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2CAN050011

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

Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Additional Information in Support of Proposed License Change for Cycle 14
Risk-Informed Operation

Gentlemen:

On March 9, 2000 (2CAN030003), Entergy Operations submitted a proposed license change to allow risk-informed operation for the remainder of the 14th operational cycle for Arkansas Nuclear One, Unit 2 (ANO-2). Supplemental information in support of the proposed change was submitted on April 11, 2000 (2CAN040005) and April 28, 2000 (2CAN040006). Based on several interactions with the Staff concerning the proposed change, the following supplemental information is provided as attachments to this letter:

1. Nominal Mp Values for 2P99
2. Aptech Report AES 99033642-1-2, "Detection Probability for Axial Outside Diameter Stress Corrosion Cracking at Support Structures Determined Using a Supplemental Performance Demonstration," May 1999
3. 2R13 Look-Back Evaluation
4. Tube Pull Data

Attachments 1 and 3 represent attempts to develop revised input assumptions for risk calculations based on comments received from the Staff. The data included in these attachments are conservative representations developed for discussion purposes and are not to be considered representative of actual steam generator conditions. Development of appropriate input assumptions is continuing.

Should you have questions concerning the information provided, please contact me.

A001

Very truly yours,

Jimmy D. Vandergrift
Director, Nuclear Safety Assurance

JDV/jjd
attachments

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Attachment 1

Nominal Mp Values for 2P99

Subject: Mp Distribution for Staff - Discussions

Gentlemen,

This is to confirm the information we discussed this afternoon.

Per discussions with Steve Long this AM and early afternoon:

1. Omit the calculation of Mp for sub-crack lengths less than 0.25".

2. The table of Mp values should run from 1.0 (no crack) to 10.0 in increments of 0.10, i.e., 91 bins for the cumulative distribution function. Westinghouse already did increments of 0.1, but has to revise the number of indications so the results are not available.

Additional discussions later in the afternoon:

1. Four distribution cases will be generated. A condition monitoring evaluation and three operational assessment evaluations. An e-mail from Dan Meatheany at 3:54PM provided the interval designation, the operating temperature and the operating times, and the temperature adjusted operating times. The adjusted times are not used by the Westinghouse code, the growth distributions is adjusted instead.

2. An overall distribution and two maxima distributions will be provided a la the work performed for Farley last year. Basically, for each simulation of the SG the maximum value of mp falling in the very hot plume zone will be retained and the maximum value falling in the hot plume zone will be retained. The distribution of locations is as follows: 50% of the tubes are in the cold zone, 40% of the tubes are in the hot plume zone, and 10% of the tubes are in the very hot plume zone. Random draws from a uniform distribution are used to determine which zone each particular value of mp falls into. The following table illustrates the scheme, consider that the mp values for one simulation of a SG of 200 indications have been ordered in ascending order.

i	R(U)	Zone	Action
200	0.45	C	
199	0.65	H	Retain as maximum in the hot zone
198	0.75	H	
197	0.35	C	
196	0.91	VH	Retain as maximum in the very hot zone

The distribution of maximum values for the hot and very hot zones will be provided.

3. Data values will be transmitted in ASCII files suitable for reading in FORTRAN.

OUTAGE INTERVAL	ACTUAL EFPY	EFPY TEMP. Adjusted*	OPERATING TEMPERATURE
2R13 - 2P99	0.69	0.72	600 to 601.5
2P99 - June 2	0.51	0.53	601.5 to 603
2P99 - 2R14	0.80	0.83	601.5 to 603

* Based on 30 Kcal/mole

2R14 is currently scheduled for September 15th.

Arkansas Nuclear One Unit 2
Nominal Mp Values for 2P99 SG B Eggcrate Indications

	SG	ROW	TUBE	IND	%TW	LENGTH	LOCATION		AVG DEP	MAX DEP	RPC LEN	STRDEP	STR LEN	MP-ARGONNE	POD
1	B	8	134	SAI	91%	0.56	01H	+0.53	90.09	100	0.53	93.87	0.49	6.809	0.995
2	B	102	110	SAI	81%	1.55	02H	-0.20	82.66	99	1.28	84.80	1.16	4.728	0.995
3	B	72	72	SAI	83%	0.77	02H	+0.34	80.95	92	1.22	85.77	0.91	4.594	0.990
4	B	53	83	SAI	78%	0.64	01H	+0.01	78.23	98	0.74	83.23	0.59	3.327	0.994
5	B	102	98	SAI	69%	0.6	02H	+0.18	79.61	94	0.68	81.25	0.66	3.213	0.992
6	B	32	108	SAI	83%	0.68	01H	-0.58	57.71	98	2.02	84.90	0.41	2.935	0.994
7	B	5	153	SAI	98%	0.59	07H	+0.42	89.07	97	0.25	92.44	0.24	2.839	0.994
8	B	17	49	SAI	74%	0.77	06H	+0.15	74.39	87	0.73	76.86	0.68	2.783	0.984
9	B	32	108	SAI	80%	0.55	01H	-0.10	64.82	82.5	0.57	77.36	0.65	2.777	0.976
10	B	32	100	SAI	87%	0.52	01H	+0.28	73.49	97	0.42	89.51	0.27	2.753	0.994
11	B	1	51	SAI	70%	0.95	04H	+0.04	71.94	86	0.84	72.81	0.81	2.613	0.983
12	B	9	115	SAI	66%	0.78	01H	+0.42	70.92	96	0.72	77.89	0.45	2.493	0.993
13	B	26	40	SAI	64%	0.64	02H	+0.63	75.14	92	0.52	77.06	0.50	2.455	0.990
14	B	10	150	SAI	91%	0.59	03H	+0.37	78.14	97	0.4	81.88	0.36	2.401	0.994
15	B	23	55	SAI	62%	1.39	02H	-0.35	63.74	79	1.27	66.55	1.08	2.380	0.967
16	B	47	91	SAI	68%	0.91	01H	+0.33	67.57	79	0.71	68.63	0.68	2.227	0.967
17	B	28	36	SAI	69%	0.49	02H	+0.43	62.52	90	1.01	63.87	0.94	2.176	0.988
18	B	33	71	SAI	87%	0.69	01H	+0.23	70.58	82	0.49	72.40	0.48	2.150	0.975
19	B	36	36	SAI	67%	1.03	02H	-0.15	62.88	73	0.9	63.89	0.87	2.137	0.945
20	B	16	140	SAI	74%	0.72	03H	+0.46	66.39	76	0.64	68.12	0.61	2.129	0.958
21	B	36	116	SAI	66%	0.72	01H	+0.25	63.02	75	0.76	64.71	0.72	2.082	0.954
22	B	49	77	SAI	83%	0.39	01H	+0.73	85.14	97.5	0.21	90.39	0.19	2.068	0.994
23	B	58	106	SAI	88%	0.61	01H	+0.48	64.01	91	0.61	77.26	0.32	2.032	0.989
24	B	48	52	MAI	56%	0.66	01H	+0.63	72.17	84	0.43	73.01	0.41	2.031	0.979
25	B	32	46	SAI	69%	0.62	02H	+0.38	68.32	82	0.49	70.11	0.47	2.023	0.975
26	B	33	109	SAI	54%	0.81	01H	-0.45	61.34	68	0.74	63.83	0.67	2.004	0.915
27	B	32	108	SAI	71%	0.49	01H	+0.17	65.06	81	0.55	69.32	0.47	1.995	0.973
28	B	33	71	SAI	83%	0.42	01H	-0.12	64.38	91	0.6	66.07	0.56	1.993	0.989
29	B	106	90	SAI	58%	0.71	02H	+0.61	62.79	92	0.67	63.79	0.65	1.988	0.990
30	B	68	44	SAI	57%	0.98	03H	+0.03	56.22	85	0.78	70.77	0.43	1.987	0.981
31	B	4	156	SAI	60%	0.83	02H	-0.19	59.06	70	0.78	64.02	0.60	1.959	0.928
32	B	84	76	SAI	87%	0.49	01H	+0.43	72.09	91	0.37	74.65	0.35	1.955	0.989

Arkansas Nuclear One Unit 2
Nominal Mp Values for 2P99 SG B Eggcrate Indications

	SG	ROW	TUBE	IND	%TW	LENGTH	LOCATION		AVG DEP	MAX DEP	RPC LEN	STRDEP	STR LEN	MP-ARGONNE	POD
33	B	77	125	SAI	81%	0.82	02H	+0.34	62.31	89	0.59	71.12	0.39	1.917	0.987
34	B	7	61	SAI	80%	0.46	02H	+0.56	59.73	96	0.6	64.90	0.51	1.889	0.993
35	B	67	57	SAI	64%	0.43	01H	+0.73	75.65	85	0.3	78.00	0.29	1.887	0.981
36	B	9	115	SAI	61%	0.49	01H	-0.47	68.15	88	0.4	71.20	0.37	1.880	0.985
37	B	37	95	SAI	56%	0.99	01H	-0.48	56.73	72	0.84	57.72	0.82	1.874	0.940
38	B	47	93	SAI	71%	0.97	01H	-0.12	57.64	69.5	0.77	60.66	0.62	1.872	0.925
39	B	42	38	SAI	71%	0.39	01H	+0.09	80.03	92	0.26	81.69	0.24	1.854	0.990
40	B	48	96	SAI	56%	1.32	01H	+0.10	53.30	67	1.15	53.98	1.12	1.852	0.908
41	B	13	31	SAI	52%	0.85	02H	-0.48	56.73	90	0.76	58.22	0.73	1.845	0.988
42	B	9	127	SAI	63%	0.36	01H	-0.32	67.60	84	0.37	74.69	0.31	1.840	0.979
43	B	10	16	SAI	65%	0.94	02H	+0.35	55.83	74	0.83	57.30	0.76	1.835	0.949
44	B	63	123	SAI	97%	0.59	02H	+0.39	81.83	93	0.21	86.94	0.19	1.818	0.991
45	B	77	113	SAI	75%	0.56	01H	+0.45	60.17	79	0.54	67.68	0.37	1.798	0.967
46	B	95	45	SAI	94%	0.43	02H	+0.38	63.85	86	0.43	68.63	0.37	1.798	0.983
47	B	29	123	SAI	64%	0.84	04H	+0.49	69.31	77	0.35	71.30	0.33	1.796	0.961
48	B	12	106	SAI	46%	0.85	01H	-0.40	54.73	65	0.76	57.94	0.64	1.795	0.891
49	B	1	51	SAI	66%	0.62	03H	+0.26	56.91	69	0.68	56.94	0.66	1.773	0.922
50	B	16	118	SAI	55%	0.81	01H	+0.78	54.41	69	0.74	59.34	0.52	1.764	0.922
51	B	20	52	SAI	65%	0.51	01H	+0.45	62.59	79	0.44	64.38	0.42	1.753	0.967
52	B	60	44	SAI	66%	0.90	02H	+0.02	54.26	72	0.72	58.23	0.55	1.745	0.940
53	B	4	20	SAI	71%	0.71	01H	-0.52	59.06	68.5	0.55	59.05	0.54	1.740	0.919
54	B	28	44	SAI	67%	1.58	01H	+0.31	51.47	93	0.82	63.22	0.35	1.724	0.991
55	B	65	97	SAI	48%	0.58	02H	-0.51	55.51	69	0.58	60.65	0.45	1.711	0.922
56	B	52	36	SAI	52%	0.75	01H	+0.59	54.22	73	0.63	55.66	0.60	1.699	0.945
57	B	63	115	SAI	76%	0.64	01H	+0.11	66.35	78	0.34	69.04	0.32	1.697	0.964
58	B	77	83	SAI	31%	0.38	02H	-0.10	68.27	85	0.33	70.09	0.30	1.695	0.981
59	B	36	116	SAI	54%	0.78	01H	+0.65	54.60	67	0.61	55.51	0.59	1.689	0.908
60	B	47	93	SAI	52%	0.76	01H	-0.50	52.57	65	0.68	54.29	0.64	1.688	0.891
61	B	68	112	SAI	73%	0.69	02H	+0.01	58.36	69	0.46	60.19	0.44	1.669	0.922
62	B	8	148	SAI	72%	0.65	01H	+0.72	54.82	72	0.55	58.43	0.46	1.662	0.940
63	B	12	106	SAI	60%	0.78	01H	+0.47	51.75	63	0.65	57.72	0.47	1.659	0.872
64	B	75	89	SAI	76%	0.49	02H	+0.83	77.66	92	0.22	82.45	0.20	1.659	0.990

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Nominal Mp Values for 2P99 SG B Eggcrate Indications

	SG	ROW	TUBE	IND	%TW	LENGTH	LOCATION	AVG DEP	MAX DEP	RPC LEN	STRDEP	STR LEN	MP-ARGONNE	POD
65	B	60	108	SAI	52%	1.14	01H +0.27	52.86	62	0.64	52.94	0.62	1.646	0.861
66	B	12	62	SAI	53%	0.44	01H +0.48	51.19	69	0.67	54.58	0.49	1.640	0.922
67	B	60	108	SAI	66%	1.08	01H +0.71	57.33	67	0.45	59.44	0.42	1.636	0.908
68	B	65	125	SAI	75%	0.46	02H -0.65	63.46	72	0.34	66.04	0.32	1.626	0.940
69	B	11	143	SAI	91%	0.39	01H -0.08	79.25	86.5	0.2	83.03	0.19	1.623	0.983
70	B	10	150	MAI	83%	0.38	01H +0.35	75.57	85.5	0.24	76.06	0.23	1.619	0.982
71	B	11	13	SAI	71%	0.54	03H +0.01	65.54	82	0.28	74.72	0.24	1.618	0.975
72	B	38	110	MAI	54%	0.54	01H +0.51	51.90	70	0.57	53.15	0.55	1.605	0.928
73	B	13	55	SAI	69%	0.59	01H +0.27	51.43	68	0.57	61.31	0.32	1.600	0.915
74	B	48	52	MAI	69%	0.51	01H +0.79	59.18	71.5	0.38	61.46	0.36	1.593	0.937
75	B	104	116	SAI	71%	0.23	01H -0.50	68.75	83	0.26	73.98	0.23	1.582	0.977
76	B	16	140	SAI	37%	0.71	02H +0.68	52.12	61	0.52	54.04	0.49	1.582	0.850
77	B	4	156	SAI	64%	0.50	02H +0.76	65.18	82	0.3	67.19	0.29	1.581	0.975
78	B	38	144	SAI	92%	0.36	03H -0.59	72.77	85	0.23	77.33	0.21	1.577	0.981
79	B	11	155	SAI	91%	0.40	02H +0.75	60.39	79	0.35	63.87	0.31	1.573	0.967
80	B	4	28	SAI	60%	0.72	01H -0.74	51.26	64	0.52	52.88	0.49	1.562	0.882
81	B	67	119	SAI	99%	0.31	01H -0.11	79.31	93	0.18	85.23	0.16	1.559	0.991
82	B	106	90	SAI	65%	0.61	02H -0.44	67.85	91.5	0.26	72.22	0.24	1.557	0.989
83	B	42	38	SAI	59%	0.7	01H +0.65	51.38	72	0.51	55.21	0.40	1.550	0.940
84	B	84	112	SAI	51%	0.79	02H +0.51	58.54	71	0.36	59.55	0.35	1.543	0.934
85	B	75	85	SAI	65%	0.67	03H +0.68	57.52	69	0.37	60.89	0.32	1.541	0.922
86	B	40	116	SAI	56%	0.59	01H +0.70	53.50	65.5	0.44	55.09	0.40	1.536	0.896
87	B	92	102	SAI	72%	0.35	02H +0.64	68.08	81	0.25	72.49	0.23	1.535	0.973
88	B	36	116	SAI	49%	0.39	01H +0.87	61.93	81	0.3	65.42	0.27	1.525	0.973
89	B	65	119	SAI	20%	0.53	01H -0.62	45.86	68	0.68	50.03	0.49	1.525	0.915
90	B	115	65	SAI	67%	0.41	02H +0.39	54.06	66	0.4	56.51	0.37	1.518	0.900
91	B	10	150	MAI	72%	0.46	01H +0.71	55.20	69	0.38	57.21	0.36	1.514	0.922
92	B	14	112	SAI	57%	0.59	04H +0.59	47.13	67	0.56	50.30	0.49	1.512	0.908
93	B	23	143	SAI	58%	0.80	02H -0.04	42.15	64	0.85	43.26	0.81	1.508	0.882
94	B	67	111	SAI	70%	0.59	01H -0.39	56.96	73	0.35	58.36	0.34	1.505	0.945
95	B	35	33	SAI	49%	0.18	03H +0.36	80.71	99	0.17	83.58	0.16	1.504	0.995
96	B	12	56	SAI	78%	0.54	02H +0.80	56.10	89	0.36	57.71	0.34	1.504	0.987

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	SG	ROW	TUBE	IND	%TW	LENGTH	LOCATION		AVG DEP	MAX DEP	RPC LEN	STRDEP	STR LEN	MP-ARGONNE	POD
97	B	89	73	SAI	79%	0.67	02H	+0.17	52.38	74	0.42	53.81	0.40	1.502	0.949
98	B	32	148	SAI	88%	0.56	03H	+0.52	68.59	79	0.23	71.37	0.22	1.483	0.967
99	B	2	34	SAI	42%	0.94	02H	-0.45	60.78	86	0.29	63.20	0.27	1.483	0.983
100	B	28	36	SAI	61%	0.44	02H	-0.19	53.76	75	0.36	55.09	0.35	1.463	0.954
101	B	16	140	SAI	51%	0.23	03H	+0.31	57.05	69	0.32	61.25	0.27	1.461	0.922
102	B	75	91	SAI	53%	0.56	02H	+0.12	63.89	85	0.25	67.91	0.23	1.459	0.981
103	B	21	109	SAI	79%	0.52	01H	+0.67	66.42	78	0.23	70.63	0.21	1.452	0.964
104	B	52	82	SAI	35%	0.67	01H	+0.22	42.18	64	0.65	42.94	0.63	1.449	0.882
105	B	33	117	SAI	65%	0.42	05H	+0.54	46.95	58	0.47	48.98	0.43	1.449	0.811
106	B	45	89	SAI	56%	0.39	01H	+0.68	56.67	65	0.3	59.46	0.27	1.433	0.891
107	B	12	148	SAI	74%	0.53	02H	+0.16	54.98	78	0.31	57.80	0.29	1.425	0.964
108	B	104	116	SAI	79%	0.29	01H	+0.43	59.29	80	0.27	62.04	0.25	1.424	0.970
109	B	117	89	SAI	42%	0.42	01H	-0.44	52.58	62.5	0.33	55.10	0.31	1.416	0.867
110	B	24	24	SAI	44%	0.26	01H	+0.26	38.77	74.5	0.61	56.06	0.26	1.414	0.952
111	B	47	145	SAI	91%	0.41	02H	+0.55	61.02	88	0.25	66.32	0.21	1.414	0.985
112	B	49	19	SAI	41%	0.34	04H	+0.66	55.72	68.5	0.29	59.76	0.26	1.410	0.919
113	B	38	110	MAI	61%	0.89	01H	+0.72	44.81	73	0.45	47.03	0.41	1.407	0.945
114	B	53	109	SAI	50%	0.57	01H	-0.62	45.74	60	0.42	53.01	0.29	1.398	0.838
115	B	6	116	SAI	62%	0.55	01H	-0.12	42.64	56	0.51	48.05	0.33	1.392	0.782
116	B	119	65	SAI	85%	0.57	04H	+0.51	56.07	73	0.26	63.14	0.21	1.370	0.945
117	B	40	56	SAI	75%	0.39	03H	+0.49	61.88	74	0.22	67.62	0.19	1.368	0.949
118	B	31	49	SAI	47%	0.77	01H	+0.20	40.81	69	0.49	42.25	0.46	1.367	0.922
119	B	3	57	SAI	43%	0.59	01H	-0.74	40.06	68	0.52	40.63	0.51	1.366	0.915
120	B	7	119	SAI	46%	0.29	01H	-0.06	52.23	73	0.29	55.29	0.27	1.363	0.945
121	B	40	116	SAI	54%	0.46	01H	+0.54	57.66	84	0.24	70.11	0.16	1.358	0.979
122	B	83	109	SAI	46%	0.45	01H	-0.32	47.22	63	0.34	50.24	0.31	1.356	0.872
123	B	121	113	SAI	47%	0.25	01H	-0.62	45.24	73	0.35	73.00	0.26	1.353	0.945
124	B	31	125	SAI	56%	0.59	01H	-0.27	35.89	57	0.52	47.83	0.29	1.347	0.797
125	B	32	24	SAI	79%	0.28	01H	+0.41	58.84	68.5	0.23	61.23	0.22	1.347	0.919
126	B	89	51	SAI	57%	0.38	01H	+0.10	50.59	61.5	0.29	52.93	0.27	1.342	0.856
127	B	46	126	SAI	72%	0.44	01H	+0.57	49.03	62.5	0.3	51.88	0.27	1.336	0.867
128	B	102	98	SAI	44%	0.35	01H	+0.46	48.91	77	0.3	49.96	0.29	1.331	0.961

Arkansas Nuclear One Unit 2
Nominal Mp Values for 2P99 SG B Eggcrate Indications

	SG	ROW	TUBE	IND	%TW	LENGTH	LOCATION	AVG DEP	MAX DEP	RPC LEN	STRDEP	STR LEN	MP-ARGONNE	POD
129	B	83	109	SAI	51%	0.3	01H +0.77	45.98	65	0.33	47.83	0.31	1.329	0.891
130	B	24	136	SAI	83%	0.31	03H +0.28	60.43	83	0.21	65.34	0.19	1.329	0.977
131	B	39	111	SAI	90%	0.29	01H +0.79	48.30	75	0.29	56.25	0.23	1.327	0.954
132	B	18	126	SAI	60%	0.56	01H +0.73	40.18	52	0.42	41.66	0.40	1.323	0.712
133	B	23	143	SAI	28%	0.25	01H +0.81	34.03	47	0.64	38.17	0.46	1.321	0.610
134	B	45	69	SAI	73%	0.44	02H -0.30	50.45	60.5	0.27	55.41	0.23	1.318	0.844
135	B	86	118	SAI	6%	0.52	01H +0.39	38.84	60.5	0.44	39.91	0.42	1.316	0.844
136	B	34	52	SAI	53%	0.43	06H +0.51	41.01	55	0.38	47.61	0.27	1.308	0.765
137	B	58	106	SAI	59%	1.62	01H -0.40	43.07	64	0.65	41.65	0.37	1.307	0.882
138	B	84	112	SAI	60%	0.37	02H -0.62	59.16	98	0.2	73.86	0.14	1.292	0.994
139	B	44	72	SAI	87%	0.45	01H +0.05	53.64	95	0.22	65.44	0.16	1.284	0.992
140	B	20	132	SAI	72%	0.46	02H -0.07	44.10	51	0.3	45.63	0.28	1.281	0.693
141	B	6	138	MAI	25%	0.28	01H +0.65	43.40	53	0.3	45.11	0.28	1.275	0.731
142	B	9	125	SAI	52%	0.46	01H +0.43	50.99	61	0.23	54.08	0.21	1.269	0.850
143	B	7	113	SAI	90%	0.33	01H +0.62	65.75	92	0.16	73.44	0.13	1.267	0.990
144	B	27	127	SAI	48%	0.62	04H +0.65	33.29	50	0.46	41.62	0.29	1.267	0.673
145	B	75	45	SAI	56%	0.4	02H -0.40	52.71	61	0.21	56.56	0.19	1.255	0.850
146	B	4	150	SAI	51%	0.75	01H -0.44	28.90	56	0.62	32.55	0.46	1.254	0.782
147	B	12	30	SAI	62%	0.44	01H +0.53	44.94	52	0.26	47.35	0.24	1.251	0.712
148	B	55	95	SAI	51%	0.75	01H +0.11	35.66	60	0.38	36.56	0.36	1.250	0.838
149	B	5	3	SAI	45%	0.87	01H +0.65	43.34	52	0.28	45.02	0.25	1.250	0.712
150	B	1	137	SAI	60%	0.59	01H -0.35	33.71	61	0.41	45.57	0.20	1.245	0.850
151	B	26	144	SAI	43%	0.31	01H -0.39	46.27	58	0.24	49.46	0.21	1.240	0.811
152	B	6	140	SAI	72%	0.36	02H -0.49	42.86	57	0.25	45.03	0.23	1.224	0.797
153	B	3	141	SAI	25%	0.45	01H +0.33	42.42	56.5	0.25	47.63	0.21	1.222	0.789
154	B	52	82	SAI	44%	0.34	01H -0.10	31.62	56.5	0.43	33.89	0.35	1.220	0.789
155	B	61	115	SAI	25%	0.62	02H +0.59	33.79	45	0.35	35.08	0.32	1.217	0.565
156	B	42	142	SAI	34%	0.41	01H +0.54	49.59	61	0.2	52.04	0.19	1.217	0.850
157	B	42	78	SAI	84%	0.72	01H +0.80	56.03	68	0.17	61.06	0.15	1.214	0.915
158	B	8	128	SAI	17%	0.52	01H +0.80	41.54	65	0.25	43.03	0.24	1.213	0.891
159	B	6	136	SAI	90%	0.38	01H -0.39	48.81	64	0.2	50.84	0.19	1.211	0.882
160	B	27	127	SAI	46%	0.82	02H +0.67	22.58	34	0.67	25.33	0.55	1.200	0.321

Arkansas Nuclear One Unit 2
Nominal Mp Values for 2P99 SG B Eggcrate Indications

	SG	ROW	TUBE	IND	%TW	LENGTH	LOCATION	AVG DEP	MAX DEP	RPC LEN	STRDEP	STR LEN	MP-ARGONNE	POD
161	B	136	88	SAI	30%	0.44	01H +0.40	37.79	70	0.26	44.70	0.19	1.195	0.928
162	B	16	116	SAI	50%	0.65	05H +0.61	32.45	50.5	0.32	34.44	0.28	1.188	0.683
163	B	120	114	SAI	82%	0.28	03H +0.82	57.03	67	0.15	60.38	0.14	1.185	0.908
164	B	123	99	SAI	48%	0.59	01H -0.35	31.70	53	0.32	43.82	0.15	1.184	0.731
165	B	74	66	SAI	41%	0.65	01H +0.52	39.47	69	0.24	40.97	0.21	1.180	0.922
166	B	11	143	SAI	1%	0.33	01H +0.69	50.78	69	0.17	53.47	0.15	1.177	0.922
167	B	34	130	SAI	39%	0.48	02H +0.52	23.67	44	0.45	31.52	0.20	1.163	0.543
168	B	86	104	SAI	48%	0.42	01H -0.48	35.29	54	0.23	42.16	0.15	1.154	0.749
169	B	7	119	SAI	64%	0.29	01H +0.20	48.16	67	0.16	53.77	0.13	1.154	0.908
170	B	104	100	SAI	83%	0.85	02H +0.37	66.75	81.5	0.11	74.20	0.10	1.152	0.974
171	B	10	148	SAI	31%	0.33	01H +0.80	46.19	56	0.16	50.18	0.14	1.145	0.782
172	B	38	114	SAI	71%	0.42	02H +0.23	47.70	63	0.15	51.33	0.14	1.139	0.872
173	B	13	57	SAI	50%	0.39	01H +0.78	40.11	58	0.18	44.18	0.15	1.138	0.811
174	B	92	100	SAI	72%	0.68	02H +0.58	48.80	67	0.14	51.47	0.13	1.130	0.908
175	B	66	28	SAI	59%	0.36	02H -0.65	50.50	66	0.13	53.56	0.12	1.123	0.900
176	B	62	36	SAI	74%	0.59	03H +0.74	17.96	61	0.45	21.33	0.33	1.117	0.850
177	B	9	127	SAI	51%	0.39	01H +0.95	24.13	33	0.26	25.49	0.24	1.107	0.301
178	B	6	138	MAI	6%	0.40	01H +0.73	28.68	41.5	0.21	30.91	0.19	1.106	0.485
179	B	23	143	SAI	94%	0.27	01H -0.32	30.46	52.5	0.19	31.67	0.17	1.096	0.722
180	B	5	21	SAI	69%	0.43	03H +0.02	56.10	72	0.1	61.87	0.09	1.096	0.940
181	B	4	150	SAI	86%	0.43	01H +0.82	45.95	66	0.1	50.53	0.09	1.071	0.900
182	B	11	135	SAI	4%	0.33	03H -0.24	33.88	47	0.13	36.82	0.12	1.070	0.610
183	B	84	116	SAI	52%	0.82	02H +0.58	33.46	56.5	0.12	41.80	0.09	1.061	0.789
184	B	57	83	SAI	72%	0.49	01H +0.40	35.93	53	0.1	38.13	0.09	1.051	0.731
185	B	53	109	SAI	37%	0.15	01H +0.11	24.88	47	0.13	32.07	0.09	1.047	0.610

Attachment 2

Aptech Report AES 99033642-1-2

AES 99033642-1-2
May 1999

Detection Probability for Axial Outside Diameter Stress Corrosion Cracking at Support Structures Determined Using a Supplemental Performance Demonstration

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Appendix A — Entergy ANO Unit 2 Bobbin Coil ETSS A-1

Section 1
INTRODUCTION

The objective of this program was to determine bobbin coil probability of detection (POD) for axial stress-corrosion cracking at support structures using a supplemental performance demonstration (SPD). The resulting POD is to be used for determining Arkansas Nuclear One (ANO) Unit 2 operating interval. Pulled tube data with known maximum percent through-wall (TW) depths were used to construct grading units. Entergy ANO Unit 2 2R13 eddy current analysis guidelines were used for data analysis. Five teams of primary and secondary production and resolution analysts - a total of 20 analysts - participated.

Section 2 describes factors that were considered in designing and assembling the grading units that were used for the SPD. In addition, data analyst training and testing activities remotely conducted at ANATEC and Duke Engineering & Services facilities in San Clemente, California, and Charlotte, North Carolina, respectively, are described.

Detection probability calculations for axial outer diameter stress corrosion cracking (ODSCC) at support structures are presented in Section 3. Results are given for five analysis teams consisting of primary, secondary, and resolution analysts. Human factor effects on bobbin coil POD are illustrated and compared with the technique limit, which is the best one can achieve. The result obtained using rotating probe technology (pancake coil) is also provided for comparison.

Section 4 concludes with a discussion of significant observations and provides recommendations for future consideration.

Section 2
SUPPLEMENTAL PERFORMANCE DEMONSTRATION

2.1 DESIGN CONSIDERATIONS

Implementation of a realistic SPD requires consideration of many factors. Since the results of the SPD will be used to establish POD with percent through-wall as the independent variable, metallographic grading units must be selected which adequately span the depth spectrum of interest. From an eddy current analysis perspective, analysis conditions as reflected by the presence of extraneous test variables, must be closely duplicated. For the case of axial ODSCC at non-dented eggcrates, the bobbin coil mix channel residual and the presence of deposits can strongly effect detection.

2.1.1 ABB/CE Pulled Tube Data

Table 2-1 provides a listing of tubes removed from ABB/CE steam generators for axial cracking at support structures. Five metallographic grading units are available from ANO Unit 2 steam generators, with seven grading units available from other ABB/CE plants. Figure 2-1 shows a histogram of the total ABB/CE pulled tube population for axial ODSCC at support structures. It is clear that the limited pulled tube data must be supplemented with additional data to adequately cover the depth spectrum.

2.1.2 ANO Unit 2 ODSCC Indications at Eggcrates

Figure 2-2 shows a histogram of bobbin coil voltages (P1 mix channel normalized to 2.75 volts using 20% flat-bottom holes) for eddy current indications at non-dented eggcrates diagnosed as axial ODSCC from Unit 2 2R13 and earlier outages. Essentially all of the larger amplitude

indications have been removed from service leaving a population of smaller amplitude signals with a mean of 0.38 volts.

An impedance plane presentation of phasor voltage and phase angle for Unit 2 2R13 eddy current data is shown in Figure 2-3. Phasor voltage measurements for ABB/CE pulled tube data points are overlaid for comparison.

2.2 ENTERGY SPD GRADING UNITS DESCRIPTION

2.2.1 Detection Probability Data Set

2.2.1.1 Metallographic Perspective

The ABB/CE metallographic grading units shown in Figure 2-1 were pooled with grading units from a Westinghouse plant pulled tube database to give a depth distribution shown in Figure 2-4. The Westinghouse database consists of tubes with axial ODSCC at drilled support plates with eddy current analysis conditions that duplicate conditions for ODSCC at eggcrates in ABB/CE units. Distribution endpoints are represented with a number of grading units at 0% and 100% through-wall with intermediate depths represented in a somewhat uniform manner. The independent variable endpoint data are important in that they provide clamping effects for POD curve fitting. A total of ninety-two metallographic grading units were assembled for the Entergy SPD. These are listed in Table 2-2. Grading unit identification, maximum metallographic depth in percent through-wall, and bobbin coil eddy current signal amplitude are provided. All signal amplitudes were measured using a common voltage normalization for direct comparison.

2.2.1.2 Eddy Current Perspective

Phasor voltage measurements for the entire set of Entergy SPD grading units are shown in Figure 2-5. Signal amplitudes vary over a 10:1 dynamic range with phase angles somewhat uniformly distributed across the impedance plane.

2.2.2 ANO Unit 2 Data Set

An additional data set consisting solely of grading units from ANO Unit 2 was also created. These data consisted of tubes with indications at eggcrates that had either been pulled, in-situ pressure tested, or confirmed using rotating probe technology. Table 2-3 provides a listing of these forty grading units.

2.3 ENTERGY SPD OVERVIEW

A total of three days were allocated for the Entergy SPD. Two days were dedicated to analyst training and testing for the ABB/CE data sets while the third day was utilized for the W data set training and testing.

2.3.1 Analyst Training

Data analyst training was conducted at ANATEC facilities in San Clemente, California, and Duke Engineering & Services facilities in Charlotte, North Carolina, by remote video. Twenty analysts from ANATEC, Verner and James, and Duke Engineering & Services participated. Five analysis teams, consisting of primary and secondary production and resolution analysts, were formed. Team assignment and role as a production or resolution analyst was left to the discretion of the participants. Team membership is listed in Table 2-4.

Training activities consisted of both lecture and laboratory sessions. Entergy personnel conducted the lecture session providing an overview of the Unit 2 analysis guidelines and the examination technique specification sheet (ETSS) that was to be used for analysis. A copy of the ETSS is provided in Appendix A. Special instruction six on page 4 of the ETSS provides specific guidance on the analysis of indications at support structures. Calibration groups from the 2R13 SPD were used during the laboratory session to provided analysts examples of analyzed indications. An important aspect of the training program was to duplicate the training given prior to the 2R13 outage. This was achieved by using the same training material, and having the individual that conducted the 2R13 training lead the SPD training.

2.3.2 Analyst Testing

All training material was turned in prior to analyzing the SPD test data sets with the exception of the ETSS, which would normally be available during an outage. Primary and secondary analyses were conducted independently with no inter-team communications. Resolution analysts were instructed to disposition reported discrepancies rather than conduct a wholesale data review. No revisiting of completed tubes was permitted.

Table 2-5 provides a listing of the calibration groups that were analyzed during the testing phase of the SPD. Tubes of interest were dispersed within a relatively large amount of placebo data to simulate field analysis pressures. A total of approximately 139 tubes were analyzed distributed within 59 calibration groups. A large number of nondegraded support structures were present with an average ratio of 12:1 between nondegraded and degraded/defective intersections.

Primary and secondary analysis reports were compared using the Eddynet Compare program with comparison parameters established by Entergy personnel. Tubes with analysis discrepancies were then passed to primary and secondary resolution analysts for resolution and preparation of the final report. Primary, secondary, and resolution analyst reports were thus available for each calibration group for individual performance assessment.

Table 2-1

ABB/CE PULLED TUBES WTH ODSCC
AT SUPPORT STRUCTURES

Plant	Tube	Location	Structure	Depth,%TW
ANO 2	R19L55	02H	Eggcrate	49
		01H	Eggcrate	56
	R96L116	02H	Eggcrate	59
	R16L56	01H	Eggcrate	100
	R70L98	01H	Eggcrate	100
Palo Verde 2	R127L140	08H	Eggcrate	89
		07H	Eggcrate	100
	R22L13	01H	Plate	56
	R29L24	01H	Plate	40
St. Lucie 2	R59L95	02H	Eggcrate	13
		01H	Eggcrate	52
	R120L12	03H	Eggcrate	72

Table 2-2

ENTERGY SPD DETECTION PROBABILITY GRADING UNITS
CONSISTING OF POOLED ABB/CE AND W DATA

Grading Unit	Depth, %TW	Voltage	Grading Unit	Depth, %TW	Voltage	Grading Unit	Depth,% TW	Voltage	Grading Unit	Depth, %TW	Voltage
1	56	0.29	24	54	0.59	47	55	0.29	70	100	5.51
2	49	0.39	25	56	0.75	48	62	0.98	71	53	0.17
3	59	0.57	26	53	1.7	49	49	0.6	72	45	0.16
4	100	3.14	27	35	0.45	50	69	0.75	73	0	0
5	100	1.46	28	41	0.71	51	49	0.93	74	100	6.28
6	89	0.89	29	47	1.55	52	76	2.62	75	38	0.35
7	56	1.47	30	60	1.9	53	58	2.38	76	26	0.29
8	40	0.41	31	34	0.19	54	56	0.91	77	96	2.36
9	72	2.96	32	26	0.11	55	96	3.23	78	65	0.92
10	52	0.59	33	30	0.35	56	72	1.39	79	77	0.4
11	68	2.31	34	21	0.04	57	52	0.28	80	79	1.74
12	52	0.59	35	21	0.62	58	98	1.37	81	98	0.95
13	20	0.28	36	13	0	59	83	0.68	82	88	1.06
14	52	1.11	37	30	0.4	60	68	0.99	83	100	4.08
15	20	0.31	38	30	0.59	61	97	1.82	84	82	1.31
16	20	0.14	39	100	14.14	62	64	0.66	85	90	0.34
17	47	0.32	40	29	2.11	63	0	0	86	87	1.19
18	22	0.47	41	29	1.37	64	100	3.72	87	90	1.15
19	52	0.96	42	18	1.15	65	100	2.89	88	62	0.65
20	36	0.68	43	24	1.41	66	100	1.56	89	42	0
21	34	0.25	44	21	0.58	67	42	0.57	90	72	0.29
22	65	0.66	45	91	1.8	68	0	0	91	0	0
23	61	0.3	46	65	0.59	69	100	6.48	92	0	0

Table 2-3

ANO UNIT 2 GRADING UNITS

Grading Unit	State	Tube	Location	%TW	Year
1	**Pulled Tubes**	19-55	2H	49	1992
2	"		1H	56	1992
3	"	96-116	2H	59	1992
4	"	16-56	1H	100	1996
5	**Insitu**	8-116	1H	100	1995
6	**Pressure Test**	16-60	1H	Not known	1996
7	" (burst)	82-118	1H	"	1997
8	"	9-117	1H	"	1997
9	"	11-129	1H	"	1997
10	"	34-70	1H	"	1997
11	" (burst)	37-67	1H	"	1997
12	"	23-65	2H	"	1997
13	"	60-88	1H	"	1998
14	"	74-98	1H	"	1998
15	"	48-70	1H	"	1998
16	"	3-147	2H	"	1998
17	"	14-136	1H	"	1998
18	"	33-73	2H	"	1999
19	"	63-77	3H	"	1999
20	" (burst?)	85-67	1H	"	1999
21	**2R13 RPC**	63-117	1H	"	1999
22	**Confirmed**	17-19	1H	"	1999
23	"	34-26	1H	"	1999
24	"	109-109	1H	"	1999
25	"	6-122	1H	"	1999
26	"	9-113	2H	"	1999
27	"	24-108	2H	"	1999
28	"	26-26	2H	"	1999
29	"	85-67	1H	"	1999
30	"	136-70	2H	"	1999
31	"	111-45	2H	"	1999
32	"	106-92	2H	"	1999
33	"	80-88	2H	"	1999
34	"	79-83	2H	"	1999
35	"	4-36	3H	"	1999
36	"	1-39	2H	"	1999
37	"	63-77	3H	"	1999
38	"	4-148	1H	"	1999
39	"	63-81	1H	"	1999
40	"	33-73	2H	"	1999

Table 2-4

ENTERGY SUPPLEMENTAL PERFORMANCE DEMONSTRATION
ANALYSIS TEAMS

	Team 1	Team 2	Team 3	Team 4	Team 5
ANATEC					
Production	Secondary	Secondary	Secondary	Secondary	Secondary
Resolution	Secondary	Secondary	Secondary	Secondary	Secondary
Verner & James					
Production	Primary	Primary	Primary	Primary	Primary
Duke Engineering & Services					
Resolution	Primary	Primary	Primary	Primary	Primary

Table 2-5

ENTERGY SUPPLEMENTAL PERFORMANCE DEMONSTRATION
CALIBRATION GROUP SUMMARY

Data Set	Number of Cal groups	Number of Tubes	Number of Grading Units	Total Number of Support Structures	~ Ratio
POD	22	41	85	574	6:1
ANO Unit 2	37	98	40	882	21:1
Total	59	139	125	1456	12:1

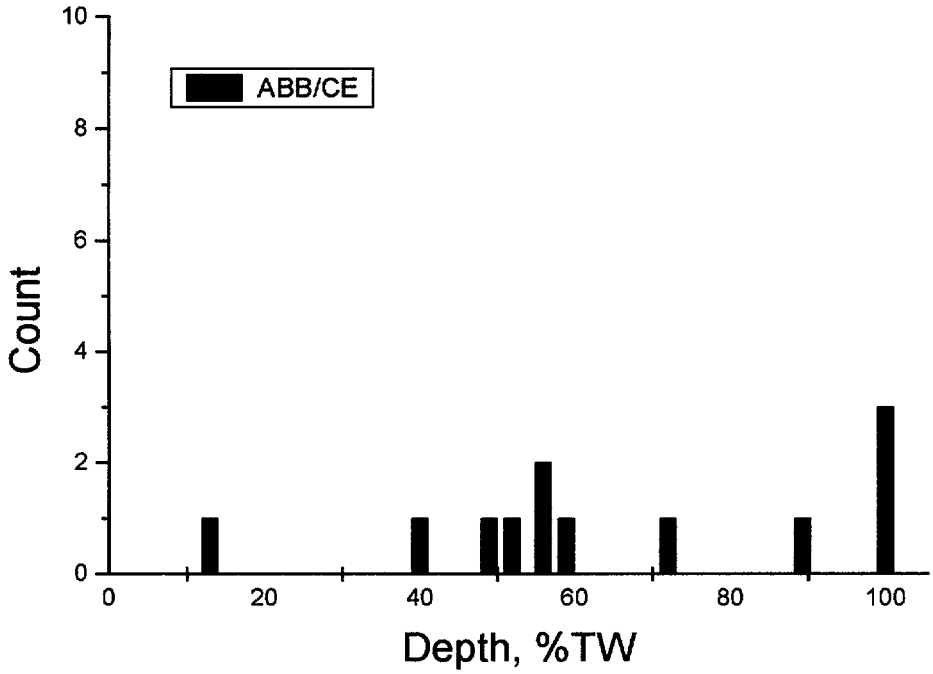


Figure 2-1 — ABB/CE Pulled Tube Data Metallographic Grading Units

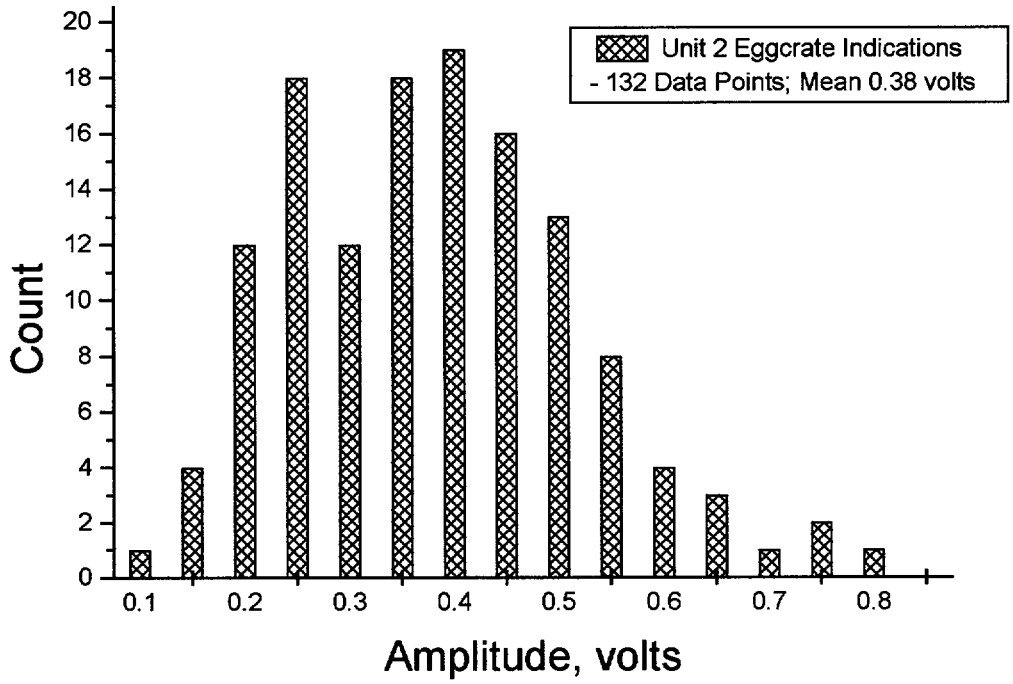


Figure 2-2 — Voltage Distribution for ANO Unit 2 Eggcrate Indications

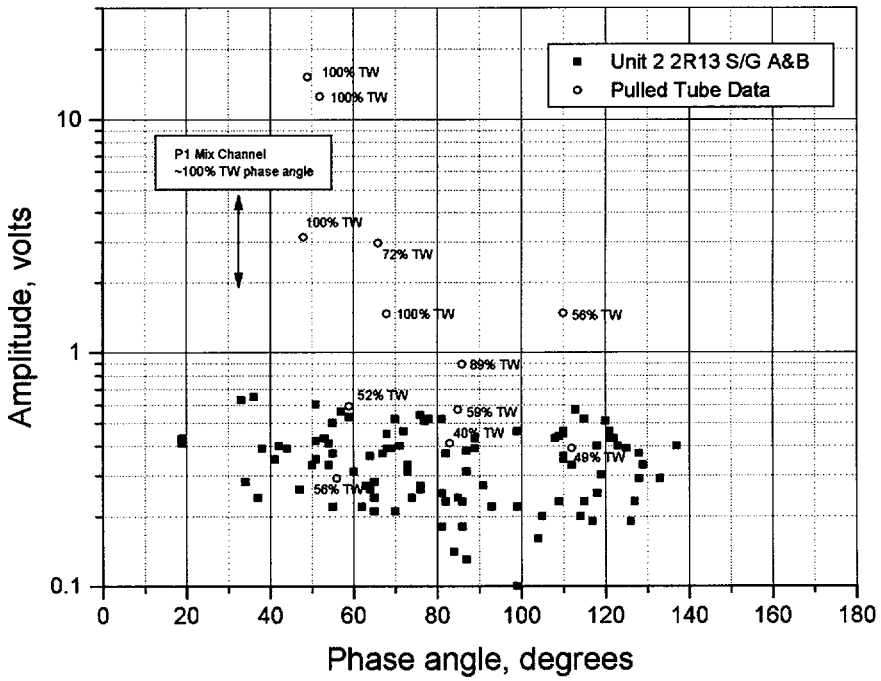


Figure 2-3 — 2R13 Unit 2 Data Compared with ABB/CE Pulled Tube Data

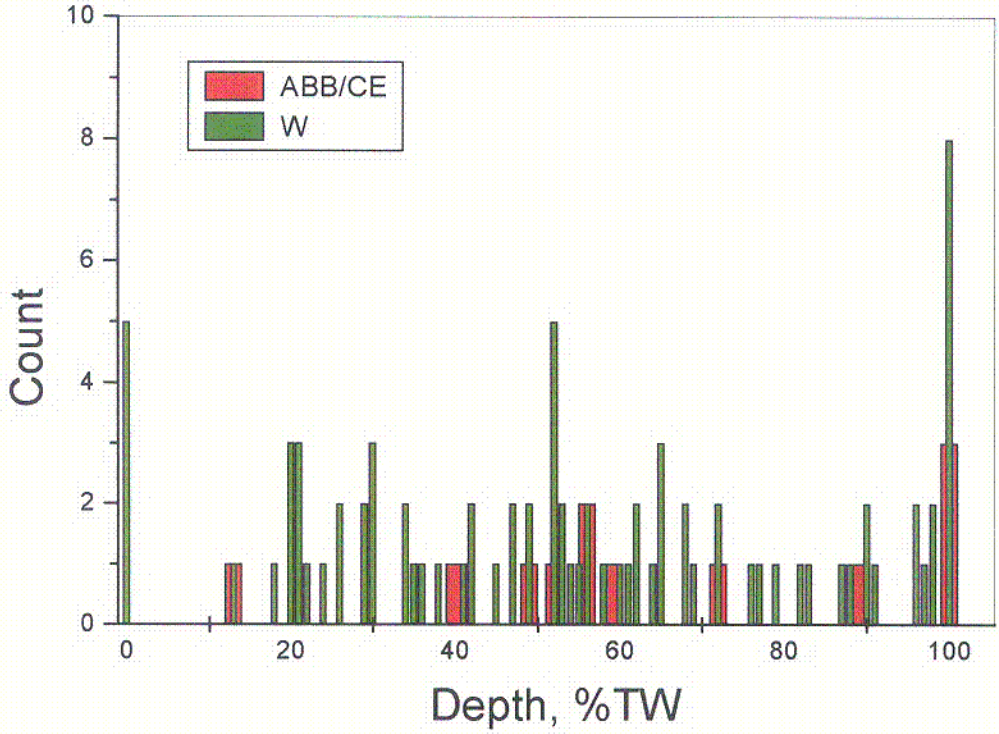


Figure 2-4 — SSPD Metallographic Grading Units Depth Distribution

C1

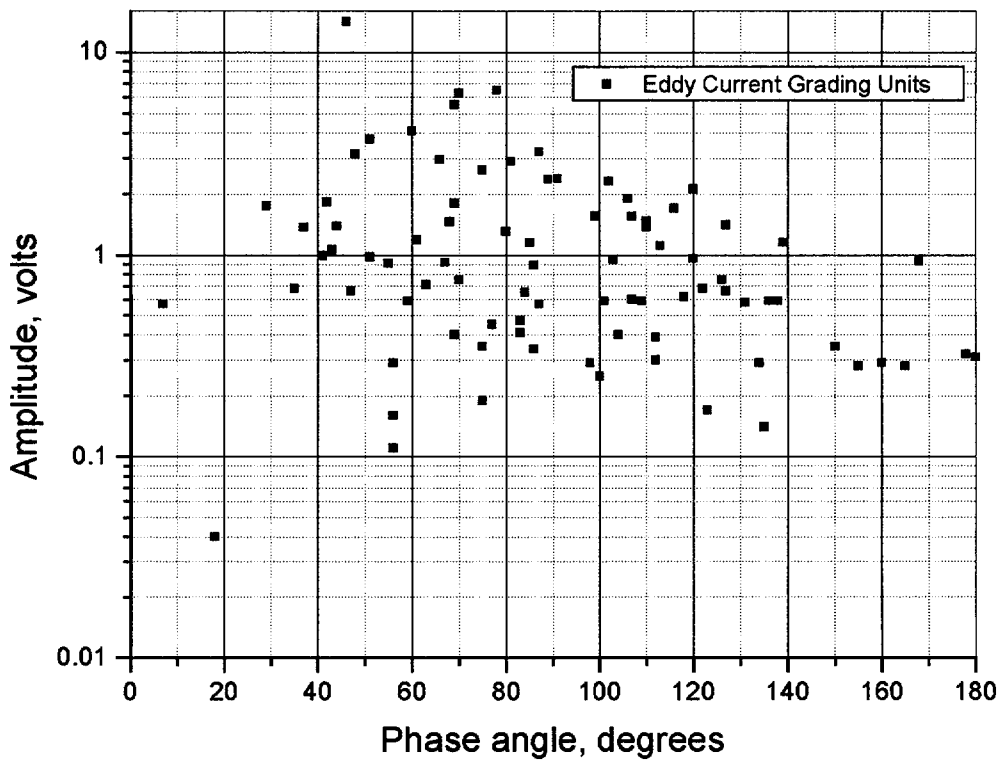


Figure 2-5 — SSPD Eddy Current Grading Units – Phasor Voltage Measurements

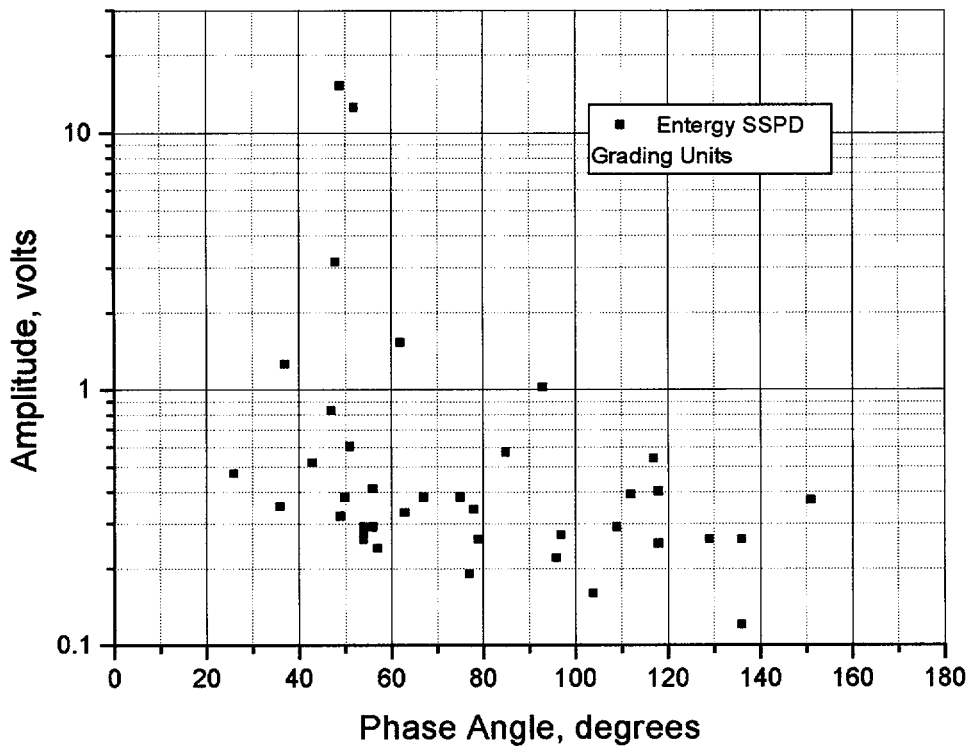


Figure 2-6 — ANO Unit 2 Grading Units – Phasor Voltage Measurements

Section 3
DETECTION PROBABILITY CALCULATIONS

3.1 PERCENT THROUGH-WALL DETECTION PROBABILITY

Table 2-2 provided a listing of grading units that form the basis for calculating POD. A total of 92 grading units are represented. For various reasons, not all teams analyzed all grading units. Grading Units 63 through 78 were not analyzed by Teams 1, 2, and 3; however, Teams 4 and 5 did analyze these data. All teams did analyze the remaining grading units for a total of 76 data points. To account for the disparity in data set analysis, three major categories were created:

- Case A consists of analysis teams that analyzed common grading units with no consideration to signal voltage. For this case, Grading Units 63 through 78 are excluded since these units were only examined by Teams 4 and 5.
- Case B consists of analysis teams that analyzed all 92 grading units, again with no consideration to signal voltage. Only Teams 4 and 5 accomplished this.
- Case C is a synthetic data set in which Team 4 analysis results for grading units 63 through 78 were pooled with those of Teams 1, 2, and 3 to achieve a complete data set for all five teams.

For each of the three major cases, Subcategories A′, B′, and C′ were also created. These cases are simply subsets in which grading units with larger voltages were excluded for probability of detection (POD) calculation. Table 3-1 provides a listing of the various categories and the conditions that describe them. In general, conservatism in the resulting POD calculation increases from Case A through Case C' with the latter being the most conservative.

The analyst hit-miss scatter plot data were fitted using logistic regression. Log-logistic and Beta function fits were also considered but the standard logistic fit was deemed most appropriate. A log-logistic fit is normally used when independent variable endpoint data are absent; this artificially constrains the POD curve at a value of 0 and distorts the curve at 100% TW. For the Entergy POD data set, numerous data points were available at the extremes of the independent variable. A Beta function fit to the scatter plot data acts like a low-pass filter converging to 0 and 1 at the independent variable endpoints (normalized values) with essentially a straight line in between. Tables 3-2 through 3-4 provide listings of the slope and intercept coefficients (logistic fit) for primary, secondary, and resolution analysts for the various cases that were analyzed.

Figure 3-1 shows a plot of signal amplitude versus maximum depth for the smaller amplitude eddy current grading units that were used for calculating POD. Grading units with amplitudes of less than 1 volt for intermediate depths less than ~ 80% through-wall were excluded. A histogram for grading units with signal amplitudes less than 1 volt used in calculating POD is shown in Figure 3-2. This may be compared with the data from ANO Unit 2 shown in Figure 2-2. Finally, Figure 3-3 shows phasor voltage measurements for the smaller voltage data set.

Grading Units 63 through 78, which were only analyzed by Teams 4 and 5, are from tubes removed from Commonwealth Edison plants, Byron 1 and Braidwood 1. Metallographic data for these tubes are shown in Figure 3-4, while Figure 3-5 summarizes the corresponding relationship between eddy current signal amplitude and maximum depth. These grading units are important in that independent variable endpoints are represented, and smaller amplitude voltages are available at intermediate depths.

3.1.1 Cases A and A′

Resolution analyst bobbin coil POD curves for all five teams are shown in Figure 3-6. The upper graphic shows results for all voltages, while the lower graphic shows results for which grading units with larger voltages are excluded. For comparison, a technique limit POD curve is also provided, along with a POD curve using pancake coil technology. The technique limit curve is the best one can achieve using a bobbin coil and assumes a perfect observer (i.e., all reportable

indications are reported). The pancake coil curve illustrates the achievable POD, assuming that rotating probe technology is used to resolve resolution analyst disputes. In other words, bobbin coil primary and secondary analysis result discrepancies are resolved using a supplemental diagnostic technique rather than the opinion of a resolution analyst.

Detection probability results presented in the lower graphic represent degradation in performance because of the exclusion of larger amplitude signals, which contribute to the better POD shown in the upper graphic.

3.1.2 Cases B and B′

Bobbin coil POD curves for Team 3 and Team 4 resolution analysts are shown in Figure 3-7. The upper graphic shows results for all voltages while the lower graphic shows results for which grading units with larger voltages are excluded. For comparison, a technique limit POD curve is also provided, along with a POD curve using pancake coil technology.

Detection probability results presented in the lower graphic represent degradation in performance because of the exclusion of larger amplitude signals, which contribute to the better POD shown in the upper graphic.

3.1.3 Case C′

Case C′ bobbin coil POD curves for all resolution analyst teams are shown in Figure 3-8. Case C results are not presented since they are less conservative. As with previous figures, the graphic shows results for which grading units with larger voltages are excluded. For comparison, a technique limit POD curve is also provided, along with a POD curve using pancake coil technology.

Case C′ results are the most conservative of all cases considered and are the results used for ANO Unit 2 runtime analyses.

3.2 VOLTAGE DETECTION PROBABILITY

ANO Unit 2 grading units listed in Table 2-3 were used to calculate POD with signal amplitude or voltage as the independent variable. In this case, a log-logistic equation was used to fit the data. Table 3-5 provides a listing of slope and intercept coefficients for all teams.

Figure 3-9 shows an overall summary of team performance for the 40 grading units. The fraction reported by primary, secondary, and resolution analysts is presented. Since all of these grading units were confirmed using rotating probe pancake coil technology, a 100% confirmation rate for each team is shown for comparison. Production analyst reporting performance (primary or secondary) ranges from 52% to 100%. For three of the teams (Teams 1, 2, and 5) resolution analyst performance actually degraded overall system performance.

Figure 3-10 shows an example of primary, secondary, and resolution analyst performance for Team 1 and resolution team performance for all five teams. Team 1 resolution analyst performance shown in the upper graphic tends to balance primary and secondary analysis results although the resolution process degrades performance. Overall team performance shown in the lower graphic is somewhat consistent for four of the five teams. Reso3 performance is lower, as reflected by the POD curve still approaching unity at a signal amplitude of 5 volts.

Voltage detection probability for grading units used to establish POD as a function of percent through-wall was also calculated. Figures 3-11 and 3-12 show a comparison for Teams 4 and 5. Resolution POD curves for both teams show comparable results.

Table 3-1

GRADING UNIT SUBSETS USED FOR POD CALCULATIONS

Case	Conservatism	Analysis Teams	Signal Amplitudes	Excluded Grading Units	Data Pooling	Total Grading Units
A	Least	All teams	All voltages	Note 1	None	76
A′	Intermediate	All teams	Smaller voltages (Subset of Case A)	Note 1	None	61
B	Intermediate	Teams 3 & 4	All voltages	None	None	92
B′	Intermediate	Teams 3 & 4	Smaller voltages (Subset of Case B)	Note 2	None	77
C	Intermediate	All teams	All voltages	None	Note 3	92
C′	Most	All Teams	Smaller voltages (Subset of Case C)	Note 2	Note 3	77

Notes:

(1) Grading Units 63 through 78

(2) Larger voltage signals at intermediate depths; grading units 7, 11, 26, 29, 30, 40, 41, 42, 43, and 80

(3) Team 4 analysis results for Grading Units 63 through 78 were pooled with results for Teams 1, 2, and 3 to form a complete data set

Table 3-2

PRIMARY ANALYST LOGISTIC REGRESSION COEFFICIENTS FOR VARIOUS CASES

Case	Team	"a" Coefficient	"b" Coefficient
A	Primary 1	1.524	0.060
	Primary 2	2.067	0.080
	Primary 3	2.234	0.063
	Primary 4	2.441	0.067
	Primary 5	2.391	0.079
A′	Primary 1	2.075	0.063
	Primary 2	2.732	0.087
	Primary 3	3.222	0.073
	Primary 4	3.106	0.073
	Primary 5	3.295	0.090
B	Primary 4	2.760	0.073
	Primary 5	2.632	0.079
B′	Primary 4	3.411	0.079
	Primary 5	3.506	0.089
C′	Primary 1	2.634	0.069
	Primary 2	3.107	0.085
	Primary 3	3.792	0.080
	Primary 4	3.411	0.079
	Primary 5	3.506	0.089

Table 3-3

SECONDARY ANALYST LOGISTIC REGRESSION COEFFICIENTS FOR VARIOUS CASES

Case	Team	"a" Coefficient	"b" Coefficient
A	Secondary 1	3.190	0.076
	Secondary 2	2.004	0.075
	Secondary 3	1.030	0.021
	Secondary 4	2.391	0.071
	Secondary 5	2.117	0.086
A′	Secondary 1	5.321	0.105
	Secondary 2	2.676	0.081
	Secondary 3	1.532	0.026
	Secondary 4	3.457	0.087
	Secondary 5	2.767	0.092
B	Secondary 4	2.828	0.075
	Secondary 5	2.385	0.080
B′	Secondary 4	3.957	0.091
	Secondary 5	3.068	0.087
C′	Secondary 1	5.987	0.114
	Secondary 2	3.113	0.082
	Secondary 3	2.227	0.038
	Secondary 4	3.957	0.091
	Secondary 5	3.068	0.087

Table 3-4

RESOLUTION ANALYST LOGISTIC REGRESSION COEFFICIENTS FOR VARIOUS CASES

Case	Team	"a" Coefficient	"b" Coefficient
A	Resolution 1	2.312	0.071
	Resolution 2	2.439	0.084
	Resolution 3	2.417	0.071
	Resolution 4	2.441	0.077
	Resolution 5	2.333	0.088
A′	Resolution 1	3.188	0.084
	Resolution 2	3.333	0.094
	Resolution 3	3.443	0.083
	Resolution 4	3.409	0.089
	Resolution 5	3.100	0.097
B	Resolution 4	2.827	0.079
	Resolution 5	2.589	0.083
B′	Resolution 4	3.877	0.092
	Resolution 5	3.391	0.092
C′	Resolution 1	3.675	0.087
	Resolution 2	3.712	0.094
	Resolution 3	3.972	0.089
	Resolution 4	3.877	0.092
	Resolution 5	3.391	0.092

Table 3-5

VOLTAGE POD LOG LOGISTIC
REGRESSION COEFFICIENTS

Team	Analyst	"a" Coefficient	"b" Coefficient
1	Primary	3.302	2.936
	Secondary	1.978	3.96
	Resolution	2.815	2.803
2	Primary	23.676	3.664×10^{-8}
	Secondary	2.2	3.371
	Resolution	3.043	2.867
3	Primary	1.961	2.051
	Secondary	2.502	2.186
	Resolution	2.076	0.876
4	Primary	1.599	2.377
	Secondary	3.828	6.889
	Resolution	2.526	3.482
5	Primary	4.526	6.327
	Secondary	1.191	2.766
	Resolution	2.077	2.854

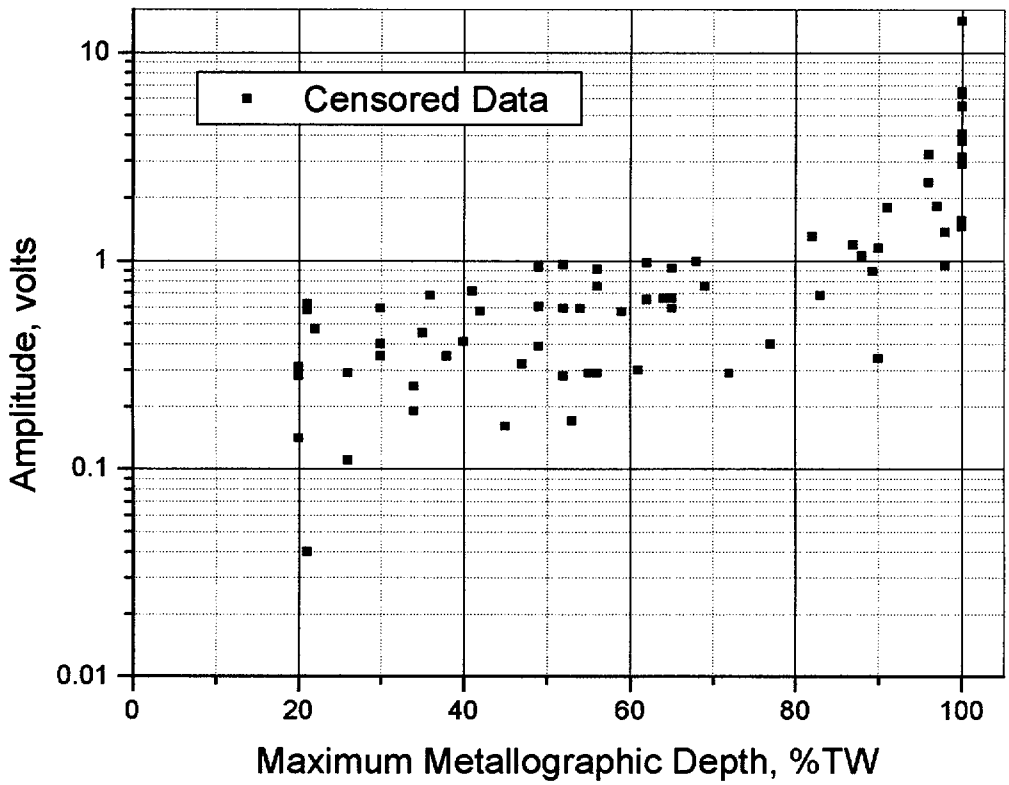


Figure 3-1 — Eddy Current Grading Units - Signal amplitude versus depth (Censored Data)

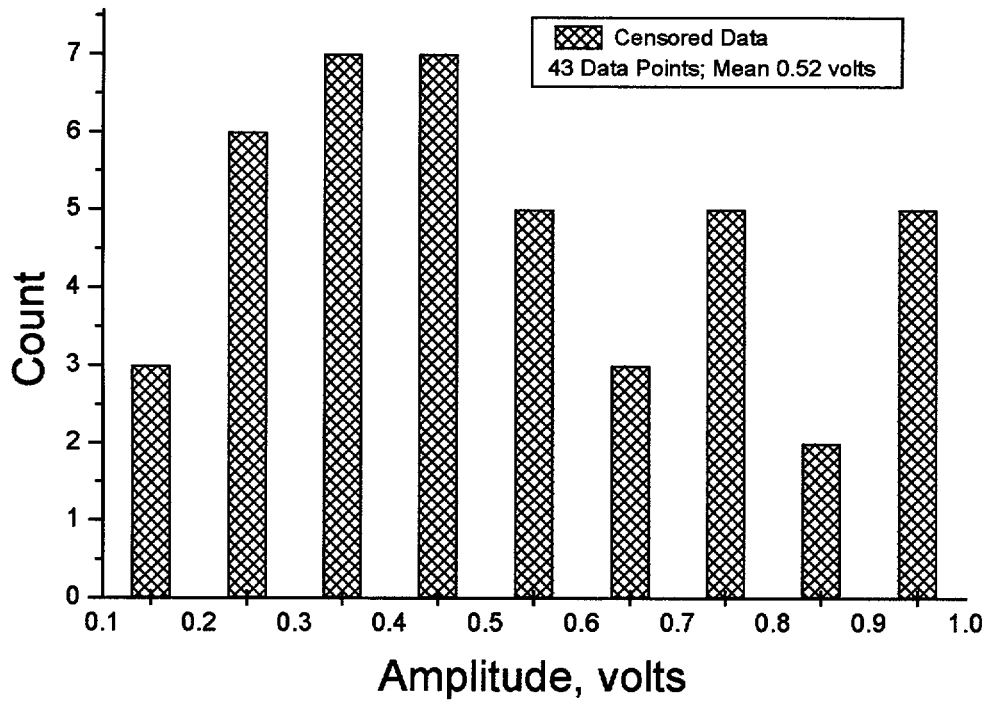


Figure 3-2 — Eddy Current Grading Units - Voltage histogram for intermediate depths (Censored Data)

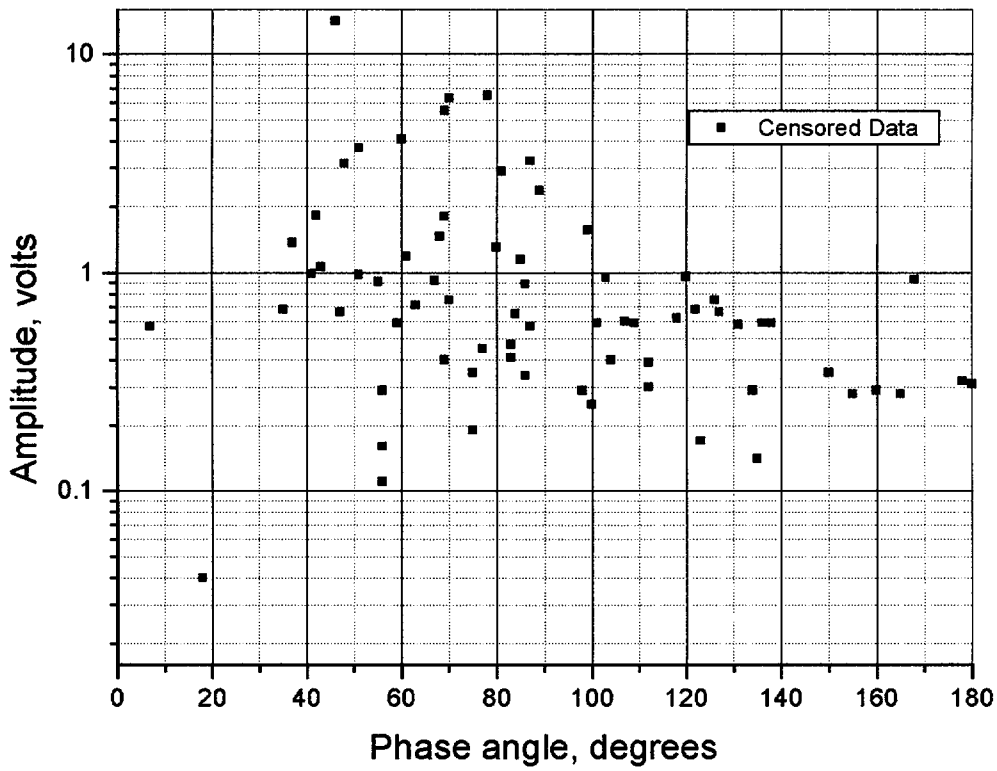


Figure 3-3 — Censored Data Eddy Current Grading Units – Phasor voltage measurements

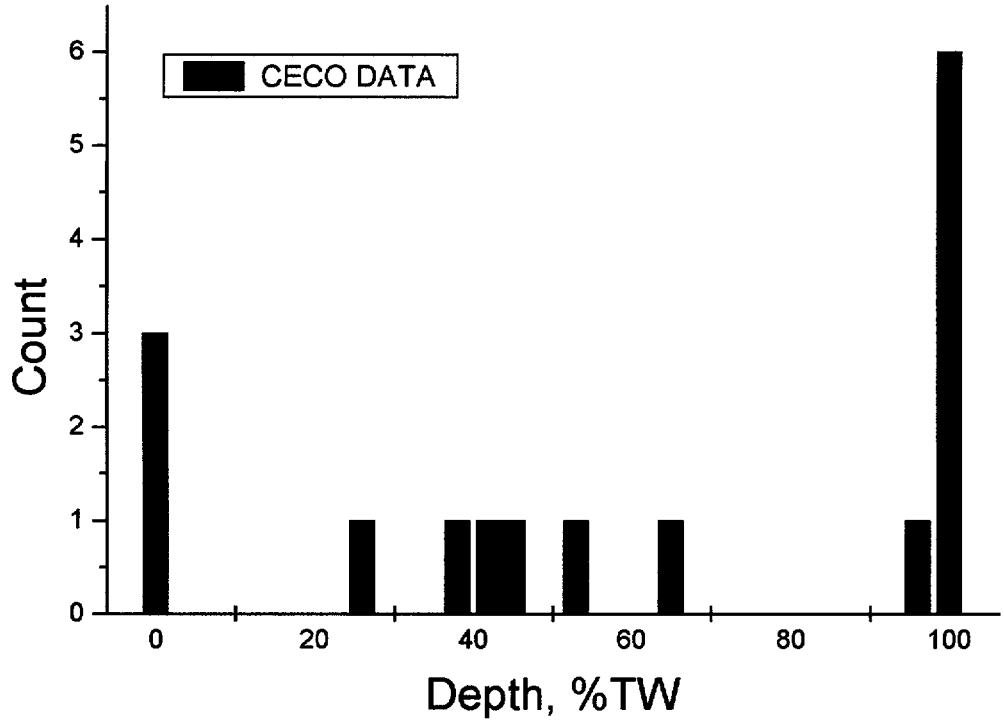


Figure 3-4 — CECO Data Metallographic Grading Units

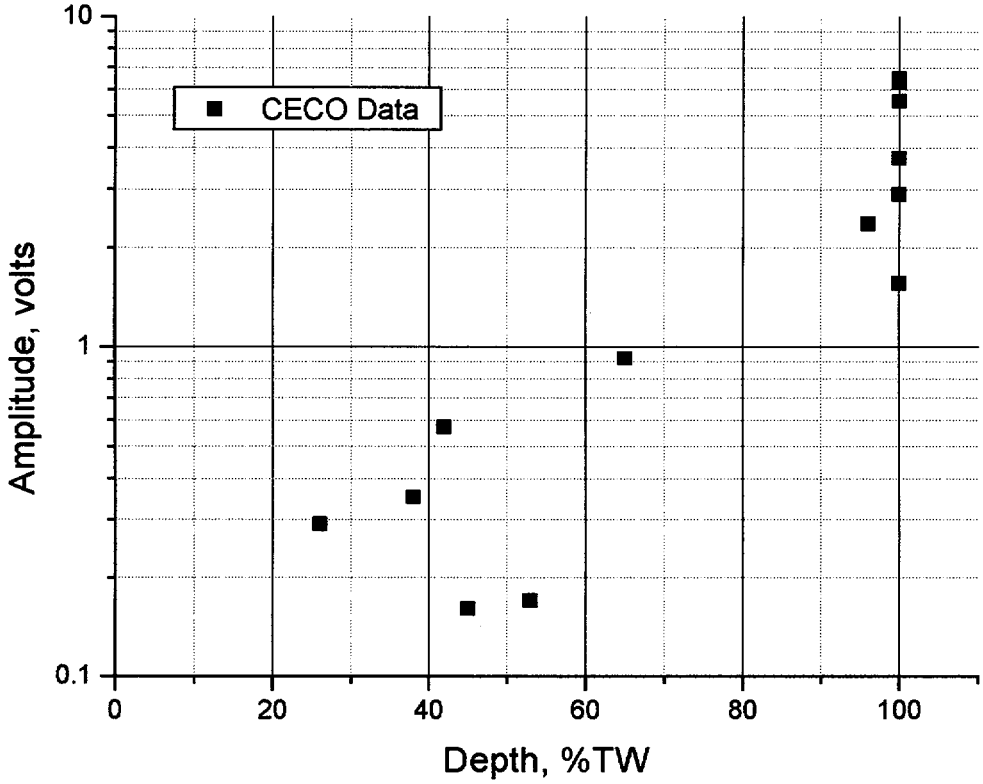
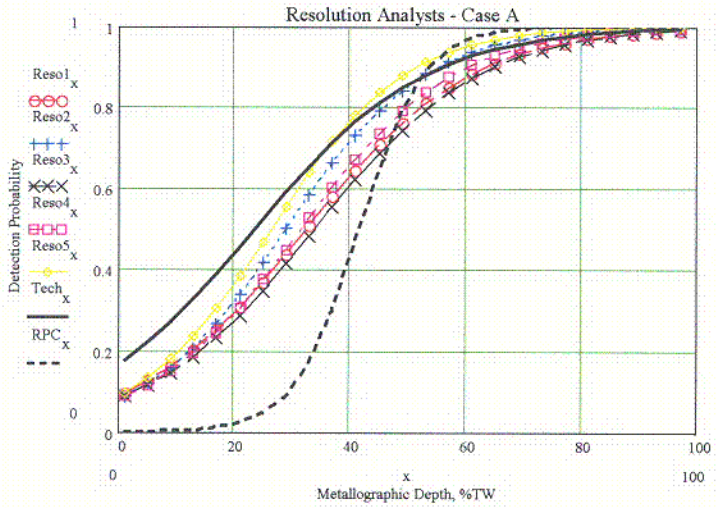


Figure 3-5 — CECO Data Eddy Current Grading Units



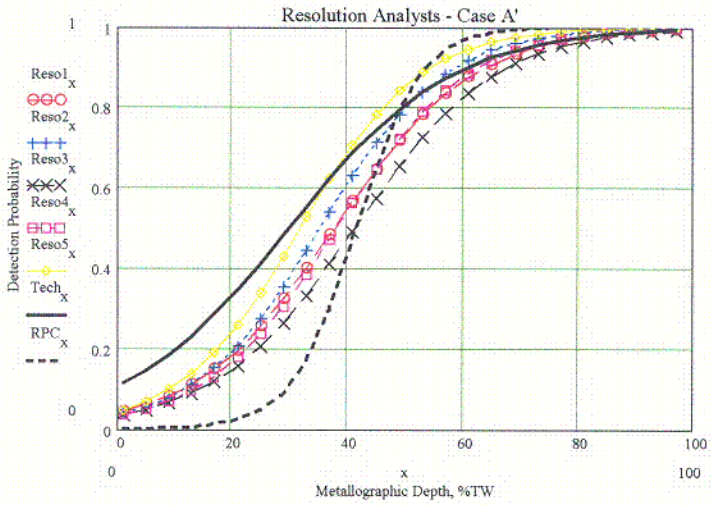
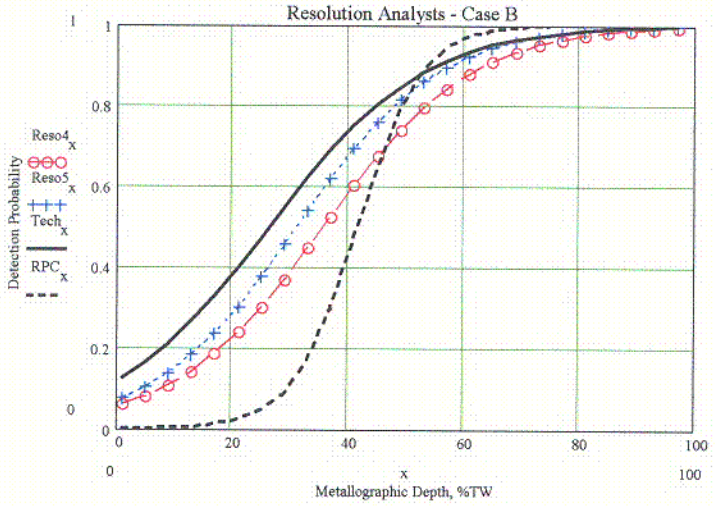


Figure 3-6 — Detection Probability for Cases A and A′

C2



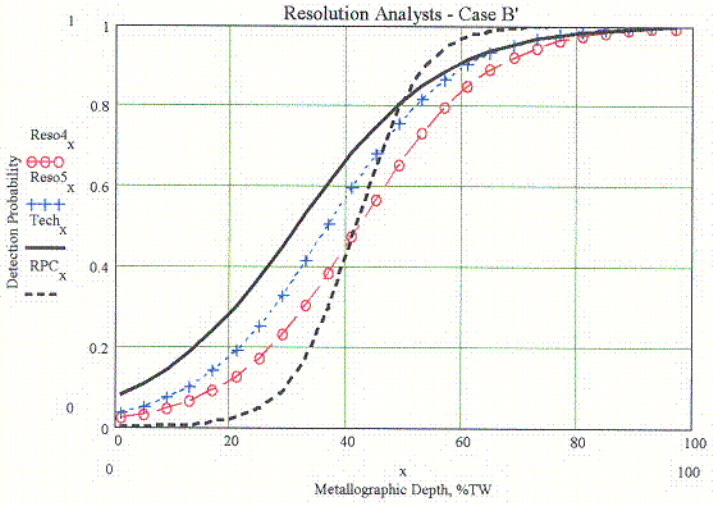


Figure 3-7 — Detection Probability for Cases B and B′

C3

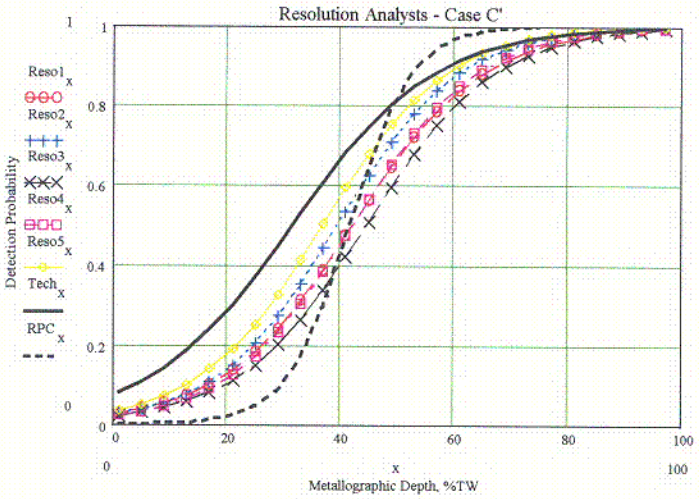


Figure 3-8 — Detection Probability Case C′

C4

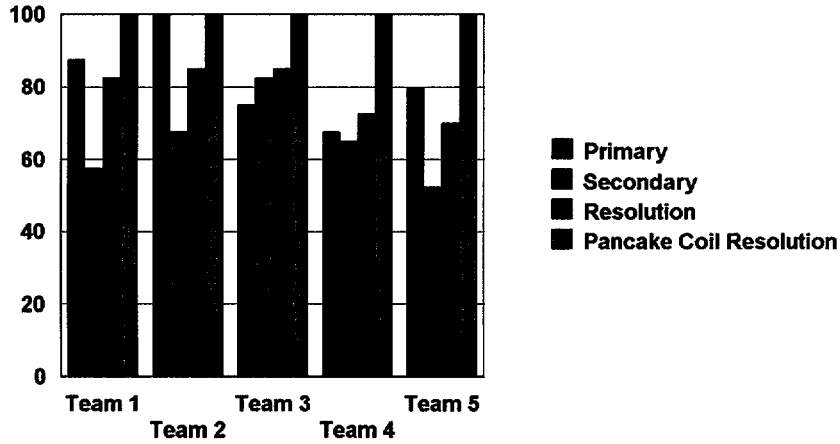
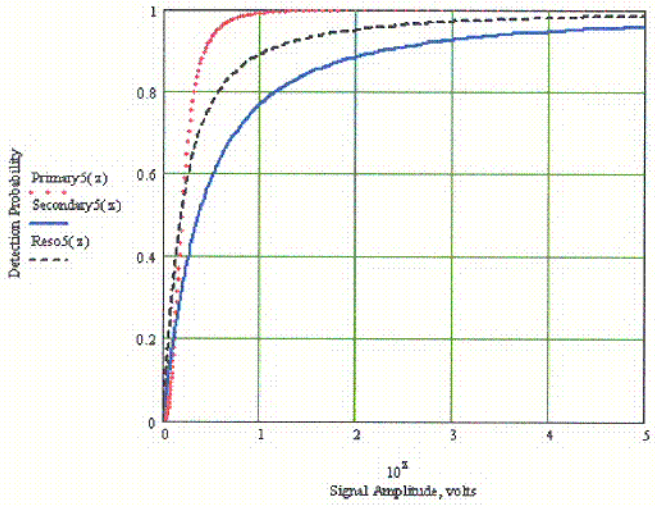
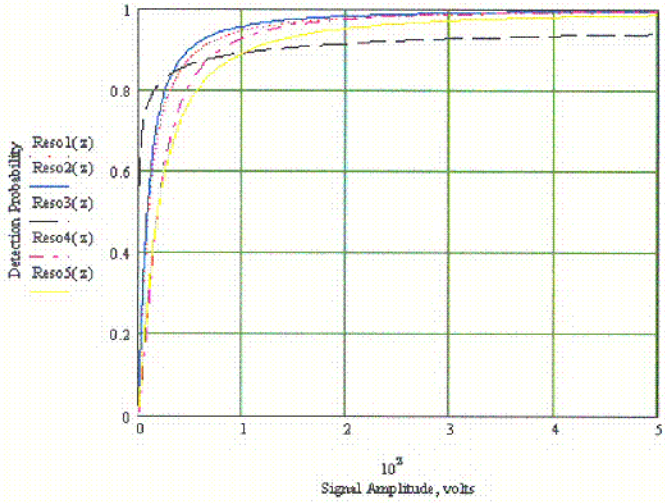


Figure 3-9 — Relative SPD Team Detection Performance for ANO Unit 2 Grading Units Consisting of Bobbin Coil Indications at Eggcrates Attributed to ODSCC



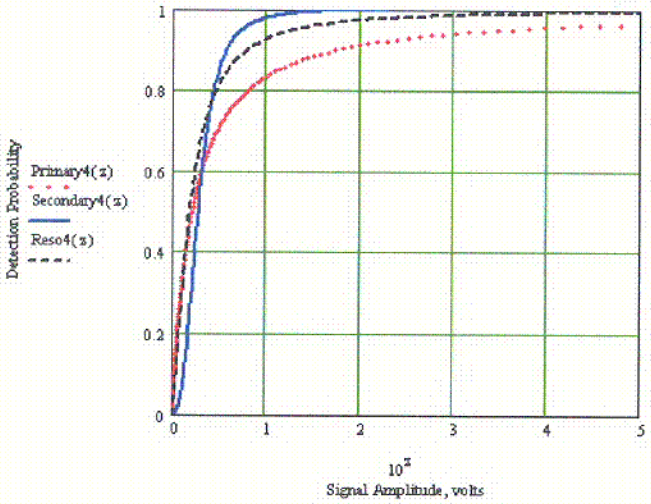
Team 1 – Primary, Secondary, and Resolution Analysts



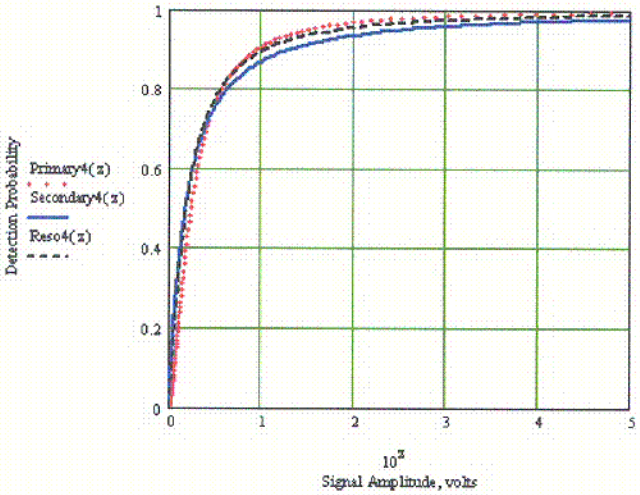
All Resolution Teams

Figure 3-10 — Voltage Detection Probability – Entergy Bobbin Coil Grading Units

C5



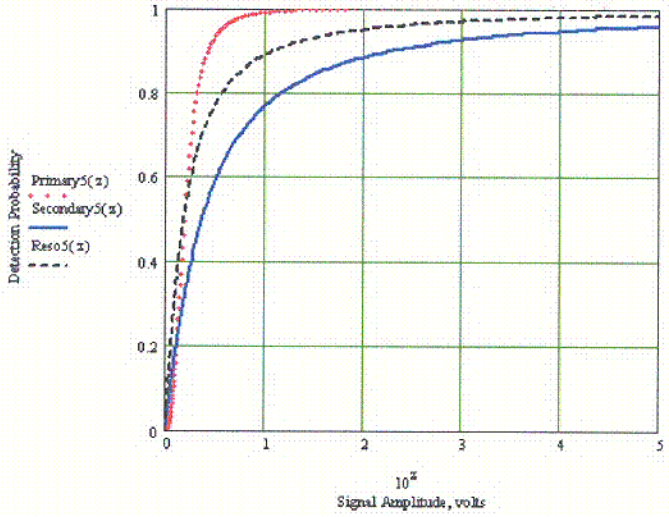
Entergy Grading Units



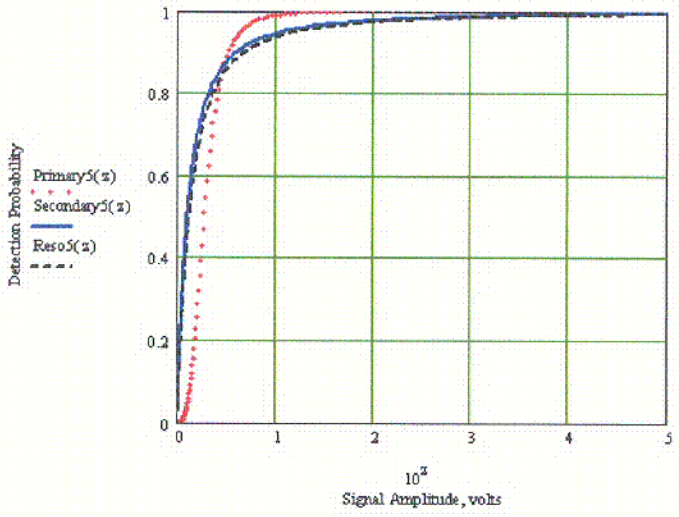
%TW Grading Units

Figure 3-11 — Voltage Detection Probability Comparison.

CG



Entergy Grading Units



%TW Grading Units

Figure 3-12 — Voltage Detection Probability Comparison

Section 4
DISCUSSION

4.1 DETECTION PROBABILITY — % TW AS THE INDEPENDENT VARIABLE

Case C′ results shown in Figure 3-8 are the most conservative set of POD curves and are recommended for use for operating interval calculations. Resolution analyst POD is very consistent with performance approaching the technique limit at depths greater than approximately 60% through-wall. Both the technique and analysts meet Electric Power Research Institute (EPRI) Appendix H requirements in which an 80% POD has to be demonstrated for depths greater than 60% through-wall. An approximate twenty-point gain - at 60% through-wall - is further achieved by using rotating probe technology for resolution.

4.2 DETECTION PROBABILITY – VOLTAGE AS THE INDEPENDENT VARIABLE

Not surprisingly, POD is a very strong function of signal amplitude or voltage. This single parameter is often used as a simple measure of signal-to-noise ratio, which controls POD. Analyst performance, as summarized in Figure 3-9, is somewhat far ranging with one analyst achieving perfect detection, while other individuals only reported approximately 50% of the sample. The gain in using rotating probe technology for final resolution is comparable to results discussed in the previous section ranging from approximately 18% to 30%.

Of particular interest are analysis results for Tube R85L67 that did not meet pressure test requirements during 2R13 in-situ pressure testing. This tube was correctly analyzed and reported by nine of the ten production analysts during the Entergy SPD. During resolution by Team 4, the indication reported by the primary analyst was deemed nonreportable by the resolution analyst, changing the state of the tube to NDD.

4.3 CONCLUSIONS AND RECOMMENDATIONS

Adequacy of the POD curves has to be viewed in the context of resulting operating interval calculations. Hence, no absolute judgment can be provided at this time. However, analysis results by the various teams are judged to be very consistent with overall performance approaching the bobbin technique limit. The use of rotating probe technology for final resolution does provide a clear and significant benefit and is recommended for future application.

Appendix A

ENTERGY ARKANSAS NUCLEAR ONE, UNIT 2
BOBBIN COIL EXAMINATION TECHNIQUE
SPECIFICATION SHEETS

Examination Technique Specification Sheet		
ETSS # 1 - BOBBIN PROBE		Page: 1 of 4
Site: Entergy Operation Inc. Arkansas Nuclear One Unit #2		

Examination Scope	
Applicability: Standard ASME Code Examination. Use for detection of IGA/ODSCC at non-dented drilled and eggcrate support structures, in freespan tubing and within sludge pile region. This technique includes the detection and sizing of wear diagonal and vertical straps using differential 400/100-amplitude mix.	
Instrument	Tubing
Manufacturer/Model: Zetec MIZ-30A or Equiv.	Material Type: Inconel 600
Data Recording Equipment	OD/Wall (inch): 0.750" OD X 0.048" Wall
Manuf./Media: HP HD 1.3Gb Optical or Equiv.	Calibration Standard
Software	Type: ASME with Fan Bar Wear and EDM
Manufacturer: Zetec	Analog Signal Path
Version/Revision: EN 98, Latest Approved Version	Probe Extension Manuf.: Zetec
Examination Procedure	Extension Type & Length: Universal 945-1760, 75 ft.
Number/Revision: HES-28 Rev. 9	Slip Ring Model Number: 508-2052

Scan Parameters				
Scan Direction: Pull				
Digitization Rate, Samples Per Inch (minimum):	Axial Direction	≥33	Circ. Direction	N/A

Probe Speed	Sample Rate	RPM Set	RPM Min	RPM Max
≤48 IPS	1777	N/A	N/A	N/A
≤24 IPS	1100	N/A	N/A	N/A

Probe		
Description (Model/Diameter/Coil Dimensions)	Manufacturer/Part Number	Length
A-600-M/ULC	Zetec 700-1192-061	110 ft.
A-540-SF/RM / A-560 SF/RM / A-580-SF/RM	Zetec 754-0402-001/D#2121-10-B/700-0402-051	110 ft.
A-600-M/ULC (500 nose)	Zetec D# 2120-5-G	110 ft.

Data Acquisition				
Calibration Differential Channels				
Channel & Frequency	Ch. 1 & 3 400 kHz	Ch. 5 & 7 200 kHz	Ch. 9 & 11 100 kHz	Ch. 13 & 15 20 kHz
Phase Rotation	100% TWH 40 degrees	100% TWH 40 degrees	100% TWH 40 degrees	Tube Support Ring 90 Degrees
Span Setting	100% TWH 6 divisions	100% TWH 6 divisions	100% TWH 6 divisions	Tube Support Ring 5 divisions
Calibration Absolute Channels				
Channel & Frequency	Ch. 2 & 4 400 kHz	Ch. 6 & 8 200 kHz	Ch. 10 & 12 100 kHz	Ch. 14 & 16 20 kHz
Phase Rotation	Probe Motion Horiz. Flaws up first	Probe Motion Horiz. Flaws up first	Probe Motion Horiz. Flaws up first	Tube Support Ring 90 Degrees
Span Setting	60% TWH 5 divisions	60% TWH 5 divisions	60% TWH 2 divisions	Tube Support Ring 4 divisions

Examination Technique Specification Sheet

ETSS # 1 - BOBBIN PROBE | Page: 2 of 4

Configuration Board Settings

trig: off	down	Configuration # 0				Name :				samples / sec :				rec. media =			
tester =		board # 1		board # 2		board # 3		board # 4		board # 5		board # 6		board # 7		board # 8	
# of channels =	16	probe # 1		probe # 1		probe # 2		probe # 2		probe # 1		probe # 1		probe # 1		probe # 1	
		DRIVE		DRIVE		DRIVE		DRIVE		DRIVE		DRIVE		DRIVE		DRIVE	
		A D B C		A D B C		A D B C		A D B C		A D B C		A D B C		A D B C		A D B C	
Drive Polarity		N	N			N	N										
Group Number		1	1			2	2										
Coil Number		1	5			1	5										
FREQ #1	Time Slot # 1																
400 kHz	G: x 2 / 12.0 V	D	A			D	A										
FREQ #2	Time Slot # 2																
200 kHz	G: x 2 / 12.0 V	D	A			D	A										
FREQ #3	Time Slot # 3																
100 kHz	G: x 2 / 12.0 V	D	A			D	A										
FREQ #4	Time Slot # 4																
20 kHz	G: x 4 / 12.0 V	D	A			D	A										
FREQ #5	Time Slot # 5																
FREQ #6	Time Slot # 6																
FREQ #7	Time Slot # 7																
FREQ #8	Time Slot # 8																

END LOC CH :	1	1	DRIVE A : D = A1-A2, P = dr:A1 pu:A2,DP = dr : D1&D2 pu : A1&A2
THRESHOLD :	off	off	DRIVE B : D = B1-B2, A = A1-B2
(P) GAIN :	x6		P = dr : B1 pu:B2, DP = dr : C1&C2 pu : B1&B2
ACTIVE PROBES :	2		DRIVE C : D = C1-C2, A = D1-C2
			DRIVE D : D = D1-D2

Default Gain/PD | Print Screen | OK EXIT

Special Instructions

1. The A-600-M/ULC probe is the primary use probe for the bobbin examination. The A-580SF/RM and A-560SF/RM are used to test low row tubes.
2. The A-580-SFRM probe can be used in tubes reported as RRT with the .600" probe as directed by the FTI Level III and Entergy approval. If needed, a 0.560 SF/RM probe, or a 0.540 SF/RM can be used as directed by the FTI Level III and Entergy approval.
3. Examine each tube full length or to the extent possible.
4. Enter a message at the beginning of each calibration group indicating that the data is being acquired with either single or dual probes. If dual probes are being used state which calibration group is the primary probe and which is the secondary probe.
5. When acquiring data with a single probe Coil 1 (differential) channels will be Ch1=400 kHz, Ch3=200 kHz, Ch5=100 kHz, Ch7=20kHz and the Coil 5 (absolute) channels will be Ch2=400 kHz, Ch4=200 kHz, Ch6=100 kHz, Ch8=20 kHz.
6. Slower speeds (24 IPS) are recommended in the smaller radius U-bend tubes (row 5 and below) due to probe snapping through the U-bend.
7. Three recordings of the calibration standard should be performed at the beginning and end of each calibration group.
8. As a minimum, a position verification and a message will be entered once per calibration group.
9. Tubes, which have been mis-encoded, should be corrected by entering a message to void that entry and re-examining the tube with the proper encode. This is required to maintain an accurate DSR database.

Examination Technique Specification Sheet				
ETSS # 1 - BOBBIN PROBE				Page: 3 of 4
Data Analysis				
Calibration Differential Channels				
Channel & Frequency	Ch 1 400 kHz	Ch 3 200 kHz	Ch 5 100 kHz	Ch 7 20 kHz
Phase Rotation	100% TWH @ 40 degrees	100% TWH @ 40 degrees	100% TWH @ 40 degrees	Tube Support Ring @ 90 Degrees
Span Setting Minimum	100% TWH @ 75% FSH	100% TWH @ 75% FSH	100% TWH @ 75% FSH	Tube Support Ring @ 50% FSH
Calibration Absolute Channels				
Channel & Frequency	Ch 2 400 kHz	Ch 4 200 kHz	Ch 6 100 kHz	Ch 8 20 kHz
Phase Rotation	Probe Motion Horiz. Flaws Up	Probe Motion Horiz. Flaws Up	100% TWH @ 40 Degrees	Tube Support Ring 270 Degrees
Span Setting Minimum	60% TWH @ 50% FSH	60% TWH @ 50% FSH	60% TWH @ 20% FSH	Tube Support Ring @ 40% FSH
Calibration Process and Other Channels				
Channel & Frequency	P1 (Ch 1/5) 400/100 kHz Diff	P2 (Ch 1/5) 400/100 kHz Diff	P3 (Ch 1/3/5 turbo) 400/200/100 kHz Diff	N/A
Configure & Adjust Parameters	Suppress Support Ring	Suppress Support Ring	Save 100, 60, 20 Suppress TSP TSH & TSC	
Phase Rotation	Probe Motion Horiz. Flaws start down	Probe Motion Horiz. Flaws start down	Probe Motion Horiz. Flaws start down	
Span Setting Minimum	100% TWH @ 75% FSH	50% Wear @ 50% FSH	100% TWH @ 50% FSH	

Voltage Normalization				Calibration Curves		
CH	Signal	Set	Normalize	Type	CH	Set Points
1	4X20% FBH	4 Vp-p	All	Phase	1, 3, 5, P1,	100, 60, 20 FBH
				Magnitude (Vmax)	P2	0, 30, 50 Wear

Data Screening		
Left Strip Chart	Right Strip Chart	Lissajous
P1	Ch 6	Ch P1

Reporting Requirements			
Condition/Region	Report	Ch.	Comment
Absolute Drift	ADI	6	Vert-Max (Low Row U-bend)
Freespan	DFI	→	Use "Free Span Bobbin Coil Indication Flow Chart"
Eggcrates	DSI	P1	See Note 6
Drilled Support Plates	DSI	P1	See Note 7
Batwings	DSI	P1	See Note 9
Tubesheet	DTI	P3	See Note 4
Dents	DNT	P1	All Dent Indications ≥ 3 volts located anywhere.
Indication Not Reportable	INR		Indications detected are not reportable by guidelines
Indication Not Found	INF		Resolution is require to research and resolve per guidelines
Wear	DSI	P2	Indications with no history. See Note 9.
Wear	%	P2	Vert-Max Differential At the Batwing edges only. Check contact. See Note 9.
Possible Loose Part	PLP	8	Any Indication of Secondary Side Foreign Parts, See Note 12
Loose Part Indication	LPI	P1	See Note 12

Examination Technique Specification Sheet		
ETSS # 1 - BOBBIN PROBE		PAGE: 4 OF 4

Special Instructions

1. Refer to Appendix I additional instructions regarding the data screening and evaluation of Bobbin Probe data.

2. Zoom the strip chart to a maximum value of 8 to increase visibility of small amplitude indications.

3. All areas of the tubing should be examined with both P1 and Ch6 for distortion at structure and/ or drifts that may be indicative of cracking.

4. Review tubesheet data for indications of degradation, distortion and drifts indicative of axial or circumferential cracking. Indications may be confirmed by using Ch5, Ch6 or P3. Evaluation is typical in P1 or Ch1. Based upon experience at ANO-2, take care to examine the entire tubesheet entry signal at the setup span on Ch1 and Ch3 for distorted signals indicative of cracking. Also observe the response of P3. The requirement to screen the entire tubesheet entry signal is critically important in both the hot leg and cold leg. Distorted signals, which may be indicative of a flaw on the bobbin, shall be flagged for RPC examination by reporting as DTI in the % column. If the indication is not in the expansion transition, the indication should be evaluated and reported from P1.

5. In the presence of deposits at the top of the tubesheet, if the signal has the characteristics of a flaw on P1, report these indications as an "NQI" code and test with an RPC examination.

6. Evaluate each support on the P1 process channel. Eggcrates typically have three signals representing the two edges and the center of the eggcrate. Indications can be confirmed with Ch1, 3, or 5 when deposit influence is not present. Indications that are phased in the ID plane on P1 should confirm on Ch3 and/or Ch5. Indications may not always display an expected counter-clockwise rotation.

7. Dented drilled supports should be screened with P1 and P3. P3 indications must confirm as an indication on either Ch1, Ch3, or Ch5.

8. Using P1 and Ch5 to scroll through the upper hot leg area from 07H through the u-bend region. Also evaluate this using the Ch6 strip chart for drift indications. Evaluation is typically on P1, Ch5 and Ch6. Monitor the 100 kHz absolute strip chart for positive drift (special attention to the low row u-bends).

9. Wear or fretting indications at the Batwings should be evaluated and called using P2. If the indication does not have history record as a DSI. If the indication has history record %TW. Confirmation of a contact point is made by using Ch8. If the indications are not on a contact point or are sharp and not typical of wear, evaluation should be made using P1 and report as DSI.

10. When using Auto Calibration features, make sure that you are using the file that matches the Standard being used.

11. Monitor the configuration widget for proper data sampling. Set the warning dialog to trigger at 33 axial samples.

12. Observe the stripchart and Lissajous presentations for indications occurring anywhere along the tube but especially on top of the tubesheet and supports. Possible loose parts shall be screened and reported as a Possible Loose Part (PLP) on 20 kHz absolute. This will signify the need for further characterization with a rotating probe technique.

Attachment 3

2R13 Look-Back Evaluation

ANO2 Mp Data for
2R13 Lookback Evaluation

DEFECT	ROW	LINE	Max. Depth 2R13	Struct. Depth	Sruct. Length	Mp2R13	POD
1	72	72	82.9	77.3%	0.901	3.134	0.374
2	102	110	85.4	73.2%	1.155	2.908	0.382
3	8	134	85.3	80.6%	0.456	2.659	0.381
4	102	98	83.1	71.9%	0.656	2.393	0.375
5	32	108	76.5	71.0%	0.690	2.383	0.355
6	17	49	79.4	70.0%	0.692	2.323	0.364
7	53	83	84.4	71.8%	0.585	2.296	0.379
8	1	51	78.2	66.2%	0.816	2.223	0.360
9	23	55	74.1	62.3%	1.092	2.171	0.348
10	47	91	74.0	64.2%	0.684	2.040	0.348
11	32	108	84.2	73.9%	0.384	2.030	0.378
12	36	36	69.4	60.7%	0.871	2.013	0.335
13	26	40	81.7	68.4%	0.499	2.011	0.371
14	9	115	83.3	63.5%	0.682	2.007	0.375
15	16	140	71.9	64.4%	0.614	1.985	0.342
16	36	116	70.9	61.1%	0.728	1.950	0.339
17	33	109	65.7	61.4%	0.683	1.931	0.325
18	33	71	75.7	66.8%	0.484	1.929	0.353
19	28	36	80.7	57.2%	0.950	1.915	0.368
20	10	150	84.6	71.3%	0.364	1.882	0.379
21	4	156	67.3	61.0%	0.634	1.880	0.329
22	32	108	76.5	64.9%	0.488	1.868	0.355
23	32	46	75.8	64.7%	0.472	1.843	0.353
24	48	52	77.6	67.0%	0.418	1.838	0.358
25	47	93	67.2	56.8%	0.747	1.816	0.329
26	68	44	78.5	64.4%	0.456	1.814	0.361
27	32	100	83.9	79.0%	0.250	1.811	0.377
28	58	106	82.1	60.5%	0.565	1.810	0.372
29	48	96	65.1	52.5%	1.126	1.808	0.323
30	37	95	69.0	55.3%	0.815	1.803	0.334
31	5	153	84.5	80.8%	0.232	1.801	0.379
32	33	71	81.7	59.0%	0.581	1.778	0.371
33	106	90	82.0	56.9%	0.652	1.768	0.372
34	10	16	70.2	53.6%	0.812	1.753	0.337
35	1	51	67.3	55.4%	0.672	1.738	0.329
36	12	106	62.1	54.3%	0.716	1.729	0.315
37	77	125	80.5	63.7%	0.405	1.722	0.367
38	84	76	81.7	67.0%	0.350	1.719	0.371

ANO2 Mp Data for
2R13 Lookback Evaluation

DEFECT	ROW	LINE	Max. Depth 2R13	Struct. Depth	Sruct. Length	Mp2R13	POD
39	9	115	80.6	65.1%	0.374	1.711	0.367
40	16	118	66.4	54.5%	0.665	1.709	0.327
41	77	113	74.4	58.2%	0.518	1.706	0.349
42	9	127	78.3	68.2%	0.328	1.705	0.360
43	67	57	77.9	71.5%	0.286	1.694	0.360
44	29	123	72.5	67.1%	0.336	1.693	0.344
45	13	31	80.9	52.3%	0.730	1.684	0.368
46	20	52	75.2	61.2%	0.422	1.680	0.352
47	60	44	68.5	54.4%	0.616	1.679	0.333
48	4	20	65.4	56.2%	0.544	1.677	0.324
49	65	97	66.6	56.4%	0.522	1.665	0.327
50	12	106	63.1	54.0%	0.609	1.665	0.318
51	95	45	79.0	62.5%	0.382	1.660	0.363
52	47	93	63.4	52.8%	0.650	1.659	0.318
53	7	61	83.6	56.3%	0.518	1.659	0.376
54	36	116	64.6	53.5%	0.596	1.646	0.322
55	68	112	66.9	58.3%	0.440	1.633	0.328
56	52	36	68.9	52.4%	0.608	1.627	0.334
57	63	115	73.2	64.6%	0.322	1.609	0.346
58	60	108	59.7	50.8%	0.633	1.605	0.308
59	42	38	82.2	73.0%	0.242	1.604	0.372
60	8	148	68.3	54.3%	0.501	1.601	0.332
61	65	125	69.9	63.6%	0.325	1.593	0.336
62	60	108	64.5	57.0%	0.429	1.593	0.321
63	77	83	79.0	64.3%	0.316	1.592	0.363
64	12	62	65.0	49.1%	0.650	1.576	0.323
65	28	44	82.0	47.5%	0.736	1.575	0.371
66	48	52	69.3	59.3%	0.362	1.562	0.335
67	16	140	59.3	52.3%	0.496	1.555	0.307
68	13	55	65.0	51.8%	0.510	1.554	0.323
69	38	110	66.3	50.3%	0.550	1.550	0.326
70	49	77	84.4	78.6%	0.189	1.545	0.379
71	63	123	83.0	78.0%	0.189	1.531	0.375
72	11	13	76.7	69.6%	0.241	1.530	0.356
73	4	28	61.8	50.9%	0.499	1.529	0.314
74	40	116	64.2	53.1%	0.432	1.519	0.320
75	75	85	66.6	56.9%	0.357	1.510	0.327
76	11	155	74.2	58.4%	0.336	1.510	0.349

ANO2 Mp Data for
2R13 Lookback Evaluation

DEFECT	ROW	LINE	Max. Depth 2R13	Struct. Depth	Sruct. Length	Mp2R13	POD
77	84	112	68.4	57.0%	0.354	1.509	0.332
78	4	156	76.4	62.2%	0.290	1.504	0.355
79	65	119	66.2	45.1%	0.670	1.504	0.326
80	10	150	78.2	69.1%	0.233	1.500	0.360
81	42	38	68.0	49.4%	0.494	1.500	0.331
82	104	116	77.4	68.0%	0.240	1.499	0.358
83	23	143	63.1	42.6%	0.815	1.498	0.318
84	14	112	65.1	48.0%	0.520	1.490	0.323
85	115	65	63.6	54.0%	0.380	1.487	0.319
86	10	150	66.6	54.8%	0.366	1.484	0.327
87	92	102	76.7	68.0%	0.232	1.478	0.356
88	75	89	82.0	72.8%	0.202	1.474	0.372
89	11	143	78.8	75.4%	0.188	1.473	0.362
90	38	144	78.2	70.3%	0.215	1.472	0.360
91	36	116	75.6	60.3%	0.284	1.461	0.353
92	67	111	68.9	54.9%	0.340	1.456	0.334
93	33	117	58.2	48.4%	0.452	1.454	0.304
94	89	73	69.3	50.3%	0.405	1.449	0.335
95	16	140	66.9	57.3%	0.300	1.440	0.328
96	106	90	81.5	63.4%	0.244	1.434	0.370
97	52	82	62.4	41.8%	0.633	1.433	0.316
98	32	148	74.3	66.7%	0.220	1.428	0.349
99	12	56	80.7	52.1%	0.348	1.423	0.368
100	28	36	71.0	51.9%	0.350	1.423	0.340
101	45	89	63.0	56.4%	0.290	1.413	0.317
102	2	34	78.9	57.4%	0.279	1.412	0.362
103	117	89	61.7	53.8%	0.315	1.410	0.314
104	21	109	74.0	66.3%	0.215	1.410	0.348
105	49	19	66.9	57.4%	0.270	1.397	0.328
106	53	109	59.1	46.5%	0.403	1.391	0.307
107	75	91	78.2	61.7%	0.234	1.390	0.360
108	6	116	55.6	42.6%	0.494	1.389	0.297
109	24	24	71.1	43.2%	0.470	1.386	0.340
110	67	119	82.5	75.6%	0.162	1.384	0.373
111	104	116	74.8	57.1%	0.260	1.377	0.350
112	12	148	72.4	53.0%	0.294	1.374	0.343
113	38	110	68.8	44.0%	0.424	1.371	0.333
114	47	145	80.8	58.2%	0.238	1.355	0.368

ANO2 Mp Data for
2R13 Lookback Evaluation

DEFECT	ROW	LINE	Max. Depth 2R13	Struct. Depth	Sruct. Length	Mp2R13	POD
115	3	57	66.0	39.4%	0.510	1.351	0.326
116	7	119	71.2	53.1%	0.275	1.351	0.340
117	31	125	57.0	44.2%	0.386	1.348	0.301
118	31	49	66.4	40.5%	0.468	1.348	0.327
119	83	109	61.5	48.3%	0.320	1.345	0.313
120	119	65	69.5	56.7%	0.241	1.343	0.335
121	40	56	70.4	62.5%	0.204	1.339	0.338
122	35	33	85.5	71.5%	0.164	1.338	0.382
123	23	143	48.4	35.5%	0.626	1.335	0.279
124	121	113	69.9	49.9%	0.289	1.331	0.337
125	46	126	61.5	50.1%	0.286	1.330	0.313
126	18	126	52.5	41.7%	0.404	1.329	0.289
127	89	51	59.8	50.8%	0.278	1.328	0.308
128	32	24	65.4	57.8%	0.222	1.323	0.324
129	83	109	63.9	46.5%	0.318	1.322	0.320
130	40	116	78.5	58.0%	0.219	1.320	0.361
131	45	69	59.2	51.7%	0.255	1.309	0.307
132	86	118	59.1	38.7%	0.428	1.306	0.307
133	34	52	54.4	41.6%	0.368	1.305	0.294
134	58	106	62.9	40.7%	0.378	1.301	0.317
135	39	111	70.8	50.9%	0.254	1.300	0.339
136	102	98	71.7	46.3%	0.294	1.297	0.342
137	20	132	52.2	46.1%	0.292	1.294	0.288
138	24	136	76.7	58.6%	0.198	1.288	0.356
139	27	127	51.1	38.1%	0.385	1.276	0.286
140	6	138	52.5	44.2%	0.290	1.273	0.289
141	9	125	59.9	51.8%	0.221	1.264	0.309
142	12	30	52.8	47.0%	0.251	1.260	0.290
143	4	150	56.4	29.9%	0.596	1.257	0.300
144	75	45	60.0	53.8%	0.201	1.251	0.309
145	5	3	52.0	43.4%	0.274	1.251	0.288
146	55	95	59.6	36.0%	0.372	1.248	0.308
147	1	137	59.9	34.1%	0.394	1.240	0.309
148	26	144	57.0	45.8%	0.238	1.236	0.301
149	61	115	46.6	35.5%	0.344	1.229	0.274
150	27	127	37.7	27.7%	0.584	1.229	0.252
151	44	72	83.1	52.5%	0.192	1.228	0.375
152	84	112	84.5	52.9%	0.190	1.228	0.379

ANO2 Mp Data for
2R13 Lookback Evaluation

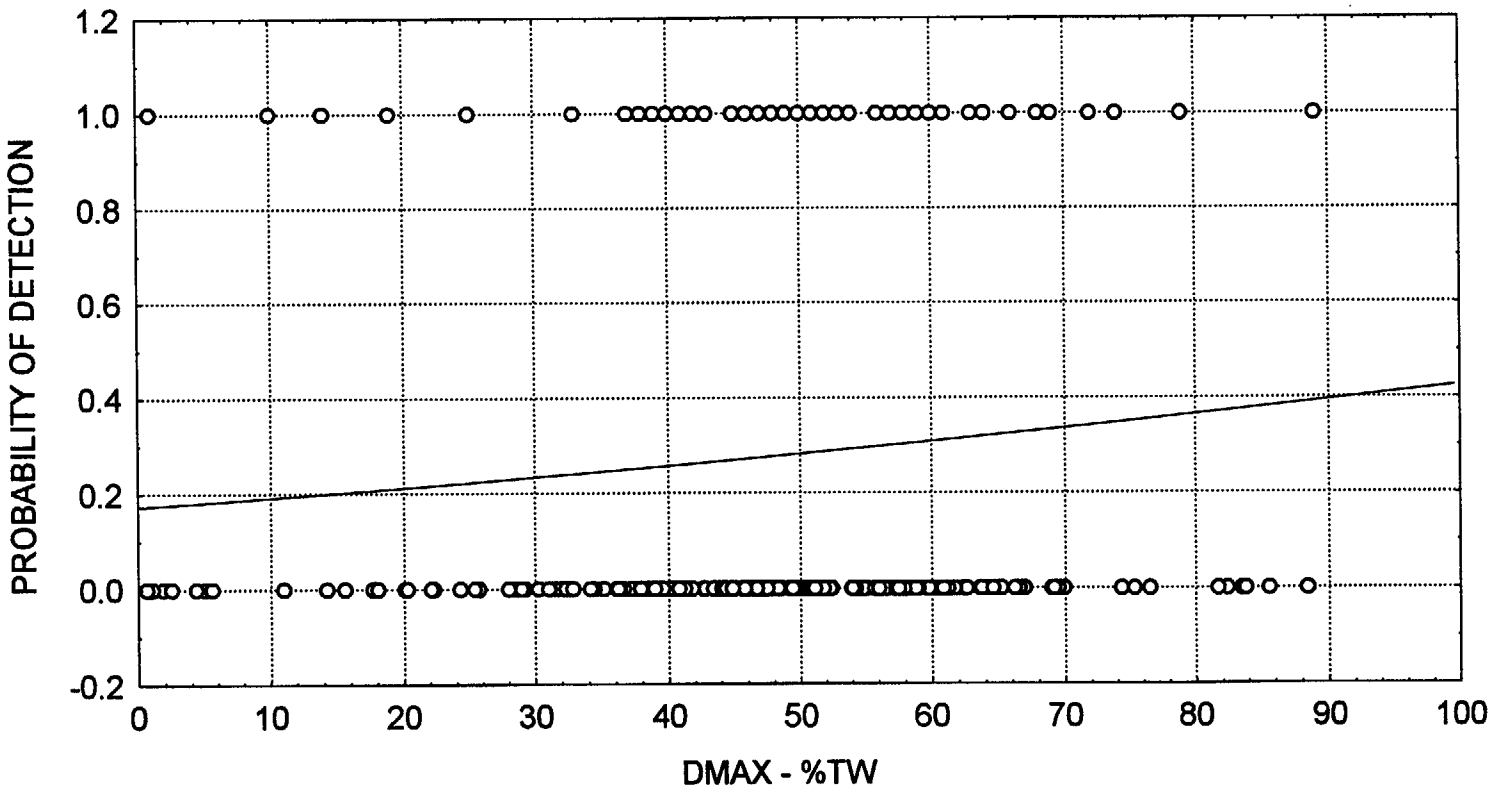
DEFECT	ROW	LINE	Max. Depth 2R13	Struct. Depth	Sruct. Length	Mp2R13	POD
153	3	141	56.4	44.8%	0.234	1.224	0.300
154	6	140	56.4	43.3%	0.244	1.222	0.299
155	42	142	61.0	50.5%	0.196	1.219	0.312
156	7	113	82.3	61.8%	0.151	1.219	0.372
157	52	82	56.2	33.3%	0.365	1.219	0.299
158	8	128	63.7	41.5%	0.244	1.208	0.319
159	6	136	62.5	48.5%	0.196	1.205	0.316
160	42	78	65.7	55.3%	0.166	1.205	0.325
161	16	116	50.8	33.3%	0.308	1.190	0.285
162	123	99	53.0	32.2%	0.314	1.185	0.290
163	136	88	66.8	37.9%	0.246	1.184	0.328
164	120	114	63.8	55.0%	0.148	1.173	0.320
165	34	130	45.8	25.5%	0.427	1.172	0.272
166	74	66	66.3	37.8%	0.231	1.171	0.326
167	11	143	65.5	47.6%	0.169	1.165	0.324
168	86	104	53.9	36.0%	0.225	1.155	0.293
169	10	148	56.4	47.4%	0.157	1.148	0.300
170	7	119	64.2	46.9%	0.157	1.146	0.320
171	13	57	58.1	40.6%	0.178	1.139	0.304
172	104	100	74.9	63.0%	0.107	1.133	0.351
173	38	114	60.7	46.3%	0.149	1.133	0.311
174	9	127	37.0	27.6%	0.254	1.124	0.251
175	92	100	63.5	46.3%	0.140	1.121	0.319
176	66	28	63.9	48.9%	0.130	1.118	0.320
177	6	138	44.4	31.1%	0.207	1.116	0.269
178	62	36	59.7	19.7%	0.375	1.114	0.308
179	23	143	53.6	31.4%	0.180	1.099	0.292
180	5	21	68.3	53.2%	0.100	1.090	0.332
181	11	135	49.1	35.4%	0.130	1.075	0.280
182	4	150	64.2	44.7%	0.100	1.069	0.320
183	84	116	56.7	33.6%	0.120	1.062	0.300
184	57	83	53.9	36.5%	0.100	1.052	0.293
185	53	109	48.4	25.6%	0.130	1.049	0.279

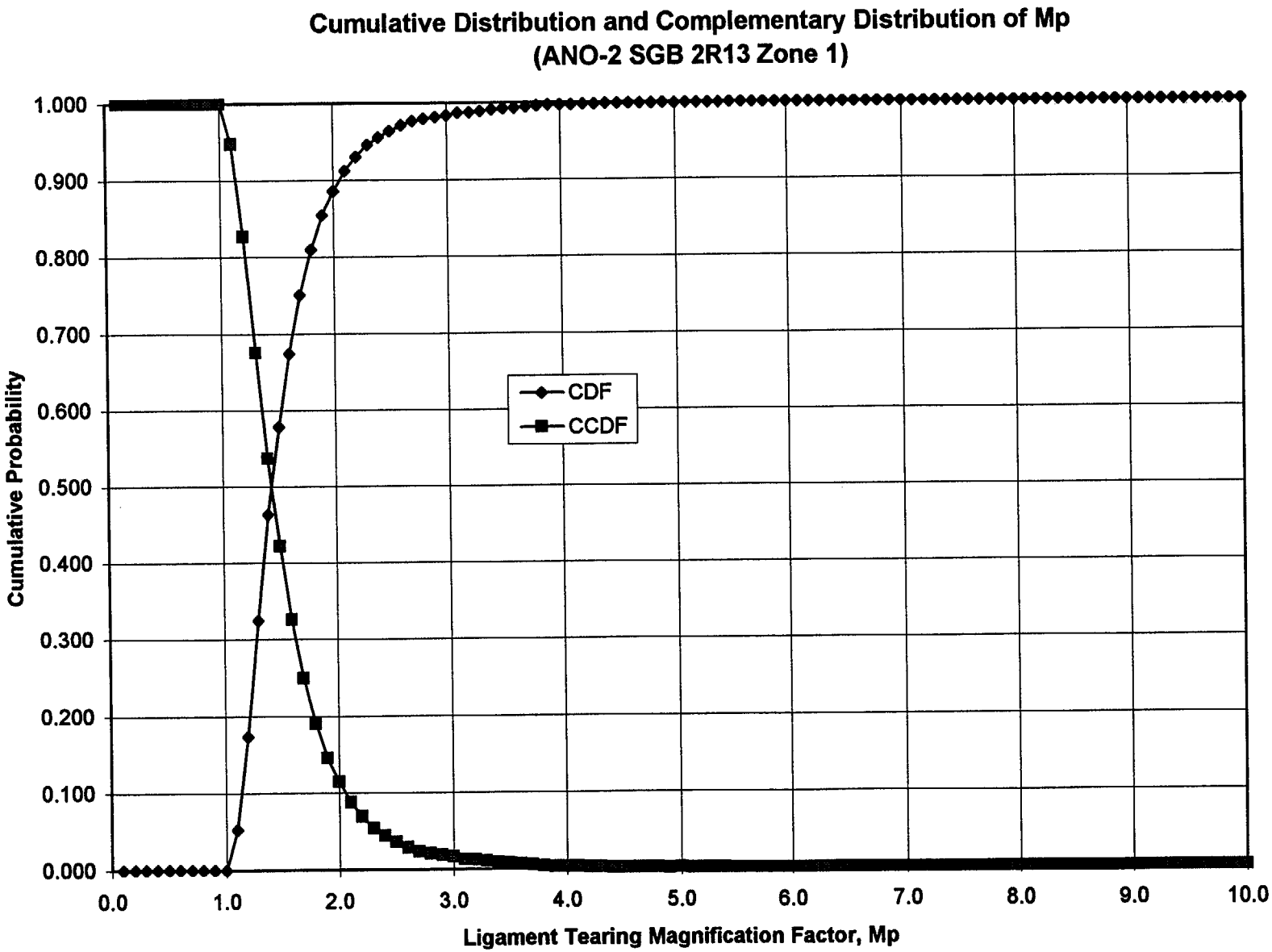
Model: Logistic regression (logit)

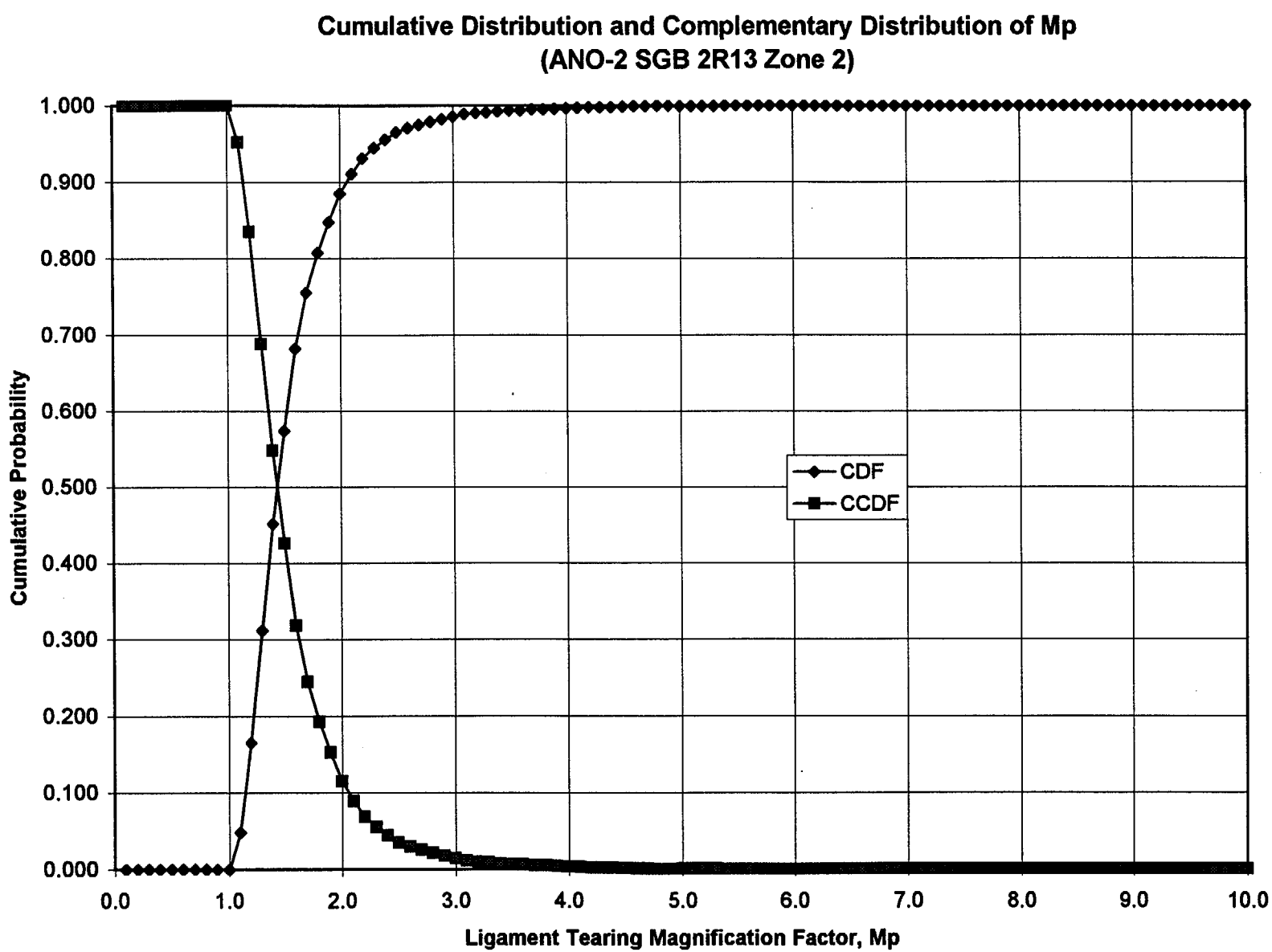
POD=exp(-1.563607+(0.0126564)*x)/(1+exp(-1.563607+(0.0126564)*x))

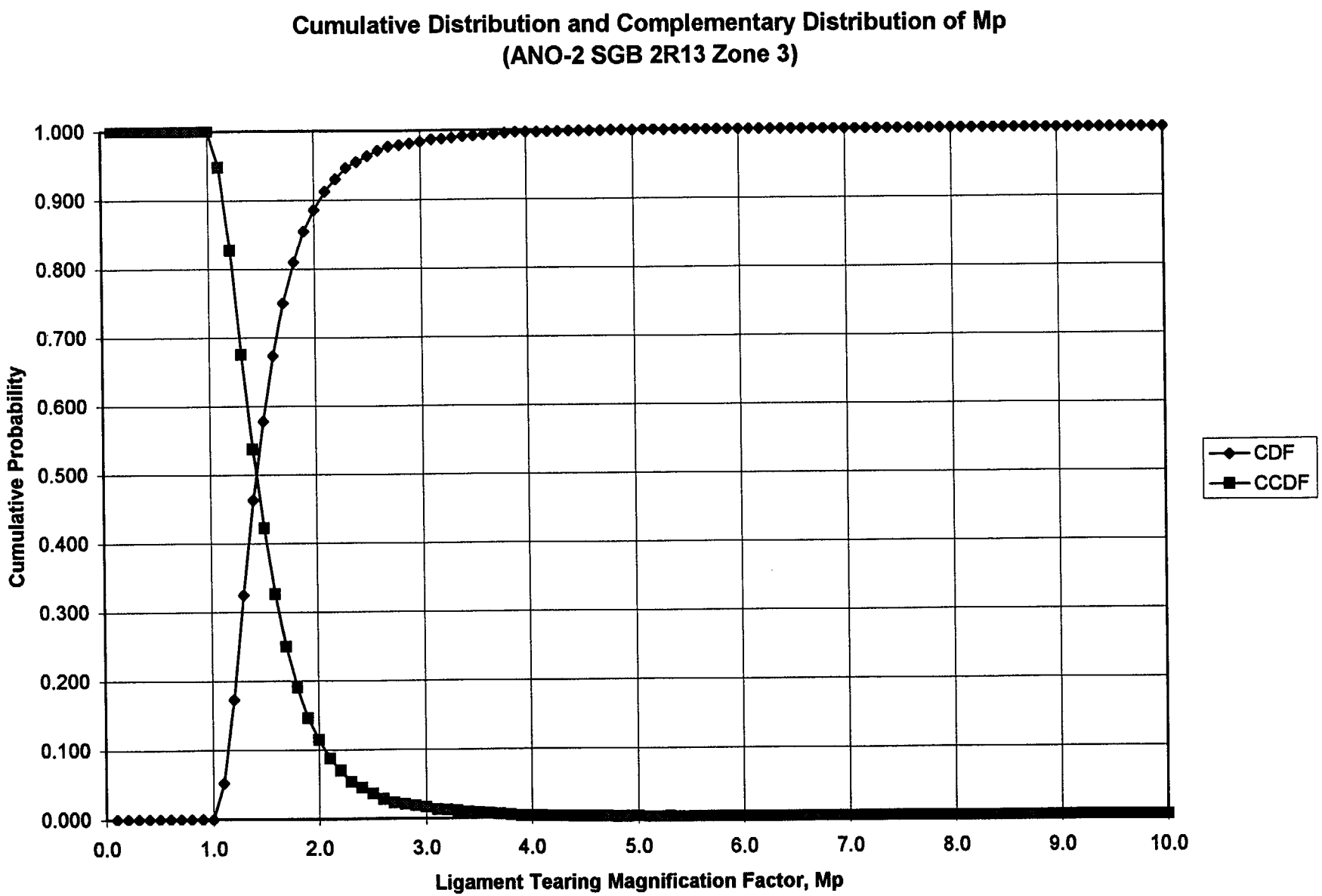
ANO-2 2P99 [UNDETECTED] AND R13 [DETECTED]

* 2P99 DATA PROJECTED TO R13 CONDITION




Cumulative Distribution and Complementary Distribution of Mp
(ANO-2 SGB 2R13 Zone 1)
Cumulative Probability
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Ligament Tearing Magnification Factor, Mp
CDF
CCDF


Cumulative Distribution and Complementary Distribution of Mp
(ANO-2 SGB 2R13 Zone 2)
Cumulative Probability
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Ligament Tearing Magnification Factor, Mp
CDF
CCDF


Cumulative Distribution and Complementary Distribution of Mp
(ANO-2 SGB 2R13 Zone 3)
Cumulative Probability
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Ligament Tearing Magnification Factor, Mp
CDF
CCDF

Attachment 4

Tube Pull Data

ANO-2 NDE/DE Uncertainty Evaluation Results - 115 Mil Pancake Coil Sizing of Axial ODSCC

AutoAxprofileProcessor

									Unadjusted NDE				Adjusted NDE				Burst Adjusted NDE					EXAM Unadjusted DE			EXAM Burst Adjusted DE				
Plant	Ins. Year	SG	Row	Col	Loc	Crack No.	Analyst	Cal. Num.	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Max. Volts	Pb	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Length (in.)	Max. Depth (%)	Avg. Depth (%)	Pb	Sf
CAE	1995	3	20	102	03H	1	A9820	00001	0.480	84.0	52.95	1.26	0.480	77.0	52.95	1.13	0.320	77.0	68.7	1.1	8.134	0.380	92.7	61.03	0.320	92.705	69.932	8.084	100.000
CAE	1955	3	20	102	03H	1	B5534	00001	0.320	77.0	57.76	1.82	0.313	77.0	57.93	1.82	0.270	77.0	63.5	1.8	9.172	0.380	92.7	61.03	0.320	92.705	69.932	8.084	100.000
CAE	1995	3	20	102	03H	1	J4498	00001	0.280	72.0	53.65	1.78	0.280	72.0	53.65	1.78	0.240	72.0	58.4	1.8	10.071	0.380	92.7	61.03	0.320	92.705	69.932	8.084	100.000
CAE	1995	3	20	102	05H	1	A9820	00001	0.130	97.0	31.86	0.32	0.145	39.5	29.26	0.24	0.145	39.5	29.3	0.2	14.336	0.410	61.3	45.93	0.270	61.273	53.606	10.480	100.000
CAE	1955	3	20	102	05H	1	B5534	00001	0.110	73.0	22.34	0.36	0.130	36.5	27.76	0.27	0.110	36.5	29.9	0.3	14.606	0.410	61.3	45.93	0.270	61.273	53.606	10.480	100.000
CAE	1995	3	20	102	05H	1	J4498	00001	0.180	50.0	13.60	0.31	0.180	30.0	19.40	0.18	0.160	30.0	20.2	0.2	15.236	0.410	61.3	45.93	0.270	61.273	53.606	10.480	100.000
CCE	1995	4	37	34	05H	1	A9820	00001	0.590	99.0	59.96	8.96	0.455	100.0	70.16	8.96	0.405	100.0	75.5	9.0	6.759	0.460	100.0	80.98	0.460	100.000	80.983	6.092	100.000
CCE	1995	4	37	34	05H	1	B5534	00001	0.470	97.0	69.03	8.76	0.440	100.0	71.50	8.16	0.390	100.0	76.4	8.2	6.965	0.460	100.0	80.98	0.460	100.000	80.983	6.092	100.000
CCE	1995	4	37	34	05H	1	J4498	00001	0.680	90.0	63.01	8.98	0.660	100.0	72.81	8.96	0.560	100.0	80.0	9.0	5.475	0.460	100.0	80.98	0.460	100.000	80.983	6.092	100.000
CCE	1995	4	37	34	03H	1	A9820	00001	0.240	79.0	50.39	0.48	0.240	58.0	37.98	0.26	0.190	58.0	43.3	0.3	12.355	0.470	52.9	43.62	0.350	52.909	48.474	10.783	100.000
CCE	1995	4	37	34	03H	1	B5534	00001	0.170	85.0	56.91	0.38	0.187	63.0	48.15	0.22	0.167	63.0	51.5	0.2	11.742	0.470	52.9	43.62	0.350	52.909	48.474	10.783	100.000
CCE	1995	4	37	34	03H	1	J4498	00001	0.260	78.0	50.95	0.45	0.260	64.5	43.62	0.39	0.170	64.5	51.4	0.4	11.644	0.470	52.9	43.62	0.350	52.909	48.474	10.783	100.000
CCE	1995	1	42	44	03H	1	A9820	00001	0.600	92.0	68.83	3.99	0.600	92.0	68.83	3.87	0.500	92.0	77.3	3.9	6.080	0.520	95.1	74.35	0.470	95.100	78.196	6.047	100.000
CCE	1995	1	42	44	03H	1	B5534	00001	0.510	87.0	70.83	2.89	0.510	87.0	70.50	2.74	0.430	87.0	77.7	2.7	6.440	0.520	95.1	74.35	0.470	95.100	78.196	6.047	100.000
CCE	1995	1	42	44	03H	1	J4498	00001	0.380	82.0	60.27	1.76	0.373	79.0	59.35	1.72	0.323	79.0	65.9	1.7	8.500	0.520	95.1	74.35	0.470	95.100	78.196	6.047	100.000
CCE	1995	1	42	44	05H	1	A9820	00001	0.400	89.0	65.43	2.08	0.400	89.0	65.43	2.08	0.350	89.0	72.0	2.1	7.569	0.530	95.5	57.73	0.360	95.527	72.353	7.410	100.000
CCE	1995	1	42	44	05H	1	B5534	00001	0.390	94.0	68.37	1.3	0.403	90.5	66.61	1.28	0.353	90.5	73.4	1.3	7.515	0.530	95.5	57.73	0.360	95.527	72.353	7.410	100.000
CCE	1995	1	42	44	05H	1	J4498	00001	0.470	89.0	64.78	2.89	0.470	85.0	64.78	2.78	0.390	85.0	72.5	2.8	7.225	0.530	95.5	57.73	0.360	95.527	72.353	7.410	100.000
ANO	1992	2	19	55	01H	1	A9820	00001	0.180	74.0	45.21	0.78	0.180	60.0	41.76	0.35	0.160	60.0	44.9	0.3	9.596	0.540	49.9	34.35	0.300	49.927	44.006	8.901	67.00
ANO	1992	2	19	55	01H	1	B5534	00001	0.160	60.0	37.70	0.27	0.190	36.0	26.57	0.23	0.150	36.0	30.3	0.2	10.846	0.540	49.9	34.35	0.300	49.927	44.006	8.901	67.00
ANO	1992	2	19	55	01H	1	J4498	00001	1.100	68.0	37.04	0.62	1.100	41.5	21.60	0.50	0.230	41.5	32.2	0.5	10.295	0.540	49.9	34.35	0.300	49.927	44.006	8.901	67.00
ALA	1996	2	6	28	TTS	2	A9820	00143	0.330	54.0	23.42	0.41	0.350	30.0	20.76	0.32	0.300	30.0	22.8	0.3	14.504	0.640	38.0	29.49	0.420	38.000	34.222	12.687	100.00
ALA	1996	2	6	28	TTS	2	B5534	00143	0.240	49.0	23.24	0.35	0.273	30.0	22.43	0.30	0.233	30.0	24.4	0.3	14.509	0.640	38.0	29.49	0.420	38.000	34.222	12.687	100.00
ALA	1996	2	6	28	TTS	2	J4498	00143	0.330	80.0	18.63	0.36	0.350	30.0	23.05	0.29	0.270	30.0	26.2	0.3	14.149	0.640	38.0	29.49	0.420	38.000	34.222	12.687	100.00
PGE	1999	2	37	32	03H	1	A9820	00157	0.490	84.0	55.37	0.69	0.495	64.0	39.57	0.59	0.270	64.0	52.5	0.6	10.851	0.654	66.8	36.94	0.280	66.847	58.054	10.075	100.000
PGE	1999	2	37	32	03H	1	B5534	00157	0.290	75.0	44.88	0.89	0.310	65.5	42.84	0.85	0.220	65.5	51.2	0.9	11.380	0.654	66.8	36.94	0.280	66.847	58.054	10.075	100.000
PGE	1999	2	37	32	03H	1	J4498	00157	0.080	39.0	4.73	0.27	0.080	30.0	15.00	0.19	0.080	30.0	15.0	0.2	16.290	0.654	66.8	36.94	0.280	66.847	58.054	10.075	100.000
ANO	1992	2	96	116	02H	1	A9820	00001	0.660	94.0	57.40	1.08	0.660	75.5	57.40	0.75	0.600	75.5	60.2	0.8	6.462	0.665	58.2	39.86	0.350	58.200	50.849	8.039	67.00
ANO	1992	2	96	116	02H	1	B5534	00001	0.320	75.0	49.91	0.81	0.340	64.5	48.34	0.76	0.270	64.5	53.2	0.8	8.125	0.665	58.2	39.86	0.350	58.200	50.849	8.039	67.00
ANO	1992	2	96	116	02H	1	J4498	00001	0.420	69.0	46.71	0.96	0.420	69.0	46.71	0.96	0.350	69.0	50.7	1.0	8.059	0.665	58.2	39.86	0.350	58.200	50.849	8.039	67.00
DLW	1995	1	22	38	03H	1	A9820	00001	0.450	22.0	7.93	0.19	0.450	30.0	13.53	0.10	0.450	30.0	13.5	0.1	15.535	0.706	43.0	32.94	0.490	42.982	38.328	11.965	100.000
DLW	1995	1	22	38	03H	1	B5534	00001	0.100	88.0	27.93	0.22	0.133	44.0	25.47	0.19	0.113	44.0	28.5	0.2	14.834	0.706	43.0	32.94	0.490	42.982	38.328	11.965	100.000
DLW	1995	1	22	38	03H	1	J4498	00001	0.060	47.0	25.83	0.19	0.080	30.0	15.20	0.14	0.080	30.0	15.2	0.1	16.275	0.706	43.0	32.94	0.490	42.982	38.328	11.965	100.000
DLW	1995	1	28	42	01H	1	A9820	00001	0.220	70.0	23.52	0.3	0.220	30.0	17.27	0.21	0.190	30.0	18.8	0.2	15.326	0.716	45.7	33.85	0.410	45.727	41.561	11.693	100.000
DLW	1995	1	28	42	01H	1	B5534	00001	0.210	89.0	33.93	0.22	0.210	30.0	22.23	0.16	0.150	30.0	26.5	0.2	14.703	0.716	45.7	33.85	0.410	45.727	41.561	11.693	100.000
DLW	1995	1	28	42	01H	1	J4498	00001	0.390	47.0	23.92	0.3	0.390	30.0	14.93	0.30	0.350	30.0	16.1	0.3	15.291	0.716	45.7	33.85	0.410	45.727	41.561	11.693	100.000
DLW	1995	1	28	42	03H	1	A9820	00001	0.200	81.0	58.18	0.6	0.200	69.0	44.99	0.12	0.200	69.0	45.0	0.1	12.281	0.718	29.5	17.85	0.280	29.473	25.223	14.245	100.000
DLW	1995	1	28	42	03H	1	B5534	00001	0.230	79.0	37.12	0.09	0.243	30.0	22.12	0.07	0.193	30.0	24.6	0.1	14.651	0.718	29.5	17.85	0.280	29.473	25.223	14.245	100.000
DLW	1995	1	28	42	03H	1	J4498	00001	0.290	75.0	49.50	0.19	0.290	30.0	21.92	0.10	0.200	30.0	25.9	0.1	14.472	0.718	29.5	17.85	0.280	29.473	25.223	14.245	100.000
ANO	1996	1	70	98	01H	1	A9820	00137	1.220	100.0	71.74	9.46	0.710	100.0	86.63	9.38	0.710	100.0	86.6	9.4	3.255	0.990	100.0	76.71	0.790	100.000	87.555	2.987	67.00
ANO	1996	1	70	98	01H	1	B5534	00137	0.750	98.0	70.16	8.4	0.690	100.0	76.28	7.52	0.600	100.0	84.8	7.5	3.784	0.990	100.0	76.71	0.790	100.000	87.555	2.987	67.00
ANO	1996	1	70	98	01H	1	J4498	00137	0.840	100.0	73.28	11.72	0.790	100.0	76.35	11.67	0.680	100.0	85.1	11.7	3.451	0.990	100.0	76.71	0.790	100.000	87.555	2.987	67.00
ALA	1996	2	6	28	TTS	4	A9820	00143	0.180	96.0	43.54	0.72	0.180	56.0	41.43	0.25	0.150	56.0	44.8	0.2	12.831	1.040	31.6	16.96	0.290	31.636	25.735	14.150	100.00
ALA	1996	2	6	28	TTS	4	B5534	00143	0.220	96.0	42.98	0.39	0.240	52.0	33.60	0.29	0.200	52.0	37.4	0.3	13.153	1.040	31.6	16.96	0.290	31.636	25.735	14.150	100.00
ALA	1996	2	6	28	TTS	4	J4498	00143	0.120	83.0	38.80	0.3	0.140	48.0	35.16	0.27	0.120	48.0	37.8	0.3	13.891	1.040	31.6	16.96	0.290	31.636	25.735	14.150	100.00
ALA	1996	2	6	28	TTS	3	A9820	00143	0.450	78.0	33.92	0.64	0.450	35.5	27.06	0.31	0.350	35.5	30.1	0.3	13.414	1.150	39.7	24.78	0.540	39.709	33.354	12.601	100.00
ALA	1996	2	6	28	TTS	3	B5534	00143	0.530	67.0	27.86	0.32	0.543	30.0	21.30	0.32	0.350	30.0	25.0	0.3	14.099	1.150	39.7	24.78	0.540	39.709	33.354	12.601	100.00
ALA	1996	2	6	28	TTS	3	J4498	00143	0.450	50.0	16.46	0.33	0.450	30.0	22.48	0.30	0.370	30.0	25.2	0.3	14.034	1.150	39.7	24.78	0.540	39.709	33.354	12.601	100.00
ALA	1998	3	6	10	01H	7	A9820	00263	0.730	99.0	54.22	0.63	0.730	61.5	43.21	0.53	0.410	61.5	53.2	0.5	10.084	1.440	64.9	40.17	0.710	64.917	54.029	9.282	100.00
ALA	1998	3	6	10	01H	7	B5534	00263	0.730	99.0	54.80	0.68	0.770	46.8	31.35	0.57	0.430	46.8	39.4	0.6	11.947	1.440	64.9	40.17	0.710	64.917	54.029	9.282	100.00
ALA	1998	3	6	10	01H	7	J4498	00263	0.850	77.0	35.82	0.69	0.770	53.5	37.39	0.53	0.450	53.5	44.9	0.5	11.118	1.440	64.9	40.17	0.710	64.917	54.029	9.282	100.00
ALA	1998	3	6	10	TSH	4	A9820	00263	0.610	92.0	63.56	1.16	0.610	65.0	46.02	0.56	0.365	65.0	53.4	0.6	10.220	1.668	59.0	30.87	0.670	59.038	46.579	10.464	100.00
ALA	1998	3	6	10	TSH	4	B5534	00263	0.460	92.0	59.79	0.68	0.473	70.0	58.97	0.63	0.403	70.0	63.4	0.6	8.695	1.668	59.0	30.87	0.670	59.038	46.579	10.464	100.00
ALA	1998	3	6	10	TSH	4	J4498	00263	0.800	82.0	49.26	0.64	0.820	63.0	40.41	0.53	0.370	63.0	52.8	0.5	10.283	1.668	59.0	30.87	0.670	59.038	46.579	10.464	100.00
ANO	1996	1	16	56	01H	1	B5534	00137	0.970	75.0	56.83	7.16	0.840	100.0	78.25	7.16	0.640	100.0	84.6	7.2	3.588	1.826	100.0	58.86	0.720	100.000	86.584	3.214	67.000
ANO	1996	1	16	56	01H	1	J4498	00137	1.260	89.0	64.93	10.96	0.900	100.0	82.35	10.96	0.770	100.0	87.5	11.0	3.023	1.826	100.0	58.86	0.720	100.000	86.584	3.214	67.000
ANO	1996	1	16	56	01H	1	A9820	00137	1.440	87.0	66.68	7.85	1.100	100.0	81.27	7.85	0.800	100.0	88.0	7.9	2.918	1.826	100.0	58.86	0.720	100.000	86.584	3.214	67.000
ANO	1992	2	19	55	02H	1	A9820	00001	0.240	73.0	47.20	0.62	0.240	58.0	41.86	0.54	0.180	58.0	49.71	0.54	9.022		49.0			49.0			67.00
ANO	1992	2	19	55	02H	1	B5534	00001	0.230	62.0	38.57	0.47	0.260	41.5	27.22	0.44	0.160	41.5	35.02	0.44	10.401		49.0			49.0			67.00
ANO	1992	2	19	55	02H	1	J4498	00001	0.380	56.0	31.08	0.43	0.350	38.5	25.52	0.36	0.230	38.5	32.00	0.36	10.310		49.0			49.0			67.00

Figure
ANO-2 ODSCC – NDE Sizing Uncertainties
Destructive Exam vs. Burst Adjusted NDE Trends - Axial Length

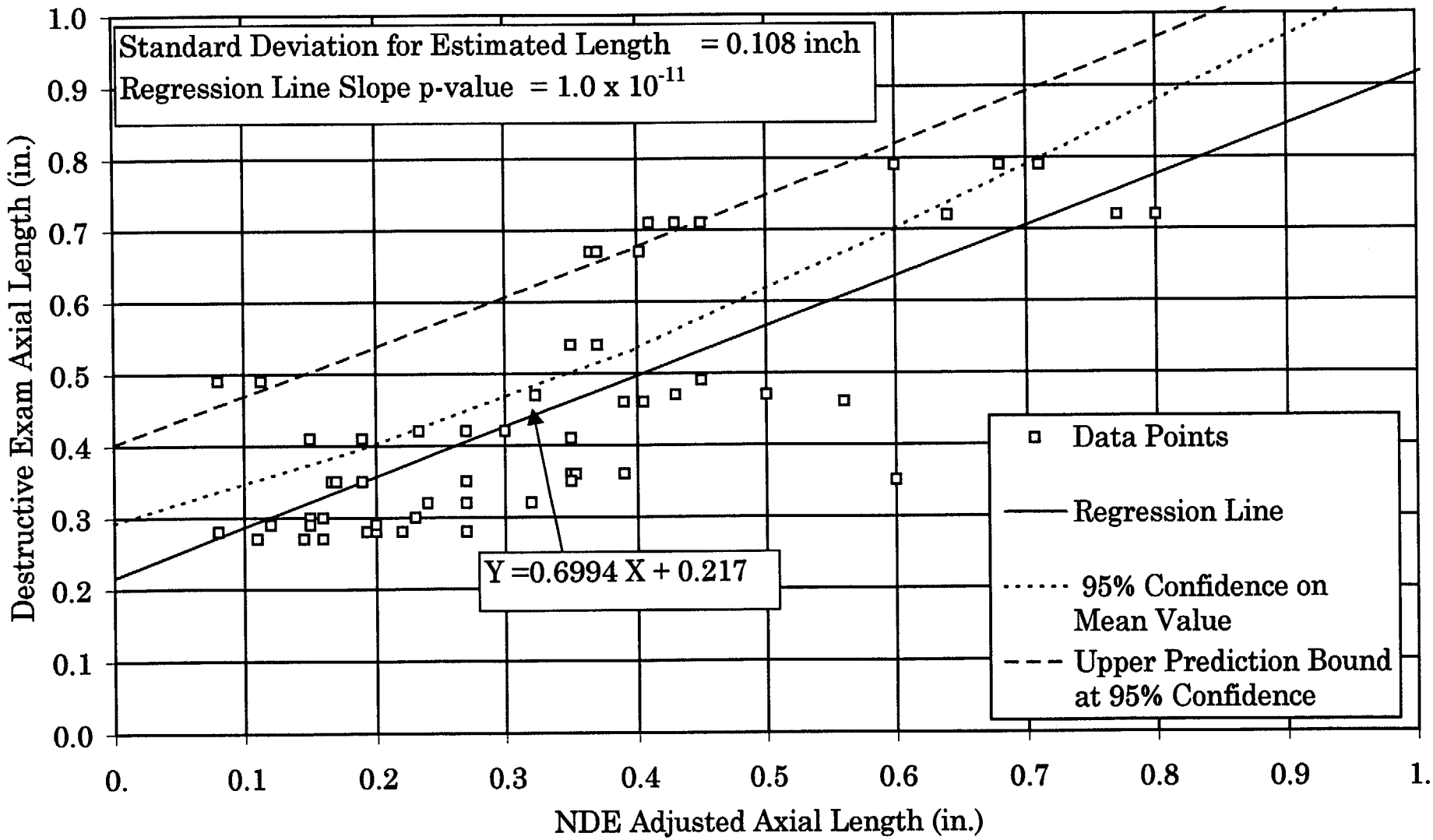


Figure
ANO-2 ODSCC – NDE Sizing Uncertainties
Destructive Exam vs. Burst Adjusted NDE Trends - Maximum Depth

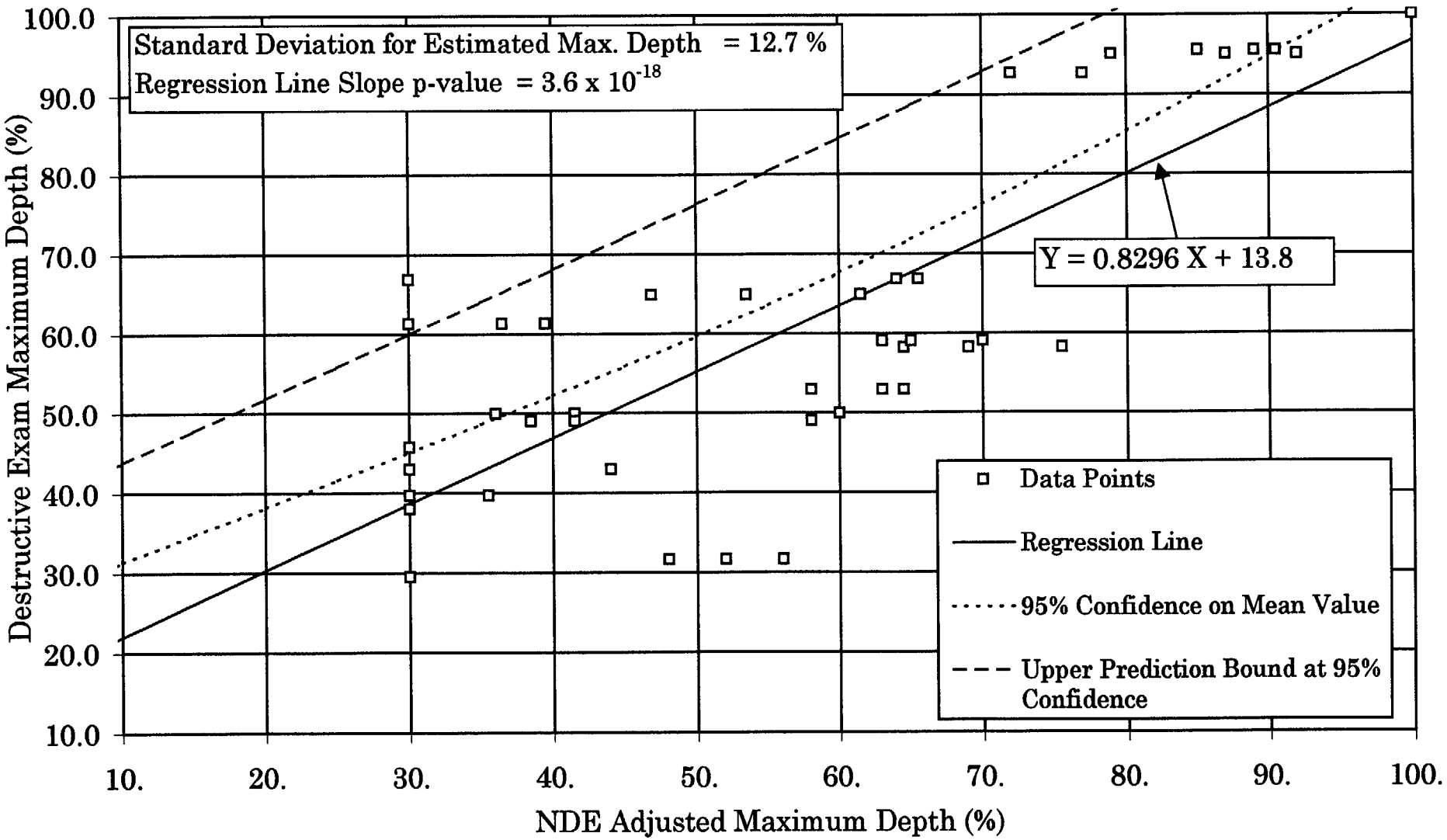


Figure
ANO-2 ODSCC – NDE Sizing Uncertainties
Destructive Exam vs. Burst Adjusted NDE Trends - Average Depth