in the bobbin data but also to the rotating probe data. The staff's concern is whether the "change" criteria (for determining when to "spin" bobbin indications) is sufficient given that the inspection results show that many of the indications show "no change" but are still flaws. That is, given that there may be no change in the bobbin signal (from one outage to the next) and that the initial review of the RPC data during the previous outage did not result in the identification of a flaw, isn't it possible that a flaw exists at this location. It would appear from the results of the inspection that it is possible.

OPPD Response:

The "change" referred to is specific to the MRPC test. Tables 3 and 4 provides information on which technique detected the indications.

The indications which exhibit no change from the previous examination are primarily low amplitude shallow flaw responses that were not reported in the previous examination due to the fact that probability of detection is lower for flaws of this magnitude. The decision to not perform another MRPC test during the current inspection is not based solely on the bobbin coil comparison. The Resolution analysis team must also review the prior cycle MRPC data to re-affirm that no flaw is present. If the team concludes that the data is questionable or that a flaw may have been present then an MRPC test is required regardless of the bobbin signal comparison. With regard to whether any random MRPC examinations have been performed to confirm the adequacy of the screening criteria, the entire CA area is first tested with the bobbin coil and it is only when the analysis is complete that the MRPC exam is started. There have been no instances in which the screening criteria has been invalidated. In addition, by sequencing the examination in this manner we obtain additional information on the bobbin probe POD. All axial ODSCC detected with the plus point coil are depth sized using an amplitude technique. Bobbin coil hits and misses are compared with the POD curves used in the operational assessment to benchmark the bobbin performance. The Comanche Peak experience is considered in the planned 2003 inspection.

NRC Question 7:

7. Circumferential indications were detected at dented hot-leg drilled supports. The dent size associated with these indications ranged from 2.3 volts to 22.09 volts. Discuss whether circumferential indications could also be present at hot-leg dents at non-drilled hole tube supports. If not, discuss the technical basis. If so, discuss whether all "dented" non-drilled hole hot-leg tube supports were inspected with an MRPC. Also, to what extent have rotating probe examinations performed at the eggcrate locations? The staff also notes that the smallest dent associated with these circumferential indications was below the dent screening criteria used at Fort Calhoun (2.3 volts).

OPPD Response:

The dent size actually ranges from no dent (by bobbin) to 22.09 volts. No circumferential cracking has been reported at an eggcrate support in any C-E unit. We believe that the significant difference in the support geometry (the openness of the eggcrate intersection) is the reason. Rotating probe examinations were performed on 100% of hot leg eggcrates numbers 1 & 2 and 20% of hot leg eggcrates 3 through 6. In addition, a small number of distorted bobbin coil signals were identified which were tested by MRPC.

NRC Question 8:

8. For the two tubes which were restricted because of a severe geometric condition, discuss how this condition occurred and whether it has been getting more severe with time. Discuss what actions were taken to confirm that these tubes satisfied the performance criteria.

OPPD Response:

The dent comparison table from 2001 to 2002 shows no apparent growth in dent levels for a large population of indications. The two tubes that were preventively plugged were not restricted to the .540" bobbin coil but the shape of the dent was such that the MRPC coil did not rotate consistently i.e., plugged for data quality reasons.

There were no specific actions taken to verify that the tubes satisfied the performance criteria and it has never been an industry requirement to confirm condition monitoring of a tube with no known degradation that has been preventatively plugged.

NRC Question 9:

9. It was indicated that "signal confirmation requirements" for reporting flaws at eggcrate supports was eliminated based on recent experience from another CE design steam generator. Please discuss what is meant by "signal confirmation requirements". Please discuss why this signal confirmation was not eliminated for all locations (i.e., regardless of whether the flaw was at an eggcrate location). For flaws identified this outage at non-eggcrate locations, discuss whether they could have been reported in the previous outage if the signal confirmation requirements had not been imposed at these locations.

OPPD Response:

Signal confirmation pertains to the screening of eggcrate locations for axial ODSCC. The initial bobbin coil screening requires the analyst to review a differential process mix which suppresses the carbon steel response. In addition, the 100 KHz differential channel is reviewed. The EPRI ETSS for this application, 96008.1 requires confirmation on the 400 KHz channel. By confirmation, it is meant that this channel also detects a flaw-like signal. At another C-E design SG examination ODSCC indications were identified by plus point MRPC for which the 400 KHz bobbin response did not confirm the flaw.

With regard to the question on why signal confirmation was not eliminated at all locations, there has been no industry experience which would indicate that flaws are being missed at other locations with this practice. The reason that the industry has adopted multi-frequency test instruments is to assist in the discrimination of benign signals from actual tube flaws. This frequently involves signal confirmation from other frequencies.

NRC Question 10:

10. During the inspection, a bobbin probe with a diameter of 0.540-inch or 0.560-inch was used to inspect the tubes during 2002. Discuss why a probe of larger diameter (that would improve the fill factor) is not used during the inspections? Include in your response a discussion of the noise levels in your tubes and the severity of the dents and how they compare to the qualification data for these probes for the examination of 0.750-inch diameter tubes with 0.048-inch wall thickness. Discuss whether the fill factor is an essential variable for the bobbin techniques used at Fort Calhoun. If so, provide the limits for the qualification. Specifically, discuss how many data points are available in the qualification data set for these sized probes for the examination of the size of tubing used at FCS.

It was identified during the April 22, 2003 call that the Examination Technique Specification Sheet for the bobbin technique now indicates the maximum probe size to be used during qualification. Does this mean that the use of smaller probes would no longer be considered adequate without a site specific demonstration? If so, what site specific demonstration was performed?

A statement was made that the noise levels in the tubes has not been systematically measured. If this is true, how was it demonstrated that the EPRI-qualified technique is applicable at FCS? If the probability of detection (POD) at fort Calhoun (based on the rotating probe data, which isn't necessarily a true POD) is less than the POD from the qualification data set (a more realistic POD), what does this imply on the ability of the bobbin probes used at FCS to detect flaws at dented and/or non-dented locations?

OPPD Response:

The physical size of the dents preclude the efficient use of larger diameter bobbin probes.

Because an appropriate methodology for quantifying noise is currently under industry discussion, there has been no systematic effort to quantify noise levels at Fort Calhoun.

With regard to the qualification data for bobbin ODSCC (ETSS 96008.1), dents were not included in this dataset. The probe fill factor is considered an essential variable and the technique specifies a fill factor of 86%, however, none of the pulled tubes in the ETSS dataset are tested with a fill factor as high as 86%. Only the 7/8" x 0.050" wall laboratory samples were tested with this higher fill factor. In the EPRI data set there are a total of 18 flaws. Of the 18, 6 are the lab samples (FF 86%), 3 are in removed tubes from Arkansas Unit 2 (FF 79%), 6 are in removed tubes from St. Lucie Unit 1 (FF 73%), and 3 are in removed tubes from Calvert Cliffs Unit 1 (FF 73%). The smallest flaw in the data set is 13% TW which was detected with the 73% FF probe. None of the tubes in the EPRI data set were tested with a .0540 inch probe (fill factor = 68%).

To assess the effect of the reduced fill factor on ODSCC detection, in 1996 ABB Combustion-Engineering conducted a series of tests on axial ODSCC as part of an Owners Group study. A series of ODSCC tube samples with 13 crack areas were fabricated in the laboratory. These samples were benchmarked with a .600" diameter bobbin probe which provides a fill factor of 84%. The signal amplitudes from the cracks were mostly less than 1 volt and thus representative of low level signals seen in operating units. The test was repeated with the .540" probe with the following results. Of the 13 indications, 11 were detected with the smaller diameter probe. One undetected indication, sample C-1, was measured at 31% TW with the .600" probe. Metallographic sectioning also showed the maximum depth as 31% TW. The second undetected indication, sample C-10, was measured at 17% TW by the .600" probe. EPRI PWR Steam Generator Examination Guidelines, Revision 5 Appendix H, Section H2.2.2 Detection Data Set states "The minimum detection data set is 11 flawed grading units. The detection data set shall have a measured depth equal to or greater than 60% of the nominal tube wall thickness. The data set shall be uniformly distributed over the depth range of 60% to 100% through-wall. It is acceptable to use a lower percent through-wall criteria for detection, rather than the 60% value." Table 6 shows that the .540" probe satisfied the detection requirements.

Table 6: Lab Sample ODSCC Detection

Number	Tube ID	.600 Volts	.600 %	.540 Volts	.540 %
1	C-1/A	0.18	31	0.39	0
2	C-2/A	3.13	87	1.14	83
3	C-2/B	0.66	78	0.27	42
4	C-3/A	0.17	31	0.38	37
5	C-3/B	0.33	48	0.71	66
6	C-4/A	0.46	28	0.40	35
7	C-5/A	121.85	98 ID	77.19	38 ID
8	C-6/A	0.08	70	0.15	62
9	C-6/B	0.11	67	0.16	72
10	C-7/A	0.47	70	0.21	35
11	C-8/A	0.13	73	0.17	27
12	C-9/A	0.16	0	0.04	NQI
13	C-10/A	0.60	17	0.68	0

Although it can be demonstrated that the .540 inch probe meets the EPRI appendix H detection requirements it is understood that a smaller fill factor probe results in a reduced test sensitivity. Any differences in essential variables must be evaluated and equivalence demonstrated if the performance indices listed in the technique are to be used in the condition monitoring process. In ETSS 96008.1 the technique detects every flaw in the data set regardless of depth (1 to 19% = 4 of 4, 20 to 39% = 3 of 3, 40 to 100% = 11 of 11). The analyst performance for this mechanism was 87% from the initial industry QDA (qualified data analyst) performance demonstration. At a steam generator integrity assessment workshop in 1999 EPRI provided methodology for determining the system POD by multiplying the technique POD and the analyst POD. In this case the result would indicate that the system POD is 87% regardless of the flaw depth.

We do not believe that a system POD of 87% is applicable at Fort Calhoun based on initial bobbin coil screening followed by MRPC examination in the critical area. Over several cycles primary and secondary analysis team hit rates with the bobbin coil versus maximum depth by plus point has been used to better estimate system performance at FCS. The system POD used for the condition monitoring process has been substantially reduced from the EPRI indices. The adjusted POD, shown in figure 3 below, has been used in the operational assessment over the last two cycles and has provided reasonable results in forecasting the number and depth distribution of ODSCC indications.

Figure 1

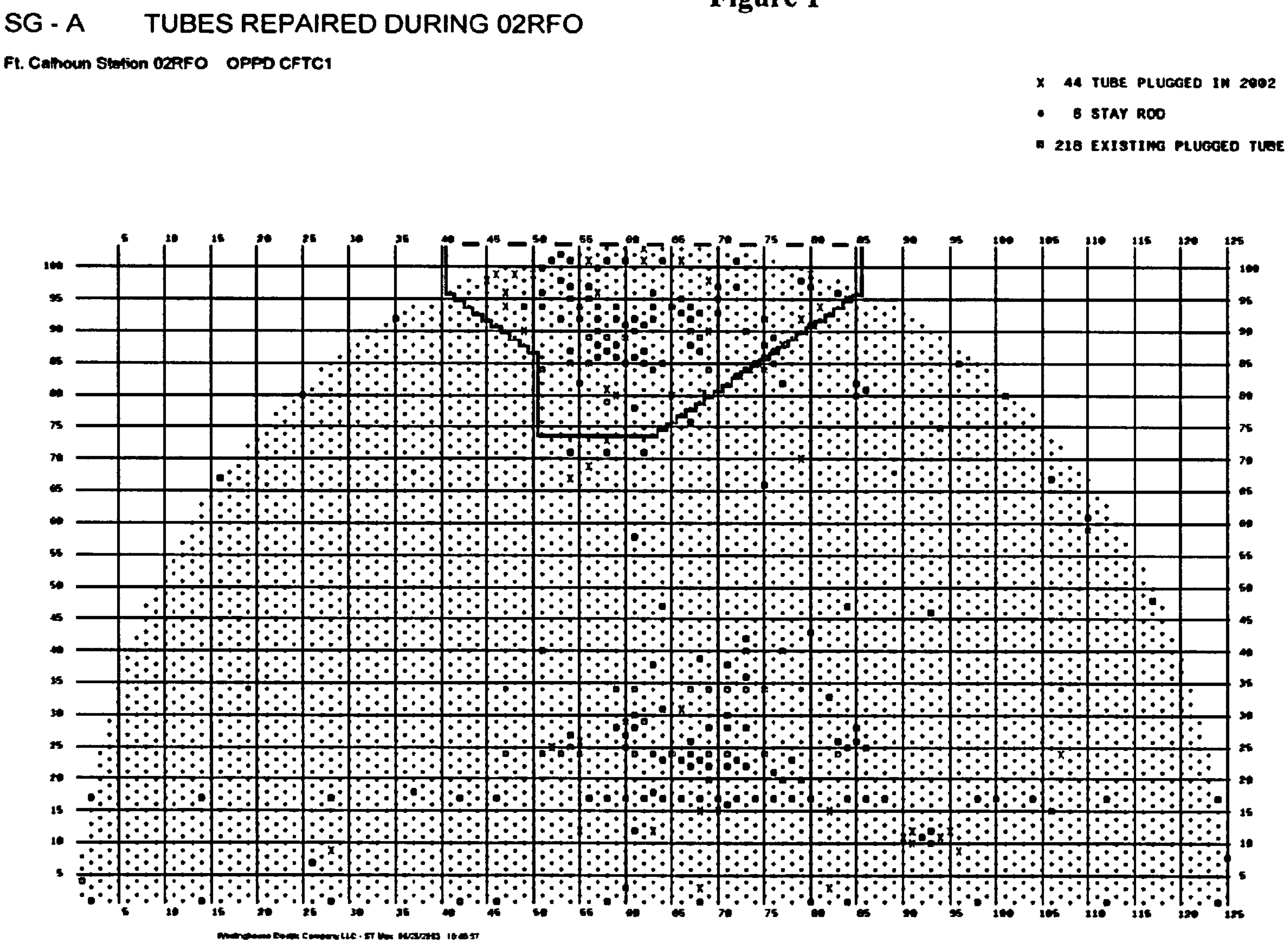

SG - A TUBES REPAIRED DURING 02RFO
Ft. Calhoun Station 02RFO OPPD CFTC1
X 44 TUBE PLUGGED IN 2002
• 6 STAY ROD
■ 218 EXISTING PLUGGED TUBE

Figure 2

SG - B TUBES REPAIRED DURING 02RFO

Ft. Calhoun Station 02RFO OPPD CFTC1

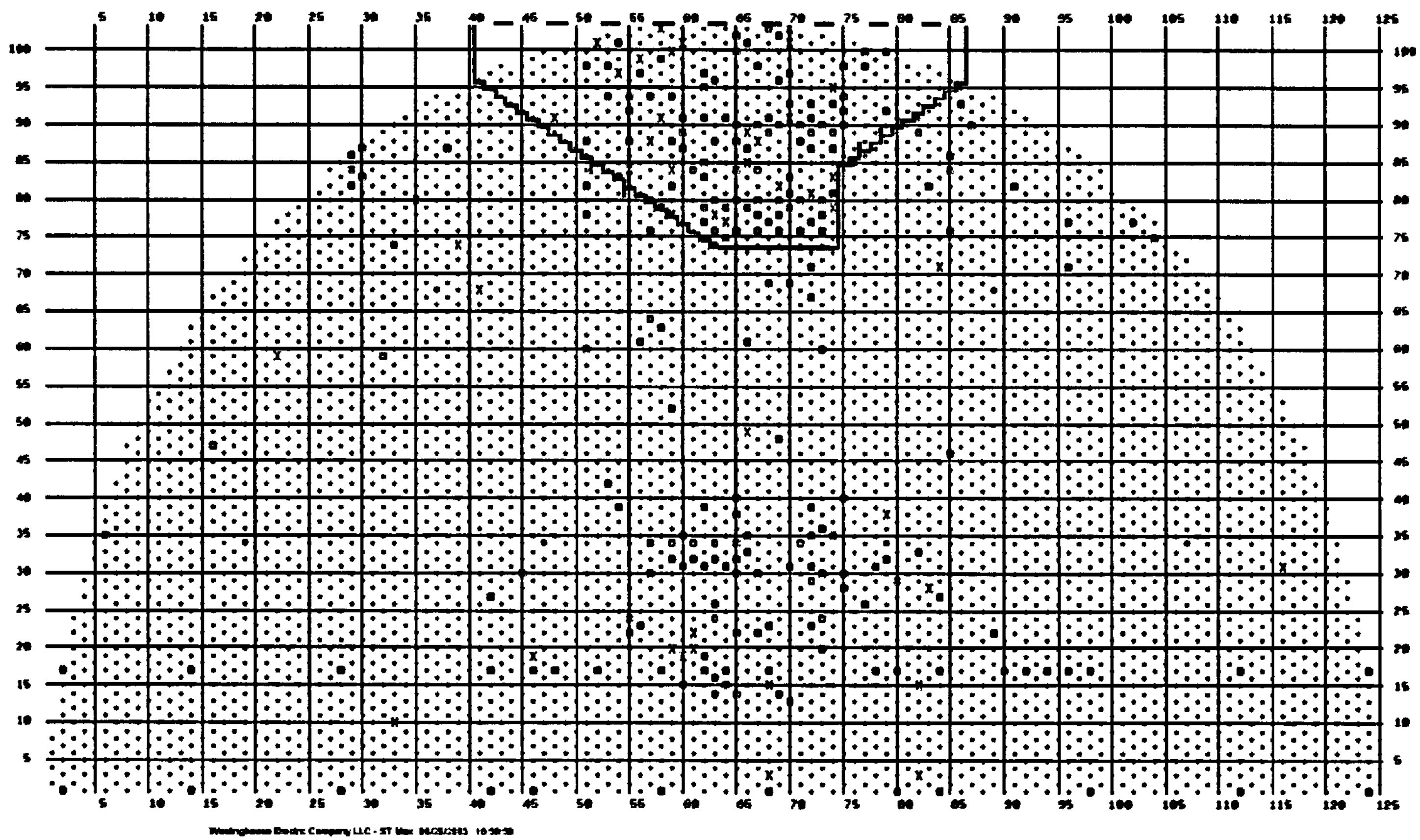
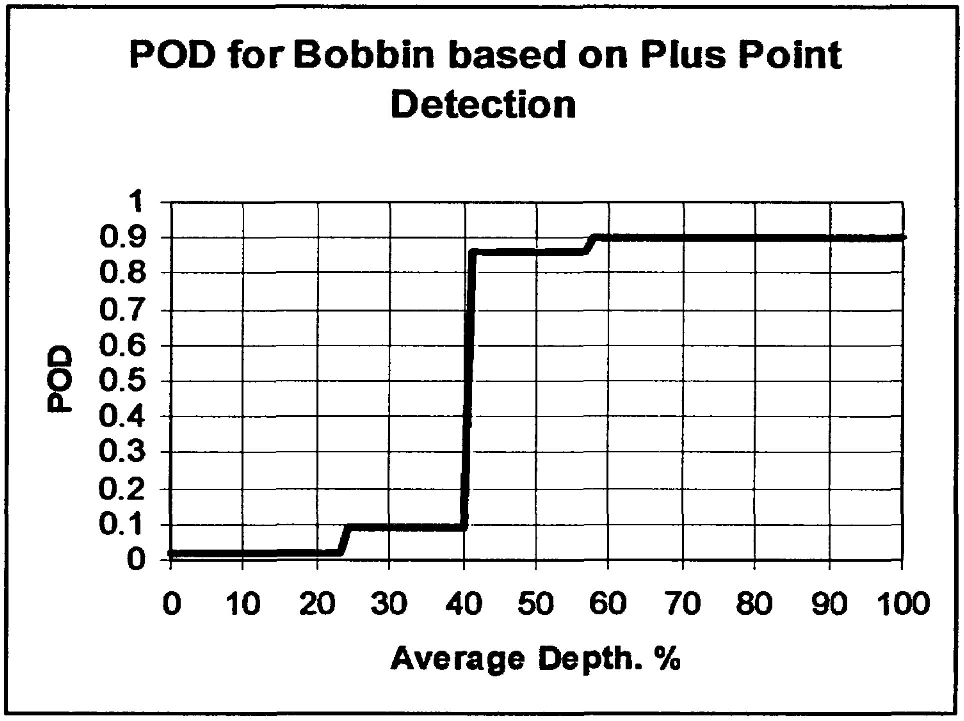


Figure 3


POD for Bobbin based on Plus Point Detection
POD
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
100
Average Depth. %