NUCLEAR ENERGY INSTITUTE

David J. Modeen
DIRECTOR, ENGINEERING
NUCLEAR GENERATION DIVISION

February 11, 2000

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

SUBJECT: Steam Generator Degradation Specific Management Database, POPCD Corrections in Addendum 3

PROJECT NUMBER: 689

References:

1. Letter from D. Modeen (NEI) to NRC Document Control Desk, "Steam Generator Degradation Specific Database, Addendum 3", dated September 22, 1999

Reference 1 forwarded Addendum 3 to the Steam Generator Degradation Specific Management Database. A minor error has been discovered in the POPCD section of the Addendum 3 report. This letter forwards a corrected version of the affected section and explains the cause and implications of the error.

The error in the Addendum-3 POPCD update involved duplication of the data for 2 inspections in 7/8" tubing plants. So, instead of 6 additional inspection data points for 7/8" tubes, this update should only include data for 4 inspections. Westinghouse has NOT used the Addendum-3 POPCD data in any tube integrity analysis, and we are not aware of anyone else using the Addendum-3 data.

Among the various POPCD distributions presented in the addendum, only the generic distribution obtained by combining the data for both 3/4" and 7/8" tubes, shown in Table 7-4, is used in leak and burst analysis. The error had no effect on the recommended generic POPCD values for indications over 1.2 volts, while the revised values for indications 1.2 volts and under changed by 0.01 to 0.02, which is insignificant. Since only indications above 1 volt contribute significantly to leak and burst results, the incorrect Addendum-3 generic POPCD data has essentially no impact. The impact is negligible because of the large indication population considered for the generic POPCD evaluation. (The total number of indications considered in the generic distribution is about 50 times that in the two inspections inadvertently included twice.) The main conclusion of the POPCD analysis remains

unaltered: the probability of detection is dependent on the bobbin voltage, and for indications over 1 volt, it substantially exceeds the NRC mandated value of 0.6.

As has been the past practice, we believe any NRC staff review of the enclosed information is exempt from the fee recovery provision contained in 10 CFR Part 170. This submittal provides information that might be helpful to NRC staff when evaluating licensee submittals provided in response to Generic Letter 95-05. Such reviews are exempted under §170.21, Schedule of Facility Fees. Footnote 4 to the Special Projects provision of §170.21 states, "Fees will not be assessed for requests/reports submitted to the NRC...[a]s means of exchanging information between industry organizations and the NRC for the purpose of supporting generic regulatory improvements or efforts."

If you have any questions regarding the technical content of this letter, please contact Dr. Govinda Srikantiah of EPRI at (650) 855-2091.

Sincerely,

J N Pilley for

David J. Modeen

JHR/edb
Enclosure

c: Mr. Ted Sullivan, U.S. Nuclear Regulatory Commission
Mr. Jim Anderson, U.S. Nuclear Regulatory Commission
Mr. Stewart Magruder, Jr., U.S. Nuclear Regulatory Commission
Mr. David Goetcheus, TVA
Ms. Helen Cothron, TVA
Mr. Greg Kammerdeiner, Duquesne Light
Mr. Richard Pearson, NSP
Mr. Rick Mullins, Southern Co
Mr. Ron Baker, South Texas
Mr. Bob Exner, PG&E
Mr. John Arhar, PG&E
Mr. Steve Swilley, TU
Mr. John Jensen, AEP
Mr. Tim Olson, Wisconsin Public Service
Mr. Tom Pitterle, Westinghouse
Mr. Bob Keating, Westinghouse
Dr. Govinda Srikantiah, EPRI
Mr. David Steininger, EPRI
NEI Steam Generator Program Task Force

Enclosure 1

Revised Section 7
To the
SGDSM Database, Addendum 3

7

PROBABILITY OF DETECTION DATA EVALUATION

This section presents updated data for probability of prior cycle detection (POPCD). Data obtained from POPCD evaluations for 18 inspections in 9 plants are presented in Addendum-2 (Reference 7-1), and that database was updated by adding results from 5 additional POPCD evaluations.

Briefly, POPCD is calculated as the ratio of indications reported at the prior inspection to the total indications (reported in prior cycle plus new indications) found at the subsequent inspection. POPCD for the n^{th} inspection (EOC_n) is defined as follows.

$$POPCD\ (EOC_n) = \frac{\{\text{Numerator}\}}{\{\text{Numerator}\} + \text{New } EOC_{n+1} \text{ RPC confirmed indications (i.e., not detected at } EOC_n)}$$

$$\{\text{Numerator}\} = EOC_{n+1} \text{ RPC confirmed and detected at } EOC_n + EOC_n \text{ RPC confirmed and repaired at } EOC_n$$

The above definition for POPCD is based on the premise that all indications that can contribute significantly to leak rate calculations for voltage-based repair criteria application can be confirmed by RPC. However, since only a fraction of the bobbin indications are RPC inspected, a more realistic definition of POPCD is obtained by replacing EOC_{n+1} RPC confirmed indications with EOC_{n+1} RPC confirmed plus not inspected indications. A more detailed description of POPCD calculation is presented in Reference 7-2. Both POPCD values based on EOC_{n+1} RPC confirmed indications as well as EOC_{n+1} RPC confirmed plus not inspected indications are presented in this report.

7.1 Updated POPCD Data

Since the update of the POPCD database reported in Addendum-2 (Reference 7-1), data are available from 5 additional inspections, of which 4 are for plants with 7/8" diameter tubing and one for a plant with 3/4" diameter tubing. This section summarizes the latest updated POPCD database which now includes results from 23 evaluations. All of the inspections considered for POPCD evaluations are inspections performed after 1992 wherein a voltage-based repair criterion is applied.

Figure 7-1 (data of Table 7-1) shows the updated POPCD data for plants with 3/4" tubing. It is based on data from 8 inspections performed since 1992. The data trend is essentially same as that for the data presented in Reference 7-1; thus, the updated results continue to support the earlier finding that POD approaches unity above about 3 volts. The average POPCD independent of voltage is about 0.61 which is in general agreement with the NRC Generic Letter 95-05 proposed voltage independent POD of 0.60.

Figure 7-2 (data of Table 7-2) shows the updated POPCD data for plants with 7/8" diameter tubing. It is based on results from 15 inspections performed since 1992. The number of indications considered in the evaluations has increased by about 35% with the addition of data from 4 more inspections. The updated POPCD values show a slight improvement in all voltage ranges except for 0^+ to 0.4 and 1.6 to 2 volt bins. Indications in the size range 0^+ to 0.4 volts do not contribute significantly affect tube integrity and, therefore, a modest decrease in POPCD for such indications is inconsequential. The POPCD value for the 1.6 to 2 volt bin decreased by about 0.02, and a change of this magnitude is not significant. The average POPCD independent of voltage remained unchanged at about 0.72 with the addition of new data. As with the original data in Addendum-1 and the subsequently updated data in Addendum-2, the presently updated data also support a POD approaching unity above 3 volts.

The combined POPCD data for 23 inspections since 1992 are given in Table 7-3, and the results based on the RPC confirmed plus not inspected indications are illustrated in Figure 7-3. The updated POPCD distribution is very similar to the distributions shown in Addenda-1 and 2. It is also in good agreement with an EPRI POD developed using multiple analysts to evaluate a large number of field indications with "truth" for indications based on "expert" opinion. POPCD supports a POD approaching unity at about 3.5 volts while the EPRI POD is about 0.98 at 2 volts and unity at 3 volts. Figure 7-3 also includes POPCD evaluated at the lower 95% confidence limit on the data for individual voltage bins. The data of Table 7-3 show 741 to 13,920 indications in all voltage bins below 2 volts, nearly 417 between 2.0 and 3.2 volts and about 66 indications above about 3.2 volts. Thus, the collective data provide a substantial database for defining a POD.

The POPCD evaluations shown in Figures 7-1 to 7-3 are based on the definition of "truth" as RPC confirmed plus not RPC inspected indications. Since many of the indications not RPC inspected would be expected to be found NDD if inspected, this represents a lower bound POPCD evaluation. Figure 7-4 shows the POPCD evaluation for all 23 inspections since 1992 based only on RPC confirmed indications. The differences between the POPCD values calculated considering RPC confirmed indications only (Figure 7-4) and those based on RPC confirmed and not inspected indications (Figure7-3) are not as significant as for the original data in Reference 7-1. However, the data based on RPC confirmed indications only still show a slight increase in POPCD below 1.5 volts.

7.2 Recommended POD Distribution

As with the data presented in Addenda-1 and 2, the results of Figure 7-3 clearly support an increase in the POD for voltage-based repair criteria applications above the POD = 0.6, independent of voltage, required by the NRC Generic Letter 95-05. For indications above 1.0 volt, the POD exceeds 0.85 and is 0.92 to near unity at 2.0 volts. A POD of 0.6 is only applicable to indications below about 0.5 volts.

A recommended voltage dependent POD was initially developed in Addendum-1 (and subsequently updated in Addendum-2) as POPCD evaluated at the lower 95% confidence level and the mid-voltage of each voltage bin. The result is then smoothed to obtain the recommended POD as shown in Figure 7-5. Updated values for the recommended POD distribution are tabulated in Table 7-4 and compared with the distribution recommended in Addendum-2. It is evident that in spite of a significant increase the database, the recommended POPCD distribution is essentially unchanged. This provides additional confidence that the recommended POD is well founded and supported by a substantial database. The updated POPCD distribution is compared with EPRI POD distribution (based on dual analyst variability) in Figure 7-6, and, as reported in Addenda-1 and 2, the two distributions show consistent trends.

The POPCD evaluations for 23 inspections since 1992 provide a database for updating the NRC generic letter requirements on POD. The POD of Figure 7-5 is recommended for voltage-based repair criteria applications as a replacement for the constant POD of 0.6. In response to a NRC RAI (Reference 7-3) on the POPCD data represented in Reference 7-1, a detailed evaluation was carried to demonstrate conservatism in the projections for EOC conditions using POPCD. Thirty-two SG cases were analyzed using the projection methodology used to demonstrate compliance with GL 95-05. The projected results were shown either to be essentially the same as or exceed those based on the actual voltages. Thus, there is a strong basis for application of POPCD for operational assessment evaluations per GL 95-05. However, per NRC GL 95-05, formal NRC approval of the recommended POD is required before application to voltage-based repair criteria analyses.

7.3 References

7-1 NP-7480-L, Addendum 2, 1998 Database Update, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," prepared for EPRI by Westinghouse (April 1998).

7-2 NP-7480-L, Addendum 1, 1996 Database Update, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," prepared for EPRI by Westinghouse (August 1996).

7-3 Letter from S. L. Magruder, Nuclear Regulatory Commission, to D. Modeen, Nuclear Energy Institute, January 24, 1997.

Table 7-1
Evaluation for POPCD for Plants with 3/4" SG Tubes
Combined Data from 8 Post-92 ('93 and later) Inspections

Voltage Bin	New Indications		Bobbin Call in Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Count
> 0 - 0.2	13	1923	2	696	32	0.723	34 / 47	0.275	728 / 2651
0.2 - 0.4	116	5798	29	4208	321	0.751	350 / 466	0.439	4529 / 10327
0.4 - 0.6	128	3522	150	5234	296	0.777	446 / 574	0.611	5530 / 9052
0.6 -0 .8	104	1321	344	3890	201	0.840	545 / 649	0.756	4091 / 5412
0.8 - 1.0	98	501	470	2387	137	0.861	607 / 705	0.834	2524 / 3025
1.0 - 1.2	57	154	212	845	894	0.951	1106 / 1163	0.919	1739 / 1893
1.2 - 1.6	40	83	245	482	785	0.963	1030 / 1070	0.939	1267 / 1350
1.6 - 2.0	6	9	82	87	247	0.982	329 / 335	0.974	334 / 343
2.0 - 2.5	4	4	26	26	96	0.968	122 / 126	0.968	122 / 126
2.5 - 3.2	2	2	9	9	67	0.974	76 / 78	0.974	76 / 78
3.2 - 3.5	0	0	0	0	5	1.000	5 / 5	1.000	5 / 5
TOTAL	568	13317	1569	17864	3081				
Total > 1V	109	252	574	1449	2094				

Table 7-2
Evaluation for POPCD for Plants with 7/8" SG Tubes
Combined Data from 15 Post-92 ('93 and later) Inspections

Voltage Bin	New Indications		Bobbin Call in Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed	RPC Confirmed plus not Inspected	Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Count
>0 - 0.2	229	582	1	241	5	0.026	6 / 235	0.297	246 / 828
0.2 - 0.4	87	1569	52	1853	76	0.595	128 / 215	0.551	1929 / 3498
0.4 - 0.6	89	1468	119	3219	180	0.771	299 / 388	0.698	3399 / 4867
0.6 -0 .8	72	942	196	3095	159	0.831	355 / 427	0.776	3254 / 4196
0.8 - 1.0	49	480	235	2255	126	0.880	361 / 410	0.832	2381 / 2861
1.0 - 1.2	47	247	225	1478	114	0.878	339 / 386	0.866	1592 / 1839
1.2 - 1.6	54	192	339	1212	126	0.896	465 / 519	0.875	1338 / 1530
1.6 - 2.0	31	51	164	282	65	0.881	229 / 260	0.872	347 / 398
2.0 - 2.5	14	14	22	22	116	0.908	138 / 152	0.908	138 / 152
2.5 - 3.2	4	4	6	6	51	0.934	57 / 61	0.934	57 / 61
3.2 - 3.5#	0	0	0	0	3	1.000	3 / 3	1.000	3 / 3
TOTAL	676	5549	1359	13663	1021				
Total > 1V	150	508	756	3000	475				

Pre-'92 database includes 3 indications between 3 and 3.5 volts and post-'92 database includes 17 indications above 3.5 volts. POPCD values for all those indications is unity.

Table 7-3
Combined POPCD Evaluation for 23 Assessments Conducted After 1992
POPCD Based on RPC Confirmed Plus Not Inspected Indications

Voltage Bin	New Indications		Bobbin Call in Both Inspections		First Inspection	POPCD			
	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed	RPC Confirmed plus not Inspected	RPC Confirmed and Plugged	RPC Confirmed		RPC Confirmed Plus Not Inspected	
						Frac.	Count	Frac.	Count
> 0 - 0.2	242	2505	3	937	37	0.142	40 / 282	0.280	974 / 3479
0.2 - 0.4	203	7367	81	6061	397	0.702	478 / 681	0.467	6458 / 13825
0.4 - 0.6	217	4990	269	8453	476	0.774	745 / 962	0.641	8929 / 13919
0.6 -0 .8	176	2263	540	6985	360	0.836	900 / 1076	0.764	7345 / 9608
0.8 - 1.0	147	981	705	4642	263	0.868	968 / 1115	0.833	4905 / 5886
1.0 - 1.2	104	401	437	2323	1008	0.933	1445 / 1549	0.893	3331 / 3732
1.2 - 1.6	94	275	584	1694	911	0.941	1495 / 1589	0.905	2605 / 2880
1.6 - 2.0	37	60	246	369	312	0.938	558 / 595	0.919	681 / 741
2.0 - 2.5	18	18	48	48	212	0.935	260 / 278	0.935	260 / 278
2.5 - 3.2	6	6	15	15	118	0.957	133 / 139	0.957	133 / 139
3.2 - 3.5	0	0	0	0	8	1.0	8 / 8	1.0	8 / 8
TOTAL	1244	18866	2928	31527	4102				
Total > 1V	259	760	1330	4449	2569				

Table 7-4
Comparison of EPRI POPCD with EPRI POD Study

Voltage Bin	EPRI# POD Study	EPRI POPCD	
		NP-7480-L Addendum-2	Updated
0.1	0.30	0.26	0.20
0.2	0.38	0.36	0.33
0.3	0.49	0.46	0.46
0.4	0.57	0.54	0.55
0.5	0.62	0.63	0.63
0.6	0.66	0.69	0.70
0.7	0.71	0.75	0.76
0.8	0.76	0.79	0.79
0.9	0.80	0.82	0.83
1	0.83	0.84	0.84
1.2	0.90	0.87	0.88
1.4	0.93	0.89	0.90
1.6	0.96	0.91	0.91
1.8	0.98	0.92	0.92
2	0.98	0.93	0.93
3	1.00	0.98	0.98
3.5	1.00	1.0	1.0

Dual analyst detection probability study

Figure 7-1
Combined POPCD Evaluation for 8 Post-92 Inspections for 3/4" Dia Plants
POPCD Based on RPC Confirmed Plus Not Inspected Indications

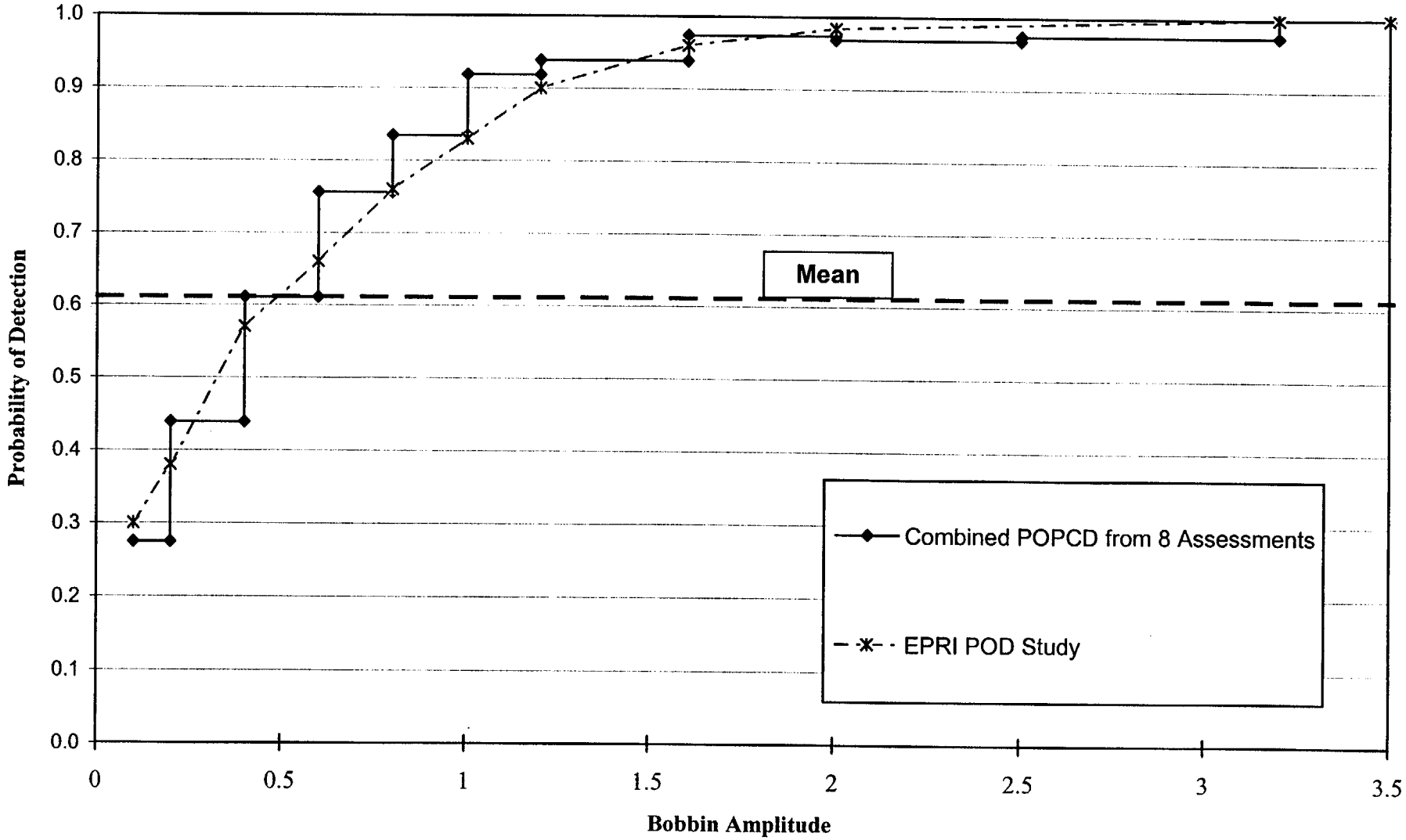

Figure 7-2
Combined POPCD Evaluation for 15 Post-92 Inspections for 7/8" Dia Plants
POPCD Based on RPC Confirmed Plus Not Inspected Indications

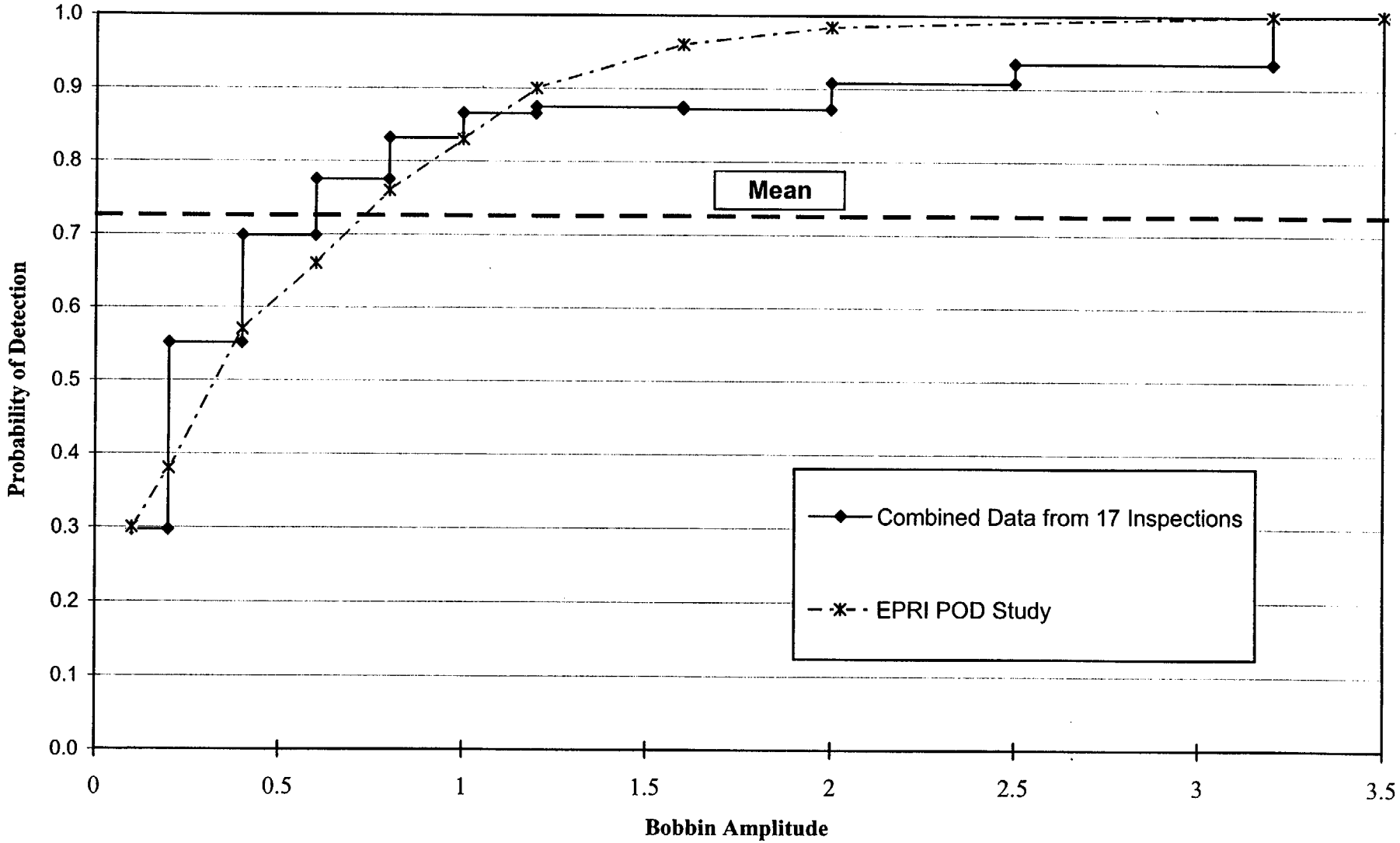

Figure 7-3
Combined POPCD Evaluation for 23 Post-'92 Inspections
POPCD Based on RPC Confirmed Plus Not Inspected Indications

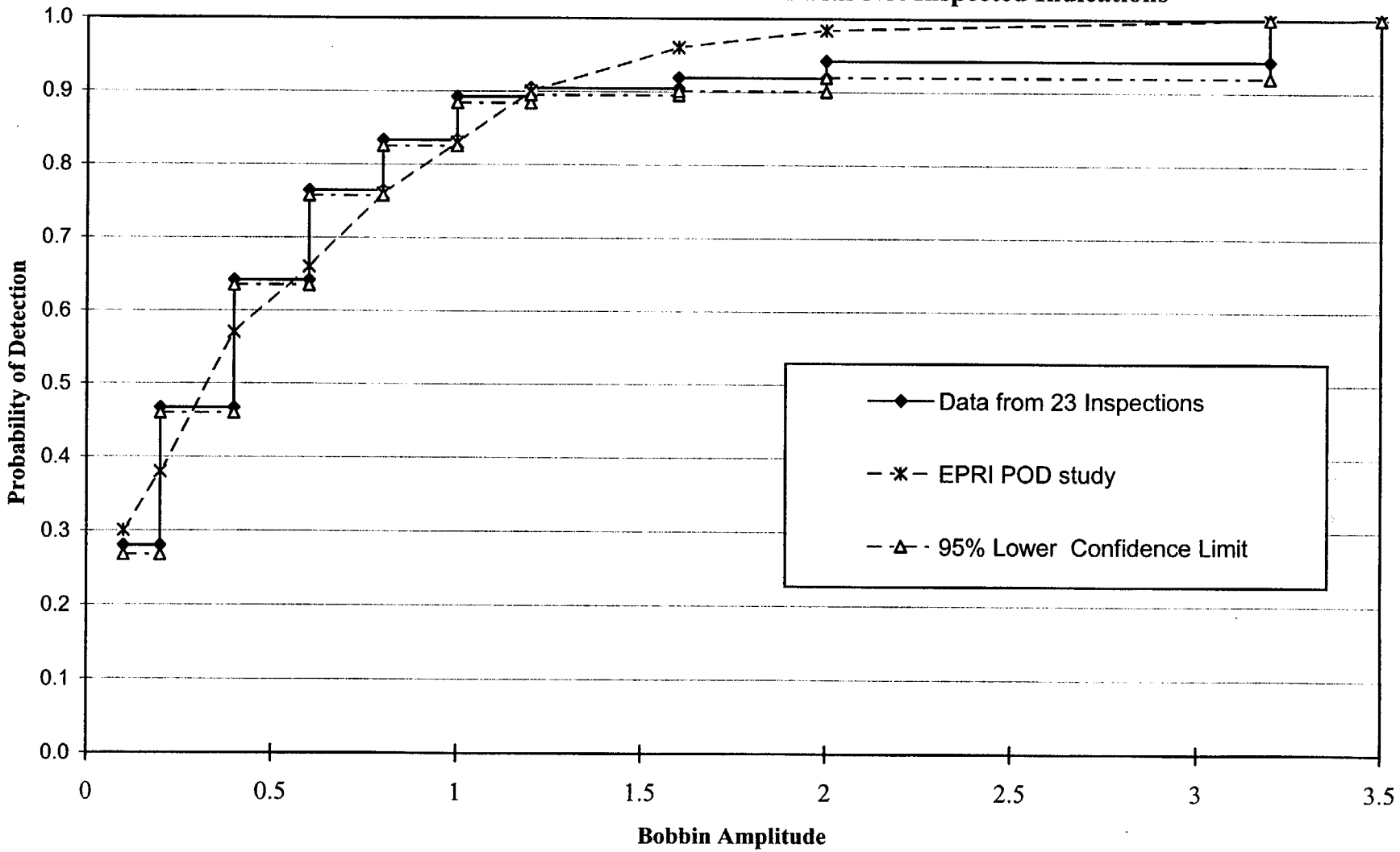

Figure 7-4
Combined POPCD Evaluation for 23 Post-'92 Inspections
POPCD Based on RPC Confirmed Indications Only

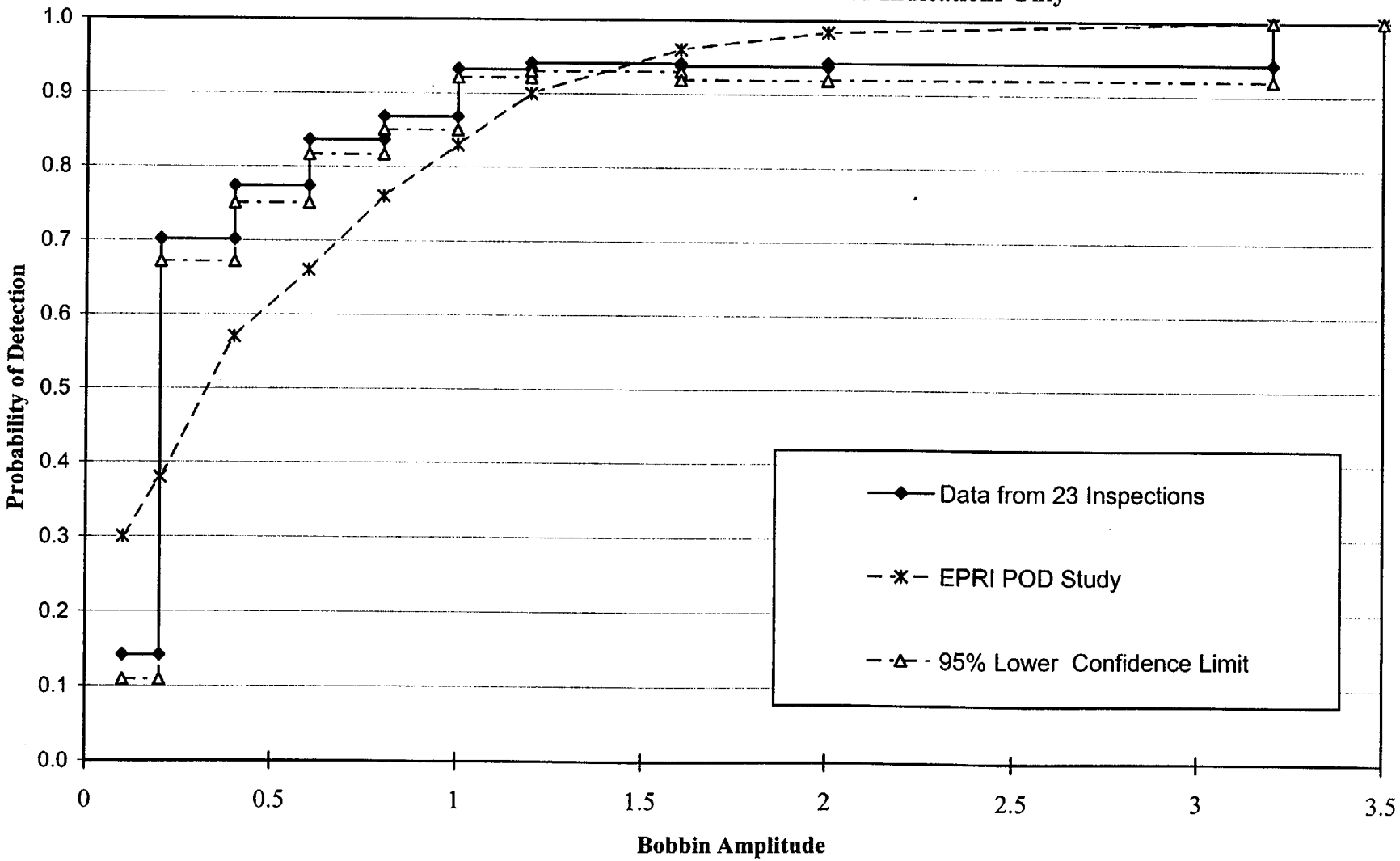

Figure 7-5
Combined POPCD Evaluation for 23 Post-'92 Inspections
POPCD Based on RPC Confirmed Plus Not Inspected Indications

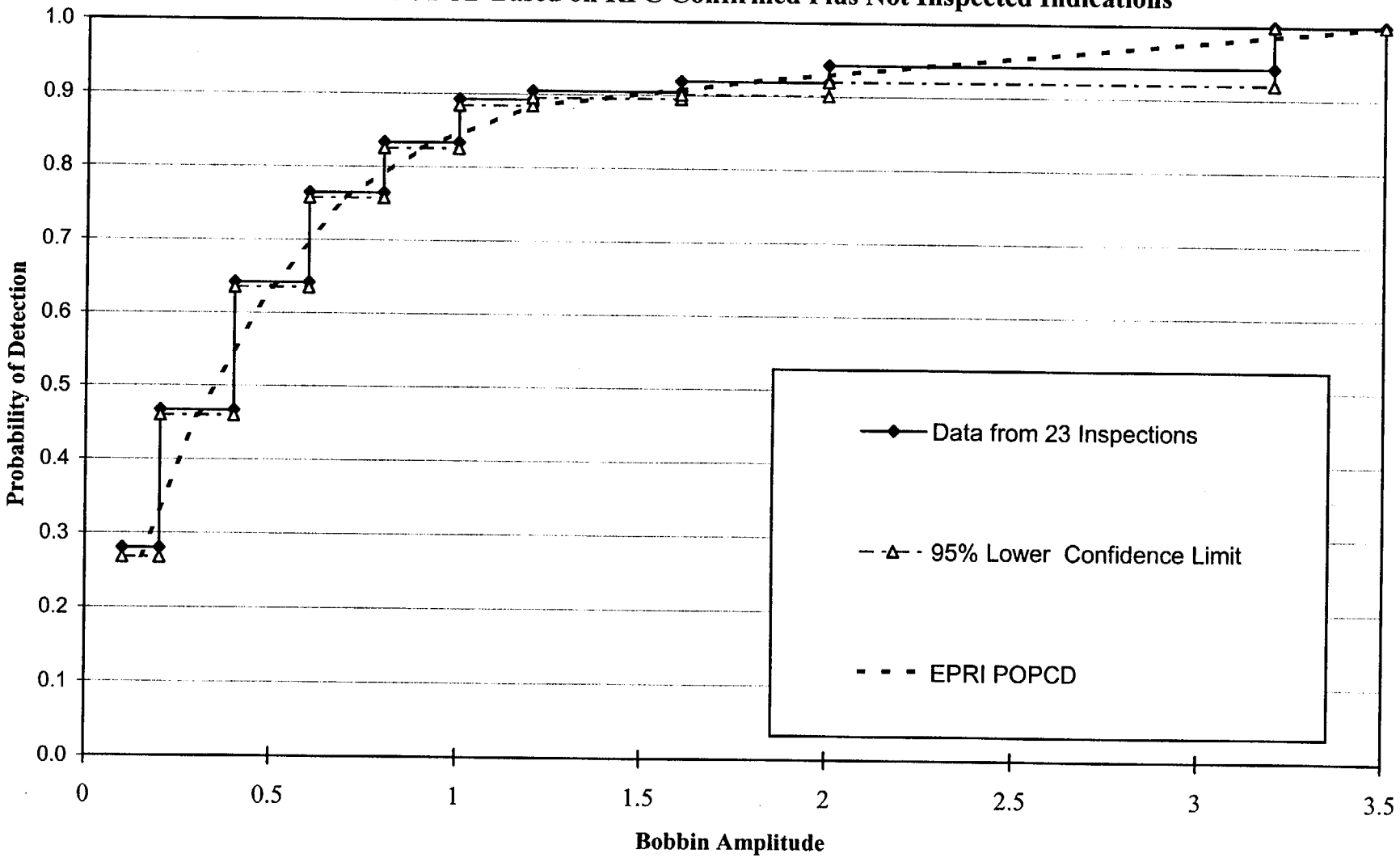

Figure 7-6
Comparison Alternate POPCD with EPRI POD
POPCD Based on RPC Confirmed Plus Not Inspected Indications