Pacific Gas and
Electric Company

David H. Oatley
Vice President and
General Manager

Diablo Canyon Power Plant
P.O. Box 56
Avila Beach, CA 93424

805.545.4350
Fax: 805.545.4234

June 26, 2003

PG&E Letter DCL-03-078

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
License Amendment Request 03-10
Revised Steam Generator Voltage-based Repair Criteria Probability of Detection Method for Diablo Canyon Unit 2 Cycle 12

In accordance with 10 CFR 50.90, enclosed is an application for amendment to Facility Operating License No. DPR-82 for Unit 2 of the Diablo Canyon Power Plant (DCPP). The enclosed license amendment request (LAR) requests NRC approval to update the DCPP Final Safety Analysis Report Update (FSARU) to use a revised steam generator (SG) voltage-based repair criteria probability of detection (POD) method for DCPP Unit 2 Cycle 12 using plant specific inspection results. The proposed POD method is based on the probability of prior cycle detection (POPCD) method described in EPRI Topical Report NP 7480-L, Addenda 1 through 5, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," dated November, 1996 through January, 2003. The POPCD implementation methods for classification of indications, voltage bin width, and regression analysis for POD analyses are updated in this LAR relative to the methods described in EPRI Topical Report NP 7480-L, Addenda 1 through 5. Technical Specification 5.5.9 (TS), "Steam Generator Tube Surveillance Program," and TS 5.6.10, "Steam Generator Tube Inspection Report," are based on Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," dated August 3, 1995, which requires the application of a POD of 0.6 to all previous bobbin indications for the determination of the indication voltage distribution for the beginning of cycle (BOC). Therefore, the use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 operational assessment (OA) is an exception to GL 95-05 and requires prior NRC review and approval.

The use of a constant POD of 0.6 for determination of the indication voltage distribution for the BOC is nonconservative for indications below about 0.5 volts and excessively conservative for indications above 1 volt. The POPCD method to determine POD provides a more realistic POD that is a function of voltage. Application of the POPCD method reduces preventative plugging of SG tubes which

maintains reactor coolant system flow margin and reduces personnel dose during refueling outages.

Upon NRC approval, the FSARU will be updated to reflect the use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA, which is an exception to the GL 95-05 guidance that requires the application of a POD of 0.6 to all previous bobbin indications.

During DCPP Unit 2 Refueling Outage 11, a 21.5-volt bobbin indication was found in DCPP Unit 2 SG 4 in the tube at row 44, column 45 at the second tube support plate (TSP) on the hot leg side (R44C45-2H). The indication was left in service following DCPP Unit 2 Refueling Outage 10, under the alternate repair criteria (ARC) for outside diameter stress corrosion cracking indications at SG TSP intersections. During DCPP Unit 2 Cycle 11, the indication voltage grew from 2.0 to 21.5 volts. On June 3, 2003, the NRC issued License Amendment No. 158 to Facility Operating License No. DPR-82 for DCPP Unit 2 that authorized revisions to the FSARU to incorporate the NRC approval to apply a POD of 1.0 to the R44C45-2H indication for the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA. The use of a POD of 1.0 for the R44C45-2H indication for the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA results in a POB which is less than the TS 5.6.10.d.5, "Steam Generator Tube Inspection Report," POB reporting limit of 1×10^{-2} through October, 2003. The approval to use the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA will result in a POB which is less than the reporting limit of 1×10^{-2} for the duration of Unit 2 Cycle 12, when used in conjunction with DCPP Unit 2 Cycle 11 voltage dependent growth with statistically developed breakpoints at 0.59 volts and 1.66 volts.

Enclosure 1 contains a description of the proposed change, the supporting technical analyses, the no significant hazards consideration determination, and figures and tables supporting the technical analyses. Enclosure 2 contains the marked-up FSARU pages for information only.

There are no TS changes required to use the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA.

PG&E has determined that this LAR does not involve a significant hazard consideration as determined per 10 CFR 50.92. Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment needs to be prepared in connection with the issuance of this amendment.

A similar request was made in PG&E letter DCL-03-017, "Revised Steam Generator Voltage-based Repair Criteria Probability of Detection Method for Diablo Canyon Unit 2 Cycle 12," dated February 24, 2003. This LAR supersedes that request. The change in this LAR is not required to address an immediate safety concern. PG&E requests approval of this LAR no later than October 1, 2003, in order to maintain the POB less than the TS 5.6.19.d.5 reporting limit of $1x10^{-2}$ for the duration of Unit 2 Cycle 12. PG&E requests the LAR be made effective upon NRC issuance, to be implemented by incorporation into the FSARU within 30 days of issuance.

If you have any questions or require additional information, please contact Stan Ketelsen at 805-545-4720.

Sincerely,

D. H. Oatley

David H. Oatley
Vice President and General Manager - Diablo Canyon

kjse/4328
Enclosures

cc: Edgar Bailey, DHS
Thomas P. Gwynn
David L. Proulx
Diablo Distribution

cc/enc: David H. Jaffe

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY Diablo Canyon Power Plant Unit 2	Docket No. 50-323 Facility Operating License No. DPR-82

AFFIDAVIT

David H. Oatley, of lawful age, first being duly sworn upon oath says that he is Vice President and General Manager - Diablo Canyon of Pacific Gas and Electric Company; that he has executed license amendment request LAR 03-10 on behalf of said company with full power and authority to do so; that he is familiar with the content thereof; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

David H. Oatley
Vice President and General Manager - Diablo Canyon

Subscribed and sworn to before me this 26th day of June 2003.

Notary Public
County of San Luis Obispo
State of California

CHUCK MACKEY
Commission # 1397547
Notary Public - California
San Luis Obispo County
My Comm. Expires Feb 1, 2007

EVALUATION

1.0 DESCRIPTION

This letter is a request to amend Operating License DPR-82 for Unit 2 of the Diablo Canyon Power Plant (DCPP).

The proposed change would revise the Operating License to allow the update of the DCPP Final Safety Analysis Report Update (FSARU) to use a revised steam generator voltage-based repair criteria probability of detection (POD) method for DCPP Unit 2 Cycle 12 using plant specific inspection results. The proposed POD method is based on the probability of prior cycle detection (POPCD) method described in EPRI Topical Report NP 7480-L, Addenda 1 through 5, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," dated November, 1996 through January, 2003. The POPCD implementation methods for classification of indications, voltage bin width, and regression analysis for POD analyses are updated in this License Amendment Request (LAR) relative to the methods described in EPRI Topical Report NP 7480-L, Addenda 1 through 5.

Technical Specification (TS) 5.5.9, "Steam Generator Tube Surveillance Program," and TS 5.6.10, "Steam Generator Tube Inspection Report," are based on Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," dated August 3, 1995, which requires the application of a POD of 0.6 to all previous bobbin indications for the determination of the indication voltage distribution for the beginning of cycle (BOC). The use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 operational assessment (OA) is an exception to the GL 95-05 guidance and requires prior NRC review and approval.

2.0 PROPOSED CHANGE

The requested change would allow use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA. This exception to GL-95-05 does not require a change to the TS since Section 5.5.9, "Steam Generator (SG) Tube Surveillance Program," and Section 5.6.10, "Steam Generator Tube Inspection Report," do not specify the bobbin POD to be used or the bobbin indications which are to be used for determination of the indication voltage distribution for the OA.

Upon approval of this LAR, the FSARU will be updated to reflect the use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA, which is an exception to GL 95-05 guidance that requires the application of a POD of 0.6 to all previous bobbin indications unless an alternate POD is approved by the NRC.

The proposed FSARU changes are provided for information only in Enclosure 2.

3.0 BACKGROUND

3.1 SG Voltage-based Repair Criteria

The SG tubes constitute more than half of the reactor coolant pressure boundary (RCPB). Design of the RCPB for structural and leakage integrity is a requirement under Title 10 of the Code of Federal Regulations, Part 50 (10 CFR 50), Appendix A. Specific requirements governing the maintenance and inspection of SG tube integrity are in the DCPP TS, Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, and Regulatory Guide (RG) 1.83. These include requirements for periodic inservice inspection of the tubing, flaw acceptance criteria (i.e., repair limits for plugging), and primary-to-secondary leakage limits. These requirements, coupled with the broad scope of plant operational and maintenance programs, have formed the basis for assuring adequate SG tube integrity.

SG tube plugging limits are specified in the DCPP TS. The current DCPP TS require that flawed tubes be removed from service by plugging if the depths of the flaws are greater than or equal to 40 percent through-wall, unless the degradation is subject to voltage-based outside diameter stress corrosion cracking (ODSCC) repair criteria, W* repair criteria, or primary water stress corrosion cracking within dented tube support plate (TSP) repair criteria. The TS 5.5.9 repair limits ensure that tubes accepted for continued service will retain adequate structural and leakage integrity during normal operating, transient, and postulated accident conditions, consistent with General Design Criteria (GDC) 14, 15, 30, 31, and 32 of 10 CFR 50, Appendix A. Structural integrity refers to maintaining adequate margins against gross failure, rupture, and collapse of the SG tubing. Leakage integrity refers to limiting primary-to-secondary leakage to within acceptable limits.

The generic criteria for voltage-based limits for ODSCC are contained in GL 95-05. The generic criteria for voltage-based limits rely on empirically derived correlations between a nondestructive inspection parameter, the bobbin coil voltage, and tube burst pressure and leak rate. The GL guidance ensures structural and leakage integrity continue to be maintained at acceptable levels consistent with the requirements of 10 CFR 50 and the guideline values in 10 CFR 100 through augmented SG tube inspections and more restrictive operational leakage limits.

GL 95-05 focuses on maintaining tube structural integrity during the full range of normal, transient, and postulated accident conditions with adequate allowance for eddy current test uncertainty and flaw growth projected to occur during the next operating cycle. In order to ensure the structural and leakage integrity of the tube until the next scheduled inspection, GL 95-05 specifies a methodology to determine the conditional burst probability and the total primary-to-secondary leak rate from an affected SG during a postulated main steam line break (MSLB) event. The methodology in WCAP-14277, Revision 1, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections," dated December 1996, is used to implement the GL 95-05 structural integrity methodology

A probabilistic analysis to quantify the potential for SG tube ruptures given a MSLB event is performed per WCAP-14277, Revision 1, and compared to a threshold value of $1x10^{-2}$ per cycle as required by GL 95-05. This threshold value provides assurance that the probability of burst (POB) is acceptable considering the assumptions of the calculation and the results of the staff's generic risk assessment for SGs contained in NUREG-0844, "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding Steam Generator Tube Integrity." Failure to meet this threshold value indicates ODSCC confined to within the thickness of the TSP could contribute a significant fraction to the overall conditional probability of tube rupture from all forms of degradation assumed and evaluated as acceptable in NUREG-0844.

The calculation of conditional burst probability is, in part, a function of the POD and the resulting indication voltage distribution at BOC. The indication voltage distribution at BOC is based on consideration of all previous bobbin indications that were detected at the BOC, including those that were plugged. The POB threshold value of $1x10^{-2}$ per cycle is contained in the DCPP Unit 1 and 2 TS 5.6.10.d.5 NRC reporting limit, which requires that PG&E notify the NRC and provide an assessment of safety significance, prior to returning the SGs to service, if the calculated conditional POB based on the projected end of cycle (EOC) voltage distribution exceeds $1x10^{-2}$.

The voltage-based ODSCC repair criteria are briefly described in FSARU section 5.5.2.5.4,"Voltage-Based Alternate Repair Criteria." The use of a voltage-based alternate repair criteria for ODSCC indications at SG TSP intersections was approved by the NRC in Amendment Nos. 124 and 122 to Facility Operating License Nos. DPR-80 and DPR-82, respectively, for DCPP Units 1 and 2 in a letter to PG&E dated March 12, 1998. PG&E requested the use of the voltage-based alternate repair criteria (ARC) for ODSCC at SG TSP intersections in PG&E letter DCL-97-034, "License Amendment Request 97-03, Voltage-Based Alternate Steam Generator

Tube Repair Limit for Outside Diameter Stress Corrosion Cracking at Tube Support Plate Intersections," dated February 26, 1997. In letter DCL-97-034, as an alternative to using a very conservative constant POD value of 0.6, PG&E requested the use of a revised POD method. This revised POD is a more realistic POD that is a function of indication voltage and is referred to as the POPCD method. Section 3.1.3 of the NRC safety evaluation for License Amendment Nos. 124 and 122 for DCPP Units 1 and 2 respectively addressed the structural and leakage integrity assessments related to the ARC and stated that "PG&E will be permitted to use a revised POD, in lieu of a constant value of 0.6, if and when a revised POD is approved by the NRC. Until that occurs, PG&E will have to use a constant value of 0.6." Based on the requirements of License Amendment Nos. 124 and 122, the use of a POD other than a POD of 0.6 in ODSCC ARC structural and leakage assessments requires prior NRC review and approval.

3.2. POPCD Method

The voltage dependent POPCD method is described in EPRI Topical Report NP 7480-L, Addenda 1 through 5, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits," dated November 1996 through January, 2003, respectively. EPRI Topical Report NP 7480-L, Addendum 5, was transmitted to the NRC in Nuclear Energy Institute letter, "Steam Generator Degradation Specific Management Database, Addendum 5," dated February 13, 2003. The use of a voltage dependent POD is supported by an eddy current reliability study performed by Argonne National Laboratory (ANL) and reported in NUREG/CR-6791, "Eddy Current Reliability Results from the Steam-Generator Mock-up Analysis Round-Robin," dated November 2002.

The industry has previously requested that the NRC review and approve the use of the POPCD values contained in EPRI Topical Report NP 7480-L, Addendum 1. In addition, PG&E previously requested in PG&E letter DCL-97-034 the approval to use the POPCD values contained in EPRI Topical Report NP 7480-L, Addendum 1, Table 7-4, under the "Recommended POD" column, as part of the request to use the voltage-based ARC for ODSCC at SG TSP intersections. The EPRI Topical Report NP 7480-L, Addendum 1, Table 7-4, POPCD values are voltage dependent POD values developed from a database of 11 inspections and are based on the lower 95 percent confidence level at the mid-voltage of each voltage bin. The POPCD database has increased to 37 inspections through NP 7480-L, Addendum 5, with no significant changes in the POPCD distribution.

3.3. Purpose for Proposed Amendments

During DCPP Unit 2 Refueling Outage 11 (2R11), a 21.5-volt bobbin indication was found in the SG 4 tube at row 44, column 45 at the second TSP on the hot leg side (R44C45-2H). The indication was left in service following DCPP Unit 2 Refueling Outage 10 (2R10), under the ARC for ODSCC indications at SG TSP intersections. During DCPP Unit 2 Cycle 11, the indication voltage grew from 2.0 to 21.5 volts. On June 3, 2003, the NRC issued License Amendment No. 158 to Facility Operating License No. DPR-82 for DCPP Unit 2 that authorized revisions to the FSARU to incorporate the NRC approval to apply a POD of 1.0 to the 21.5-volt R44C45-2H indication for the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA. The use of a POD of 1.0 for the 21.5-volt R44C45-2H indication for the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA results in a POB which is less than the TS 5.6.10.d.5 POB reporting limit of 1×10^{-2} through October, 2003. The approval to use the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA will result in a POB which is less than the reporting limit of 1×10^{-2} for the duration of Unit 2 Cycle 12, when used in conjunction with DCPP Unit 2 Cycle 11 voltage dependent growth with statistically developed breakpoints at 0.59 volts and 1.66 volts.

The use of a constant POD of 0.6 for determination of the indication voltage distribution for the BOC is nonconservative for indications below about 0.5 volts and excessively conservative for indications above 1 volt. The POPCD method to determine POD provides a more realistic POD that is a function of voltage. Application of the POPCD method reduces preventative plugging of SG tubes which maintains reactor coolant system flow margin and reduces personnel dose during refueling outages.

4.0. TECHNICAL ANALYSIS

4.1. POPCD Method

Definition

The POPCD method is described in EPRI Topical Report NP 7480-L, Addendum 1. POPCD is calculated as the ratio of indications reported at the prior inspection to the total indications found at the subsequent inspection (all indications reported in the prior cycle plus new indications). POPCD for the EOC n inspection (EOC_n) is defined as:

$$\text{POPCD} = \frac{\text{EOC}_{n+1}\text{ RPC confirmed plus not RPC inspected and detected at EOC}_n + \text{EOC}_n\text{ RPC confirmed and repaired at EOC}_n}{\text{EOC}_{n+1}\text{ RPC confirmed plus not RPC inspected and detected at EOC}_n + \text{EOC}_n\text{ RPC confirmed and repaired at EOC}_n + \text{New EOC}_{n+1}\text{ RPC confirmed plus not RPC inspected indications (i.e., not detected at EOC}_n\text{)}}$$

This definition of POPCD is based on the premise that all indications that can contribute significantly to burst and leakage for voltage-based repair criteria application can be confirmed by rotating pancake coil (RPC) inspections. The term RPC is meant to include an RPC probe or equivalent, which includes a +Point coil. The POPCD definition that is used for the ODSCC ARC analyses is based on RPC confirmed indications plus indications not RPC inspected.

The use of RPC confirmation to exclude potential false bobbin calls from the POPCD analysis is only applied to the EOC_{n+1} analysis. This application of the RPC results is applied to exclude from POPCD the probable false bobbin calls that would not contribute to tube integrity concerns at EOC_{n+1} for both previously reported and new indications. The use of RPC confirmation provides a measure of confidence that irrelevant prior and new bobbin calls are not allowed to influence the POD either as an increase or a decrease in the POD. EOC_n bobbin calls that were RPC no detectable degradation (NDD) at EOC_n but were RPC confirmed or not inspected at EOC_{n+1} are included in POPCD as bobbin detected indications at EOC_n. This can be interpreted as a difference in the application of RPC to define a 'true' indication at EOC_{n+1} from that at EOC_n. The intent is that the EOC_{n+1} RPC should define the significance of the bobbin indication for POD considerations such that the insignificant RPC NDD indications are excluded from POPCD for both previously reported and new bobbin indications. The inclusion of RPC NDD EOC_n bobbin indications as detected indications in POPCD when RPC confirmed or not inspected at EOC_{n+1} but excluding EOC_{n+1} RPC NDD from POPCD is consistent with the GL 95-05 Section 2.b.1 guidelines. This section requires that all bobbin indications at EOC_n are to be included in the OA independent of RPC confirmation with the alternative that a fraction of RPC NDD indications may be excluded. The appropriate fraction to exclude would be the indications that remain RPC NDD at EOC_{n+1}, which is the fraction excluded from POPCD.

The POPCD approach treats all new indications at an inspection as having been undetected at the prior inspection even though some of the new indications may have initiated during the operating cycle. The application of POPCD for OA then accounts for newly initiated indications as well as previously undetected indications.

Detection of Large Flaws

The single-cycle basis for POPCD assumes that large flaws would be detected during the EOC_{n+1} inspection. This assumption is supported by the industry POPCD database of 37 inspections. The multi-cycle development of a POPCD database over sequential inspections provides additional assurance that the potential for large undetected indications is included in POPCD. If an indication is undetected, it can be expected to grow over subsequent inspections to a detectable level. When detected, it is included at the BOC voltage as an undetected or new indication. As an example, for a 3-volt undetected indication, it can be expected that further growth would lead to detection at the next inspection and the indication would be included in POPCD as a 3-volt undetected indication. The DCPP database includes 3 successive inspections for Unit 2 and 2 for Unit 1, and the largest undetected indication was less than 1.5 volts. The industry data includes up to 5 successive inspections in a plant with noise levels (i.e., support plate residuals) significantly higher than currently active SGs. Nine inspections from the 2 units of the plant with high noise levels account for 70 percent of the new or undetected indications above 1.6 volts, including 4 of the 5 new indications above 2.5 volts in the industry database. However, none of the undetected indications exceeded 3.2 volts. The lower undetected threshold found in the DCPP SGs is consistent with the relatively low noise levels in the DCPP SGs.

Guidelines for Incorporating Data Into POPCD Categories

A revised table format for reporting POPCD data, relative to the NP 7480-L Addendum 5 POPCD table format, is used to develop the POPCD distributions following the guidelines described in this subsection. The DCPP POPCD data are described in Section 4.4 and are shown in Table 2 of this enclosure that reflects the revised table format. The columns provide the source of input data including the basis for defining the Cycle n voltage for the indications. The rows show the voltage bin widths. Voltage bin widths may be 0.1- or 0.2-volt wide when at least 20 indications are included in the bin. In this case, the data can be reasonably assumed to span the bin width such that the mid-bin voltage can be used to represent the bin voltage for input data to calculate the POPCD distribution. Above the highest consecutive 0.2-volt bin, the bin width is limited to 0.1 volts to provide a more accurate mid-bin width for calculating the POPCD distribution. However, the DCPP plant specific

POPCD distributions are based on uniform 0.1-volt bin widths. The use of 0.2-volt bins is included in the Table 1 data to facilitate the industry POPCD database for which revised binning would require a major effort to obtain the new bin data for replaced SGs.

Indications that were not detected at EOC_n or EOC_{n+1} by the standard bobbin inspection, but that are detected during EOC_{n+1} as a result of other RPC inspection activities are considered as new EOC_{n+1} RPC confirmed indications for the DCPP POPCD analyses. At the time of the initial POPCD development, there were so few small indications not detected via the standard bobbin inspection, but detected as a result of other RPC inspection activities, that these indications could be ignored in POPCD applications. Recent RPC inspections have resulted in increases in the numbers of these indications although the sizes continue to be low voltage indications. For DCPP POPCD data in Column I of Table 2, these indications are included in the not detected at EOC_n population. For the industry POPCD data in Table 1, these indications are not included in Column I because historical data is impractical to update. The indications found by +Point are sized by a bobbin to +Point voltage correlation or by identifying the flaw in the 200 kHz data and sizing in the mix, although these indications may not be able to be sized at the prior inspection. If the indication cannot be sized at the prior inspection, a reasonable estimate of the prior cycle voltages for incorporation into the POPCD data is to reduce the voltages by the average voltage growth for the cycle. This adjustment is applied for undetected bobbin indications that are found by RPC inspection activities. At DCPP, indications detected by the +Point coil but not by a bobbin coil are identified as axial ODSCC not detected by bobbin indications (AONDBs).

In Table 2, in order to reflect any potential influence on POPCD of new EOC_{n+1} bobbin indications that are EOC_n NDD upon lookback review of the bobbin data, the EOC_n voltages are estimated by subtracting the average growth from the EOC_{n+1} voltages. For the Table 1 industry POPCD database, this change has not been made due to the extensive effort that would be required for an expected negligible impact on POPCD.

The following indications are considered to be false bobbin coil calls and are not included in the POPCD analyses. The DCPP numbers are tabulated in columns E, F, and J in Table 2, but are not tabulated in the industry POPCD data of Table 1 due to the difficulties in collecting this historical data.

- Bobbin indications reported at EOC_n but found to be NDD by RPC inspection at EOC_{n+1} (column E). EOC_n bobbin indications confirmed by RPC at EOC_n and found to be RPC NDD at EOC_{n+1} are not

expected to occur but would be excluded from the POPCD analyses if they would occur since the Cycle n+1 inspection would expect to find a larger indication if the EOC_n indication was not a false call.

- Bobbin indications reported at EOC_n but not found by the bobbin inspection at EOC_{n+1} (column F). These indications are classified as indications not reportable (INR) and require resolution analysis to confirm that an indication is not present at EOC_{n+1}. Again, the Cycle n+1 inspection would expect to find a larger indication if the EOC_n indication was not a false call.

- New bobbin indications reported at EOC_{n+1} but found to be NDD by RPC inspection at EOC_{n+1} (column J). RPC NDD indications at EOC_{n+1} are assumed to be false bobbin calls for POPCD applications.

When new EOC_{n+1} indications are found by RPC inspection but not reported as EOC_{n+1} bobbin indications, the indications are included as new indications in the POPCD analysis for EOC_n. The voltages for EOC_n may be obtained by lookback analyses or by subtracting the average growth rate from the EOC_{n+1} voltage obtained by identifying the flaw based on a review of the 200 kHz data or by applying a site specific bobbin voltage to RPC voltage correlation. These indications will continue to be included as new indications in subsequent cycles unless the indication is reported in the normal bobbin coil inspection at a cycle following EOC_{n+1}. Thus, the indications will be considered as undetected at a minimum of two cycles, the EOC_n and EOC_{n+1} inspections. If the RPC inspection identifies more than one ODSCC indication at the same TSP intersection, the bobbin voltage assigned to the TSP is estimated as the square root of the sum of squares for the bobbin voltages inferred from the RPC indications. This is an approximation to the effect on bobbin voltage of multiple indications around the tube circumference. Indications found only by RPC inspection in deplugged tubes returned to service at EOC_n are included as new indications at EOC_n if found by bobbin and/or RPC at the EOC_{n+1} inspection.

For the POPCD evaluation all determinations of detection at EOC_n and voltages assigned to EOC_n detected indications are based exclusively on the inspection records for the EOC_n inspection. Lookback analyses are only applied to assign voltages for new indications detected at EOC_{n+1} such that EOC_n voltages are not available from the inspection records.

4.2. Fitting and Confidence Bounds

Loglogistic Fitting

The preferred approach to simulating the POD is to fit a loglogistic cumulative distribution function to the empirical data. The statistically based POD distribution such as the loglogistic provides uncertainties in the POD distribution. The POD uncertainties are included in Monte Carlo analyses as described below. This allows for an analytical simulation of the POD analogous to the simulation of the probability of leak for ODSCC indications at TSPs. The simulation of the probability of leak for ODSCC indications at TSPs is discussed in several documents pertaining to the application of the ODSCC ARC. The functional form of the loglogistic equation is,

$$P = \frac{1}{1 + e^{-[b_0 + b_1 \log(V)]}} \tag{1}$$

where P is the POD, V is the bobbin amplitude, and b_0 and b_1 are parameters obtained by performing a regression analysis of the empirical POD data. The equation can be easily rearranged into the log-odds form as,

$$\ln\left(\frac{P}{1-P}\right) = b_0 + b_1 \log(V) \tag{2}$$

where the ratio in the parentheses is the odds of detection, i.e., the ratio of the POD to the probability of nondetection.

For application to the DCPP POPCD, the data are sorted into 0.1-volt bins representing various voltage levels, e.g., 0.21 to 0.3 volts, and the POPCD distributions used for ARC analyses are developed as described in Section 4.4 using fits to weighted binary data (hit/miss = 1/0), where weighting is based on the number of indications in each bin.

Monte Carlo Techniques

The following is a description of the Monte Carlo techniques that are used to apply POPCD curves. The Monte Carlo analysis consists of simulating all of the indications in a SG several thousand times. Each simulation of all of the indications in a SG is referred to as one simulation of the SG. For each simulation of a SG, a set of random possible parameters for the POD equation, the intercept, slope and error standard deviation, for the population of ODSCC indications is determined and applied to all of the detected indications to establish a population of detected and undetected

indications. For a given POD, P, the number of indications that remain in service, N, in a given bin is given by,

$$N = \frac{N_D}{P} - N_P \tag{3}$$

where N_D is the number of indications detected and N_P is the number of indications plugged. Because the POD is a decimal value, the fraction in the above equation will not return an integer number of tubes. The result is truncated to an integer value and a random draw from a uniform distribution is used to determine if an additional indication should be added to the total as further described following Equation 4 below. The methodology to employ an analytic form for the POD is essentially identical to that used to simulate indications for evaluating the probability of burst and leak. The process is repeated so that each simulation of all of the indications in a SG is independent of the other simulations of all of the indications in the SG. In this manner, thousands of variations of the possible levels of degradation within the SG are considered. The determination of the POB and the potential leak rate during a postulated steam line break event then proceeds according the methodology outlined in GL 95-05.

For each of the Monte Carlo simulations of a SG, the elements of the population variance-covariance matrix for the parameters of the loglogistic equation are found using the estimated values from the regression analysis and a random value from the Chi-Square distribution corresponding to the degrees of freedom associated with the regression analysis. Once the population values for the variance-covariance matrix have been calculated, population parameters of the POD equation, β_0 and β_1 corresponding to b_0 and b_1, can be calculated using two random values from the standardized normal distribution based on the assumption that they are bivariate normally distributed. Given the population parameters, the POD for any indication voltage, V_i, with a bin can be calculated as,

$$P_i = \{1 + \exp[-\beta_0 - \beta_1 \log(V_i)]\}^{-1} \tag{4}$$

where the β values are the estimated population parameters corresponding to the regression parameters b_0 and b_1. For each bin of indications found during the current outage, the number of indications present that gave rise to finding the number reported for that bin is found by substituting the calculated P_i values into Equation 3. This will likely give rise to predicting that a fraction of an indication is mathematically present in one or more of the bins. Whether or not the fraction of an indication represents a whole indication being present or not during the simulation of the indications in the bin is determined by making a random

draw from a uniform distribution. If the value obtained from the uniform distribution is greater than the value of the fractional indication, an indication representing the fractional indication is not present. Likewise, if the value is less than the fractional indication value then a whole indication representing the fractional indication is present and is included in the analysis to determine the POB and potential total leak rate for that simulation of the SG. The application of this approach results in one additional indication being present in the prediction bin for a fraction of the SG simulations that matches the average value of the predicted fractional indication. For example, 10 indications in a bin with a POD of 0.33 gives rise to predicting that 30.3 indications were originally present. If the random draw from a uniform distribution is less than or equal to 0.3 the indication is present. If the number drawn is greater than 0.3 the indication is not present.

Goodness of Fit Assessment

Single-cycle POPCD distributions can be expected to change from cycle-to-cycle dependent upon the number and size of indications in a given inspection. For inspections with a large number of indications spanning up to at least 5 volts, the differences between a single-cycle POPCD and a combined cycle POPCD would be expected to be modest. Multi-cycle POPCD distributions are recommended for ARC applications. The integrated inspection experience is then included in POPCD to represent the history of undetected indications. For example, if the last inspection resulted in the largest undetected voltage indication, the last inspection results do not imply similar occurrences for the next cycle and the overall integrated history would be the best estimate for the next cycle. This conclusion is applicable as long as SG conditions at TSP intersections do not significantly degrade with operating time, which is typical of operating times after the first one or two cycles during which the residual signals form at TSP intersections. Significant increases in denting are not occurring in currently operating SGs.

The *p*-value from the POPCD regression analysis is the probability of observing a value of χ^2 as small as the one calculated from the data. If the *p*-value is found to be greater than 5 percent, i.e., the probability of randomly observing a value as small as the one calculated would be greater than 5 percent, a default value of POD of 0.6 will be applied. The associated implication would be that there could be sufficient noise at the location of the indications to interfere with the detection of the indications. For the regression results presented in Sections 4.3 and 4.4 of this letter, the *p*-values were calculated to be effectively zero. For example, the DCPP χ^2 value for the data of Section 4.4 is 879.8 for 4644 degrees of

freedom. The *p*-value for 1000 data points would be about 5 percent, for 4646 data points the *p*-value is less than $2.9x10^{-7}$.

4.3. <u>POPCD Evaluation for the Industry Database</u>

The POPCD industry database was updated in EPRI Topical Report NP 7480-L, Addendum 5. The POPCD data are given in Table 1 for the combined data from 37 inspections in plants with 7/8 inch and 3/4 inch tubing including 4 inspections from the DCPP units. The tabulated data of NP 7480-L, Addendum 5, Table 7-3 were extended in Table 1 to include indications above 3.5 volts, which are only noted in footnotes to Tables 7-1 and 7-2 of NP 7480-L, Addendum 5. In addition, the data above 3.2 volts were revaluated to include the data in 0.1-volt bins in order to more accurately define the high voltage indications for the regression analyses. The reevaluation identified additional indications above 3.2 volts that were not included in the Addendum 5 totals for this voltage range.

The prior cycle volts for Table 1 include plants that used voltages reported in the prior cycle and plants that routinely reevaluated prior cycle volts based on the last cycle indications. Reevaluating prior cycle volts based on the last cycle indication has been applied at some plants to improve the voltage calls at the prior cycle when knowledge of the flaw location from the latest analysis can improve the flaw location of distorted indications in the prior cycle in order to improve the accuracy of the flaw voltage for growth rate analyses. Based on experience, this practice has not been found to significantly change voltage growth distributions. The routine practice at DCPP is to use the voltages that were reported in the prior cycle.

The footnote in Table 7-2 of NP 7480-L, Addendum 5, notes that one indication above 3.5 volts was not reported in the prior cycle. However, the reevaluation of the initial field prior cycle voltage for this indication, as described in Section 3.5 of Westinghouse Electric Company letter SG-99-03-001, "Farley Unit-1 1999 Voltage Based Repair Criteria 90-Day Report," dated March, 1999, led to an indication less than 2 volts (applied in Table 1) based on the initial conservative evaluation including the TSP residual in the analysis. The initial look-back analysis reported the prior cycle voltage for the indication as 3.84 volts. Since this would have been the largest undetected bobbin voltage, the bobbin data were reevaluated as part of the plant's POPCD evaluation for the ARC 90-day report. The "fuzz (or measurement) balls" used to measure the flaw voltage included the lower part of the mix residual and is not representative of the flaw voltage. The reanalysis identified the flaw and assigned a 1.21-volt indication. The 3.83-volt call was clearly an error and the reevaluated voltage (1.21 volts) was used for the industry database evaluation in

Table 1. The POPCD data base in NP 7480-L Addendum 5, Table 7-2 was developed from data in the field records, which had not been revised to the reevaluation included in the 1999 Farley Unit 1 90-day report.

With regard to the presence of mix residuals and the influence of the mix residuals on sizing the indications, it must be emphasized that all TSP intersections have mix residuals after the first one or two cycles of operation. After about two cycles, the mix residuals generally do not change with operating time. The dominant voltage for the mix residual signals is not affected by the mixing used to analyze the bobbin data so the mix residual signal amplitude does not vary with operating time or nondestructive examination (NDE) analyst. Frequently, a significant part of the mix residual signal is present in bobbin data obtained without a TSP for pulled tubes examined in the laboratory. Some of the model boiler specimens show mix residuals although generally smaller than field data due to the shorter time at temperature. The bobbin response apparently includes an effect of the time at temperature at a TSP on the magnetic properties of the tube. Metallography was performed on a non-DCPP pulled tube to attempt to identify the cause for the signal, but was not successful in identifying any physical change to the tube or grain structure.

Many of the pulled tubes in the ARC database (and the POPCD database) have mix residual signals larger than typically found in currently operating SGs. Whatever influence the mix residuals may have on voltage sizing for TSP indications is built into the ARC database by the pulled tubes. The mix residuals may be more easily understood as TSP noise. The noise may distort the flaw signal particularly when the two phase responses are similar.

The mix residual voltage is not being used in current assessments (e.g., EPRI tube integrity assessment committee) of the influence of noise on detection or sizing. For signal to noise evaluations, the noise is being evaluated as the peak vertical amplitude response over one third sections of the TSP to reflect the larger noise near the edges of the TSP. The noise differences between the center and edge of a TSP affect detectability of short, low voltage indications located at the edges of the TSP. The short indications at the TSP edges must grow to the center of the TSP to become structurally significant and the lower noise levels at the TSP center provide for detection of even low voltage indications.

The noise levels at DCPP TSP intersections are lower than that found for many indications in the ARC database. Noise analyses at cold-leg TSP intersections have been performed for about 200 intersections spanning DCPP Units 1 and 2. The average peak-to-peak noise amplitudes at the TSP center was about 0.38 volt with an upper ninety-fifth percentile value of 0.70 volt. At the TSP edges, the average was about 0.51 volt with an

upper ninety-fifth percentile value of 0.88 volt. The vertical amplitude values at the ninety-fifth percentile that may influence detection are about 0.25 volt at the TSP edges and about 0.2 volt at the TSP center. Vertical amplitude noise levels that could influence detection were also evaluated for DCPP dented hot-leg TSP intersections in WCAP-15573, Revision 1, "Depth-Based Tube Repair Criteria for Axial PWSCC at Dented TSP Intersections – Alternate Burst Pressure Calculation," dated October 2001. At the TSP center, the mean vertical amplitudes are 0.12 volts, with a ninety-fifth percentile value of 0.24 volt. At the TSP edge, the corresponding values are 0.38 and 0.62 volts.

Based upon the above noise and mix residual discussion, it is not feasible or necessary to attempt to define bobbin voltages that are not affected by the TSP noise or mix residuals. All indications have a range of noise influence on voltage sizing, and the ARC database includes many indications with larger noise levels than DCPP and other plant active SGs.

The bin mid-range voltages of Table 1 are used to develop the loglogistic POPCD distribution. An exception from application of the mid-range voltage is made for the lowest voltage bin in Table 1, which ranges from greater than 0 to 0.2 volts. Most of the indications in this bin are between 0.1 and 0.2 volts so a mid-range value of 0.15 volts is assigned to the lowest voltage bin data for fitting the loglogistic function to the data. The general linear model (GLM) regression analysis of the Table 1 data is based on weighted binary input as described in Section 4.1.

Figure 1 shows the POPCD data for the industry database and the resulting loglogistic fit to the data including the lower 90-percent confidence bound on the POPCD distribution. The fractional POD data values in Figure 1 are shown for information only since the regression analysis was based on weighted binary input. The 90-percent lower bound confidence limit on POD is also shown for information only since the POPCD uncertainty distribution is included in the Monte Carlo OA for DCPP. The loglogistic function provides a very good fit to the POPCD data. The lower 90-percent confidence bound shows only a small reduction relative to the nominal fit, which supports small uncertainties for the industry POPCD distribution based on the large number of data available. The uncertainties in the upper voltage range above about 3 volts are further discussed in Section 4.4 below under the "Effect of Uncertainties in the Upper Voltage Range" subsection.

4.4. POPCD Evaluation for the DCPP Database

DCPP POPCD are available from five cycles based on the inspections at Unit 1 Refueling Outages 10 and 11 and Unit 2 Refueling Outages 9, 10, and 11. The combined data for the five outages are given in Table 2. The

data were developed following the guidelines described in Section 4.1 and include new indications found only by RPC as undetected indications. There are 4646 indications in the DCPP POPCD database of which 2158 are detected indications including all 85 indications above 1.5 volt. For POPCD evaluations, all new indications are conservatively assumed to have been undetected at the prior inspection although some of the indications may have initiated during the cycle.

Figure 2 shows the DCPP POPCD data and the resulting loglogistic fit to the Table 1 data including the lower 90-percent confidence bound on the POPCD distribution. The fractional POD data values in Figure 2 are shown for information only since the regression analysis was based on weighted binary input. The regression parameters for the DCPP loglogistic POPCD are given in Table 6. The 90-percent lower bound confidence limit on POD is also shown for information only since the POPCD uncertainty distribution is included in the Monte Carlo OA for DCPP. As found for the industry database in Figure 1, the 90-percent confidence bound supports small uncertainties for the DCPP POPCD distribution.

The industry and DCPP POPCD distributions are compared in Figure 3. Below about 1 volt, the industry data show a moderately higher POD while the DCPP POD is slightly higher than the industry database above 1 volt. The lower DCPP POD below 1 volt reflects more new indications than the industry average and may be indicative of more newly initiated indications rather than more previously undetected indications. The DCPP POPCD is about 0.99 at 4 volts, which is essentially unity relative to having negligible impact on OA.

DCPP has an adequate database to define a plant-specific POPCD, and therefore the determination of the appropriate POPCD values for DCPP Unit 2 Cycle 12, is based on the plant specific DCPP Units 1 and Unit 2 inspection results.

PG&E will use a Monte Carlo simulation of the uncertainties in the DCPP plant specific POPCD analyses to support the OA for Unit 2 Cycle 12. The statistical applications in developing the DCPP POPCD distribution together with accounting for POD uncertainties in the OA adequately address uncertainties in the upper voltage range.

<u>Effect of Uncertainties in the Upper Voltage Range</u>

Both the industry and DCPP POPCD databases are well-defined relative to the number of indications in the databases up to about 3 volts. From Tables 1 and 2, all indications above 3.2 volts for the industry database and above 1.6 volts for the DCPP database are detected. However, the

limited number of indications above these voltages lead to a reduction in the POD below unity as seen by the DCPP reduction from 1.0 for the fraction detected at about 2 volts to 0.96 for the nominal regression fit of Figure 2. The undetected indications in the industry POPCD database above approximately 1.6 volts are dominated by the data from 2 units (9 of the 37 inspections or 24 percent, SGs with 7/8 inch tubing since replaced) that had very high noise levels at the TSP intersections. The 9 inspections in these 2 units account for 70 percent of the new indications (POPCD assumption of missed indications) above 1.6 volts in Table 1 including 4 of the 5 new indications above 2.5 volts. The DCPP SG noise levels are small compared to these 2 units. For the SGs still operating, the industry database is therefore very conservative above about 1.6 volts. This difference above about 1.6 volts is seen in the NP 7480-L, Addendum 5, POPCD data by comparing the NP 7480-L, Addendum 5, figures for 3/4 inch plants with modest noise levels (Figure 7-1 of NP 7480-L, Addendum 5) and the 7/8 inch plants including the 2 units with high noise levels (Figure 7-2 of NP 7480-L, Addendum 5).

The industry database above 3.2 volts includes 82 indications all of which were detected. The DCPP database above 1.5 volts (above the lowest undetected indication) includes 85 indications. These numbers of indications provide a good statistical database to define a complete POD distribution and are only used for POPCD to define the higher voltage range POD. Given the large numbers of indications above the lowest undetected indications in the database, there is no need to truncate the POPCD curve or transform the curve to a horizontal line at any voltage.

Overall, it is concluded that the upper voltage range (above 2 volts) uncertainty is adequately addressed by the industry and DCPP databases and the statistical GLM regression analyses described previously.

TSP Noise Considerations

As noted above, 70 percent of the missed indications above 1.6 volts in the Table 1 industry database occurred in 2 units (SGs since replaced) that represent only 24 percent of the 37 inspections in the database. These units had high noise levels at TSP intersections compared to the currently operating SGs and, particularly, in comparison with the DCPP SGs. Although not numerically demonstrated by noise analyses, the noise levels for the industry POPCD database can be expected to bracket current ARC applications. However, the question of noise levels for the industry POPCD database compared to plants applying the ARC is not applicable to the proposed DCPP application of POPCD. DCPP will apply the POPCD distributions from only the DCPP inspection results. The DCPP database includes 3 consecutive inspections from Unit 2 and 2 consecutive inspections from Unit 1. Noise analyses performed for the

2 DCPP units, for example in WCAP-15573, Revision 1, at dented TSP intersections, did not show any significant differences in noise levels at TSP intersections between the 2 units. Since only DCPP data are applied for the proposed POPCD applications, the noise data in the DCPP POPCD database directly applies for ARC applications.

The POPCD approach to detection probabilities considers the potential for missing indications that might challenge structural or leakage integrity. The database includes successive inspections such as three consecutive inspections for DCPP and as many as five consecutive inspections for one of the units in the industry database with high noise levels. If a large indication was missed in one inspection, it would continue to grow until finally detected in a later inspection. The POPCD methodology includes all new indications as assumed missed indications and large new indications found in an inspection are reevaluated at the prior outage to define the undetected indication voltages for a POPCD cycle. As noted above and in Table 1, no new indications throughout the industry were found to have a prior inspection voltage greater than 3.2 volts, which is well below an indication of about 9.6 volts challenging structural integrity and a 3.2 volt indication would have a leakage probability of only about 20 percent based on NP 7480-L, Addendum 5, data. For DCPP, no new indications were found to have a prior lookback voltage greater than 1.5 volts. All large voltage indications challenging structural or leakage integrity found in ARC inspections, including DCPP 2R11, can be traced to large growth rates and not to missed indications.

Considerations for Higher Than Anticipated Growth Rates

Calculations applying POPCD or 0.6 as the POD will not predict flaws which result from voltage growth rates which are higher than previously seen (e.g. the R44C45-2H flaw which was detected as a 21.5-volt flaw in 2R11 and was detected as a 2.0-volt flaw in 2R10 and left in service per the ODSCC ARC repair criteria) and both POD methods lead to underestimates of the 2R11 maximum flaw size, burst probability, and leak rate. The overly conservative and arbitrary application of a POD of 0.6 would not have changed any assessments for corrective actions after DCPP 2R11. For smaller growth rate under predictions, the application of a POD of 0.6 can mask a real growth rate issue by leading to artificially high burst and leakage predictions with an associated conclusion that no corrective action is necessary.

A high voltage growth rate can be expected to periodically occur and cannot be predicted for a specific cycle. Normal growth in depth can lead to a large voltage increase when the upper range of depth growth occurs for a near throughwall or short throughwall indication. This occurs as the result of the exponential dependence of voltage on depth and again on

throughwall length and is inherent to the voltage-based methods for tube integrity assessments. For many occurrences of large growth rates with associated large EOC voltages (i.e., greater than 8 volts), the indications have been pulled and destructively examined. Although the largest indications found in ARC inspections have been destructively examined, all indications have demonstrated burst pressures exceeding ΔP_{SLB} and leak rates generally consistent with the ARC correlations. For indications such as the DCPP Unit 2 21.5-volt R44C45-2H indication, the conservatism of the voltage based methods led to predictions that the indication exceeded reporting thresholds for burst probability although the measured burst pressures showed margins against burst at SLB conditions.

Upon NRC approval of POPCD for Unit 2 Cycle 12, PG&E will apply POPCD in conjunction with voltage dependent growth distributions, with growth rate break points at 0.59 volts and 1.66 volts. The statistical basis for these break points was presented to the NRC in a March 4, 2003, meeting with PG&E.

4.5. Benchmarking of POPCD

In a letter dated January 24, 1997, the NRC issued a request for additional information to the Nuclear Energy Institute (NEI) requesting supplemental information in support of NP 7480-L, Addendum 1. Question 9, Part 2 requested an assessment of the ability of the POPCD approach to conservatively project the EOC voltage distribution. The NEI response to this request for additional information dated September 14, 1998, provided extensive benchmarking of POPCD analyses as summarized below. In addition, the DCPP POPCD distribution for the last operating cycle has been benchmarked against the inspection results at DCPP 2R11 as described below.

The NEI letter to the NRC dated September 14, 1998, provided a response to an NRC request for additional information on benchmarking OA using POPCD for the POD rather than a POD of 0.6. The response included Monte Carlo analyses for 32 cases including 18 SGs with 7/8 inch tubing and 14 SGs with 3/4 inch tubing together with an additional 17 sensitivity cases. The analyses compared EOC voltages with the projected values in addition to comparisons of burst probabilities and leak rates based on projected and actual (inspection results) voltage distributions. With a leak rate acceptance basis for POPCD projections being greater than or within 0.25 gpm (typically less than 5 percent of allowable limits) of the leak rate obtained from the EOC voltage distributions, the POPCD projections were in agreement with the actual EOC voltage distribution for 31 of the 32 SGs analyzed. The only

exception was a case of an indication found at EOC with a very high voltage growth that could not be predicted or accommodated using either POPCD or a 0.6 POD for the projections. With a burst probability methods acceptance basis for POPCD projections being greater than or within $5x10^{-4}$ (5 percent of the 10^{-2} POB reporting requirement) of the burst probability obtained from the EOC actual voltages, the POPCD projections were in agreement with the actual EOC voltage distribution for 30 of the 32 SGs analyzed. One exception required a methods update included in NP 7480-L Addendum 2 for deplugged tube growth rates and the second exception was the high voltage growth indication that also led to the leakage under prediction. The two exceptions could not be predicted or accommodated using either POPCD or a 0.6 POD for the projections. These benchmark analyses strongly support the use of POPCD for ARC analyses.

DCPP benchmarking analyses were performed to show the adequacy of using a DCPP POPCD distribution. Monte Carlo POB and leak rate projections were performed for DCPP Cycle 11 using the DCPP POPCD and a POD of 0.6. Two comparisons of as-found versus projections were performed to assess the POPCD methods. The first method uses the Cycle 11 voltage dependent growth distribution to separate POPCD issues from growth issues for the EOC 11 projections. The second method uses the DCPP Cycle 10 voltage dependent growth distributions but excludes the 21.5-volt R44C45-2H indication from the EOC 11 condition monitoring (CM) assessment. Since pulled tube R44C45-2H was found to have a burst pressure exceeding steam line break (SLB) accident pressure differentials, the updated CM assessment for EOC 11 excludes this indication from the burst probability analysis. The 21.5-volt R44C45-2H indication in DCPP 2R11 is clearly a growth rate issue and assessments of POPCD must either include the Cycle 11 growth rate or exclude the indication to isolate potential POPCD issues from the growth rate issue. The projected SLB leak rate and burst probability are then compared with the results obtained using the DCPP 2R11 as found voltage distribution (i.e., CM assessment). Table 3 provides the analysis results. The differences between the projected (OA analysis) and as-found (CM analysis) probability and leak rate are included in the table and compared with the magnitude for significant differences described below in Section 4.6. Significant differences are defined as differences greater than 10 percent of the reporting thresholds for burst and leakage.

The results of Table 3 show that the use of the DCPP POPCD results in insignificant differences between the OA projections and the CM results except for SG 2-4. The use of POD of 0.6 results in excessively conservative projections that are about a factor of two higher than the CM results as shown in Table 3 for SG 2-4. The fact that the POD of 0.6 predictions are so conservative would have entirely masked the increased

growth rate issues for Unit 2 Cycle 11 if the 21.5-volt R44C45-2H indication had not occurred (predicted POB of 6.46E-03 using Cycle 10 growth compared to CM result of 3.84E-03). For SG 2-4 using the Cycle 10 growth rates, the differences between the OA and CM results are due to a combination of increases in growth rates between Cycle 10 and Cycle 11 as well as the conservative treatment for NDE uncertainties in the CM analyses for indications above two volts. DCPP-2 Cycle 11 growth rates have been shown to be about 10 percent larger than Cycle 10 data between 0.6 and 1.6 volts with somewhat larger increases above 1.6 volts, thus showing increased voltage-dependent growth in the upper 2 bins. For SG 2-4, using the Cycle 11 voltage dependent growth rates including the 21.5-volt R44C45-2H indication in both the OA and CM analyses, the difference between the calculated POPCD POB and the CM POB of 2.0E-03 (2.38E-02 versus 2.18E-02) exceeds 10 percent of the GL 95-05 POB reporting threshold of 1.0E-02. This difference is principally accounted for by the application of percentage based NDE uncertainties to indications above two volts and particularly to the 21.5-volt R44C45-2H indication in the CM calculation. The influence of NDE uncertainties in the CM analysis is much greater than for the OA analysis due to the larger voltage indications in the CM analysis and to the fact that growth rates are much larger than the NDE uncertainties in the OA analysis. It is shown in Table 4, as discussed later, that the EOC voltage distribution is conservatively predicted using POPCD above 1 volt including the prediction of a 21.5-volt indication. As seen from the 2 SG 2-4 CM results, the 21.5-volt R44C45-2H indication increases the POB by more than a factor of 10. As noted in Note 5 of Table 3, a reduction of the NDE analyst variability standard deviation from 10 percent to 5 percent above 2 volts leads to a reduction in the CM POB from 2.38E-02 to 2.23E-02 for which the CM difference of 1.5E-03 by itself exceeds 10 percent of the reporting threshold. By comparing the reduced as-found calculation, 2.23E-02, to the projected value of 2.18E-02, the difference of 5.0E-04 between the CM and OA results is then insignificant.

Assessments were also performed for the ability of the POPCD method to conservatively project the EOC 11 voltage distribution using Cycles 11 and 10 growth rates. Table 4 provides a comparison of the projected and actual EOC 11 distributions for all four DCPP SGs based on POPCD and Cycle 11 voltage dependent growth. Only the SG 2-4 as found and projected distributions include the 21.5-volt R44C45-2H indication. Table 4 also provides POD of 0.6 EOC 11 projections for SG 2-4 for comparison. The notes to Table 4 provide additional information on the growth distributions used in the analysis. The results show conservative projections of indications above 1 volt and project the 21.5-volt R44C45-2H indication. Indications less than 1 volt can be slightly under predicted with POPCD and POD of 0.6, however, these indications do not contribute significantly to tube integrity calculations. For SG 2-4, the

under prediction by about 25 percent of the indications less than 1 volt is compensated for tube integrity analyses by the over prediction by about 23 percent of the number of indications greater than 1 volt. It is seen from the POD of 0.6 calculation for SG 2-4 in Table 4 that the number of indications less than 1 volt is close to a factor of 2 too low while the indications above 1 volt are over predicted by close to a factor of 2. This comparison demonstrates that POPCD provides a more accurate voltage distribution prediction than POD of 0.6.

Similar to Table 4, Table 5 provides a comparison of projected and actual voltage distributions, but applies the DCPP Unit 2 Cycle 10 voltage dependent growth distributions. The SG 2-4 as found distribution excludes the 21.5-volt R44C45-2H indication. The slight over predictions using POPCD for SGs 2-1, 2-2 and 2-3 are very reasonable above 1 volt, but the indications above 2 volts in SG 2-4 are under predicted. This difference is due to the increase in Cycle 11 growth rates above about 0.6 volt for SG 2-4. The projected distribution above 1 volt using POD of 0.6 is again excessively conservative, thus masking the growth rate issue.

Under predictions when applying POPCD are more likely to be due to growth rate uncertainties than POPCD uncertainties as shown by the differences in projected greater than 2 volt EOC voltage indications for SG 2-4 between use of 2R10 and 2R11 voltage dependent growth rates. The above benchmarking results support the adequacy of the DCPP POPCD distribution for ARC applications.

<u>Comparisons of DCPP POPCD with ANL POD from Round Robin Testing and EPRI POD from Multiple Analyst Testing</u>

As discussed above, substantial industry benchmarking has been performed to support POPCD applications. An independent POD assessment that supports the POPCD results and elimination of the 0.6 POD for ARC applications is described in the ANL study contained in NUREG/CR-6791 (Reference 5) under work sponsored by the NRC. The ANL POD results were obtained from round-robin NDE analyses of data from a SG mock-up. The ANL results discussed in this section were obtained from Figures 2.54 and 2.55 of NUREG/CR-6791, which are based on test results for axial ODSCC at TSP intersections. POD distributions as a function of bobbin coil voltage are described in the report. The NUREG/CR-6791 figures are shown in Figure 4 of this letter.

Based on the methods applied in this report, the ANL logistic fit shown in the lower part of Figure 4 appears to represent too high of a POD for the data shown in the upper figure. For example, the nominal fit approaches unity near 2 volts where the data indicates about a 0.9 POD. To permit an equivalent comparison of POD curves between the DCPP and ANL data,

the ANL bin data from the upper graph in Figure 4 were processed in the same manner as the DCPP and industry POPCD data described previously, except for using fractional data rather than weighted binary data, to obtain a loglogistic fit to the ANL data. Figure 5 compares the DCPP and ANL loglogistic POD nominal and lower 90 percent confidence curves. The comparisons show that the DCPP POPCD results are higher than the ANL results by about 0.1 below 1 volt and both are near unity above 4 volts. The trends of POD with increasing voltage are essential the same for both distributions.

EPRI also conducted blind testing of NDE analysts to develop a POD versus voltage curve. The resulting POD distribution, as developed in Tetra Engineering Group, Incorporated, Report TR-95-001, "Probability of Detection by Bobbin Inspection," dated February 6, 1995, is also reported in NP 7480-L, Addendum 5, as the EPRI POD curve. Figure 6 provides a comparison of the DCPP POPCD, industry POPCD, ANL, and EPRI POD curves. The comparison shows consistent high detectability for bobbin indications above one volt at TSP intersections independent of the methods used to develop the POD distributions. Below about two volts, the ANL results show a lower POD than POPCD and the EPRI POD. The POPCD results are based on the conservative assumption that all new indications in the inspection outage were not detected in the prior outage. For POPCD, "truth" as an indication is defined as inspection results for RPC confirmed plus not RPC inspected indications. The EPRI POD is based on testing analysts against field data for about 5726 TSP intersections from three plants with 3/4 inch tubing. The definition of "truth" (flaws in the population) for the EPRI POD is based on 890 indications confirmed by RPC, 222 indications not confirmed by RPC or not RPC inspected and 251 added indications based on expert opinion. The ANL mock-up uses laboratory grown cracks that were reviewed by a NDE Task Group and judged to be prototypical of field indications although the differences in crack morphology from field ODSCC likely contribute to the lower ANL POD above about 1 volt as well as increased NDE uncertainties. The results shown in Figure 6 clearly demonstrate the inadequacy of a POD of 0.6 to represent the strong dependence of POD on voltage, and the results support the DCPP POPCD results as consistent with three independent POD assessments.

4.6. Continuing Assessment and Reporting for POPCD

Upon implementation of POPCD, if the SLB burst probability, SLB leak rate or the largest indications (number and size) are under predicted by the previous cycle OA, the probable causes for the under predictions will be assessed and documented in the DCPP Unit 2 Cycle 12 90-day report. Under predictions of the number of low voltage flaws are generally insignificant since they are commonly due to variations in the number of

new flaws at very low voltages where RPC confirmation is not performed to eliminate potential false bobbin calls. If the under predictions are significant relative to the burst pressure reporting threshold or site specific allowable leak rate, an assessment must be made of the potential need to revise the ARC analysis methods, and this assessment will be documented in the DCPP Unit 2 Cycle 12 90-day report. A significant under prediction of burst probability is defined as 10 percent of the reporting threshold, i.e., 0.001. A significant under prediction of SLB leak rate is defined as 10 percent of the site specific allowable limit. A methods assessment will also be made for smaller burst probabilities or leak rates if the CM results are under predicted by an order of magnitude. An assessment will also be made for significant underestimates of the number of low voltage indications based on the following criterion. If the total number of indications less than 1 volt is underestimated by greater than 15 percent and the number of indications greater than 1 volt is not overestimated by about one third or more of the low voltage percentage underestimate to compensate for the low voltage underestimate, a methods assessment will be made to assess the significance of underestimating the number of low voltage indications. The one-third factor for compensation on underestimates of the number of low voltage indications is a rough estimate of the relative influence on burst and leakage estimates. In addition, an underestimate of the less than 1 volt population may be partially attributable to conservative growth rates which would increase the population above about 1 volt.

To assess the trend for potential changes in POPCD over time, the post-2R12 90-day report will compare the multi-cycle POPCD distribution with the Unit 2 Cycle 12 POPCD distribution. Differences in the two POPCD distributions will be assessed relative to the potential for significant changes in detection capability.

Historically, there have been no ARC cases where undetected indications (POD effects) have led to a challenge to structural or leakage integrity. These cases have been associated with under predictions in growth rates. It is expected that growth rates would be the first potential cause examined for ARC under predictions. Potential POD effects as the cause for under predictions would also be assessed if the probable cause for the low predictions is a larger than anticipated undetected indication or due to cumulative numbers of indications above about 1 volt. The 90-day report will document any recommended changes to POD or growth methodology indicated by the assessments.

4.7. Conclusions

The current licensed DCPP methodology of using a uniform POD value of 0.6, based on GL 95-05, results in an overly conservative and counter

intuitive estimate of the number and severity of indications remaining in the SGs following the inspection. Results of both the DCPP and industry POPCD evaluations support a high POD for bobbin indications above about 1 volt and lead to near unity for POD above 4 volts, which is consistent with the ANL round-robin results. All results show that use of a constant POD of 0.6 is nonconservative below about 0.5 volts and excessively conservative above 1 volt and leads to excessively conservative probability of burst and leakage predictions. POD uncertainties are adequately accounted for in DCPP POPCD applications through the statistical methods applied and the allowances for uncertainties included in the OA. Therefore, the application of the POPCD method for DCPP Unit 2 Cycle 12, using plant specific inspection results, is justified and appropriate for ARC analyses.

The DCPP POPCD distributions are developed based on fitting the inspection results used to define POPCD by loglogistic functions, which are commonly applied in tube integrity analyses for POD distributions. Uncertainties in the resulting POD distributions are obtained from the analyses. In addition, the DCPP POPCD results for bobbin coil detection are shown to be in good agreement with POD results obtained from ANL round-robin test results in NUREG/CR-6791, the industry POPCD results, and an EPRI POD obtained from blind testing of analysts.

Based on industry and plant specific bobbin detection data for ODSCC within the SG TSP region, large voltage bobbin indications that can individually challenge structural or leakage integrity can be detected with near 100 percent certainty and would not be left in service. These large voltage indications should not be included in the BOC voltage distribution, other than as inferred from the voltage dependent POD, for the purpose of the OA. The POPCD approach to probability of detection considers the potential for missing indications that might challenge structural or leakage integrity by applying the POPCD data from successive inspections. The database used to develop the POPCD values includes data from successive inspections. If a large indication was missed in one inspection, it would continue to grow until finally detected in a later inspection. Therefore, the use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA, in conjunction with voltage dependent growth with statistically based break points, will improve EOC projections and lead to appropriate estimates of the margin in SG tube structural and leakage integrity.

5.0 REGULATORY ANALYSIS

5.1 No Significant Hazards Consideration

PG&E has evaluated whether or not a significant hazards consideration is involved with the proposed amendment by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

Response: No.

The use of a revised steam generator (SG) voltage-based repair criteria probability of detection (POD) method, the probability of prior cycle detection (POPCD) method, to determine the beginning of cycle (BOC) indication voltage distribution for the Diablo Canyon Power Plant (DCPP) Unit 2 Cycle 12 operational assessment (OA) does not increase the probability of an accident. Based on industry and plant specific bobbin detection data for outside diameter stress corrosion cracks (ODSCC) within the SG tube support plate (TSP) region, large voltage bobbin indications which individually can challenge structural or leakage integrity can be detected with near 100 percent certainty. Since large voltage ODSCC bobbin indications within the SG TSP can be detected, they will not be left in service, and therefore these indications should not be included in the voltage distribution for the purpose of OAs. POPCD improves the estimate of potentially undetected indications for OAs, but does not directly affect the inspection results. Since large voltage indications are detected, they will not result in an increase in the probability of a steam generator tube rupture (SGTR) accident or an increase in the consequences of a SGTR or main steam line break (MSLB) accident.

Therefore, the proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different accident from any accident previously evaluated?

Response: No.

The use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA concerns the SG tubes and can only affect numerical predictions of probabilities for the SGTR accident. Since the SGTR accident is already considered in the Final Safety Analysis

Report Update, there in no possibility to create a design basis accident that has not been previously evaluated.

Therefore, the proposed change does not create the possibility of a new or different accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

Response: No.

The use of the POPCD method to determine the BOC voltage distribution for the DCPP Unit 2 Cycle 12 OA does not involve a significant reduction in a margin of safety. The applicable margin of safety potentially impacted is the Technical Specification 5.6.10, "Steam Generator Tube Inspection Report," projected end-of-cycle leakage for a MSLB accident and the projected end-of-cycle probability of burst. Based on industry and plant specific bobbin detection data for ODSCC within the SG TSP region, large voltage bobbin indications that can individually challenge structural or leakage integrity can be detected with near 100 percent certainty and will not be left in service. Therefore these indications should not be included in the voltage distribution for the purpose of OAs. Since these large voltage indications are detected, they will not result in a significant increase in the actual end-of-cycle leakage for a MSLB accident or the actual end-of-cycle probability of burst. The POPCD approach to probability of detection considers the potential for missing indications that might challenge structural or leakage integrity by applying the POPCD data from successive inspections. If a large indication was missed in one inspection, it would continue to grow until finally detected in a later inspection.

Based on the above evaluation, PG&E concludes that the proposed change presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and accordingly, a finding of "no significant hazards consideration" is justified.

5.2. Applicable Regulatory Requirements/Criteria

GL 95-05 requires the application of a POD of 0.6 to all previous bobbin indications for the determination of the indication voltage distribution for the beginning of cycle, unless another POD is approved by the NRC. This LAR requests NRC approval to use another POD. Therefore, the use of another POD approved by the NRC will continue to meet the requirements of GL 95-05.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

6.0 ENVIRONMENTAL CONSIDERATION

PG&E has evaluated the proposed amendment and has determined that the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7.0 REFERENCES

1. PG&E letter DCL-97-034, "License Amendment Request 97-03, Voltage-Based Alternate Steam Generator Tube Repair Limit for Outside Diameter Stress Corrosion Cracking at Tube Support Plate Intersections," dated February 26, 1997.
2. NRC Letter for Amendment Nos. 124 and 122 for Diablo Canyon Power Plant Units 1 and 2 respectively, "Issuance of Amendments for Diablo Canyon Nuclear Power Plant, Unit No. 1 (TAC No. M97254) and Unit No. 2 (TAC No. M97255)," dated March 12, 1998.
3. EPRI Topical Report NP 7480-L, Addendum 5, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits, Update 2002," dated January 2003.
4. EPRI Topical Report NP 7480-L, Addendum 1, "Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates Database for Alternate Repair Limits 1996 Database Update," dated November 1996.
5. NUREG/CR-6791, ANL-02/07, "Evaluation Current Reliability Results from the Steam Generator Mock-Up Analysis Round-Robin," Published November 2002, Argonne National Laboratory.
6. Jackson, P. S., EPRI Project 6424/RP-3580, Tetra Eng. Group, Inc., TR-95-001, "Probability of Detection by Bobbin Inspection," February 6, 1995.
7. SG-99-03-001, "Farley Unit-1 1999 Voltage Based Repair Criteria 90 Day Report," March 1999, Westinghouse Electric Company.
8. EPRI Report 1003138, "Pressurized Water Reactor Steam Generator Examination Guidelines: Revision 6," Final Report, October 2002.

9. WCAP-15573, Revision 1, "Depth-Based Tube Repair Criteria for Axial PWSCC at Dented TSP Intersections – Alternate Burst Pressure Calculation," October, 2001, Westinghouse Electric Company.
10. NRC Letter, S. L. Magruder (NRC) to D. Modeen (NEI), "Request for Additional Information Regarding NP 7480-L, Addendum 1, Steam Generator Tubing Outside Diameter Stress Corrosion Cracking at Tube Support Plates, Database for Alternate Repair Limits, 1996 Database Update, November 1996," January 24, 1997.
11. Nuclear Energy Institute Letter, D. Modeen (NEI) to Document Control Desk (NRC), "Steam Generator Degradation Specific Management Database, Addendum 2 and Responses to NRC Requests for Additional Information (RAI)," dated September 14, 1998.
12. Nuclear Energy Institute Letter, A. Marion (NEI) to Document Control Desk (NRC), "Steam Generator Degradation Specific Management Database, Addendum 5," dated February 13, 2003.
13. Generic Letter 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," dated August 3, 1995.
14. WCAP-14277, Revision 1, "SLB Leak Rate and Tube Burst Probability Analysis Methods for ODSCC at TSP Intersections," dated December 1996.
15. NUREG-0844, "NRC Integrated Program for the Resolution of Unresolved Safety Issues A-3, A-4, and A-5 Regarding Steam Generator Tube Integrity."
16. PG&E letter DCL-03-017, "Revised Steam Generator Voltage-based Repair Criteria Probability of Detection Method for Diablo Canyon Unit 2 Cycle 12," dated February 24, 2003.
17. NRC Letter for Amendment No. 158 for Diablo Canyon Power Plant Unit 2, "Diablo Canyon Nuclear Power Plant, Unit No. 2 - Issuance of Amendment - Alternate Method of Determining Probability of Detection for Steam Generator Tubes (TAC No. MB7875)," dated June 3, 2003.
18. PG&E letter DCL-03-026, "License Amendment Request 03-04, Emergency Request for Approval to Use an Alternate Method of Determining Probability of Detection for the Diablo Canyon Unit 2 Steam Generator 4 Tube R44C45 Indication," dated March 3, 2003.

Table 1. Industry Addendum 5 POPCD Data[1, 6]

A	B	C	D	E	F	G	H	I	J	K	L	M
	EOCn Bobbin Detected for POPCD Analysis[2]			EOCn Bobbin Detected Ind. Excluded from POPCD		New EOCn+1 (Undetected at EOCn) Ind. for POPCD Analysis			New EOCn+1 Excluded from POPCD	POPCD Calculation[1]		
Voltage Bin[3]	EOCn Bobbin Ind. RPC Confirmed at EOCn+1	EOCn Bobbin Ind. Not RPC Inspected at EOCn+1	EOCn Bobbin Ind. Detected & Repaired at EOCn	EOCn Bobbin Ind. RPC NDD at EOCn+1	EOCn Bobbin Ind. INR[4] at EOCn+1	New EOCn+1 Bobbin Ind. RPC Confirmed at EOCn+1	New EOCn+1 Bobbin Ind. Not RPC Inspected at EOCn+1	New EOCn+1 Ind. Found Only[5] by RPC Inspection	New EOCn+1 Bobbin Ind. RPC NDD at EOCn+1	EOCn Bobbin Detected Ind.	New EOCn+1 ODSCC Ind.	POPCD for Voltage Bin
>0-0.2	21	1704	43			301	2883			1768	3184	0.357
0.2-0.4	161	9883	422			348	9301			10466	9649	0.520
0.4-0.6	402	11633	493			343	5813			12528	6156	0.671
0.6-0.8	703	8404	370			254	2470			9477	2724	0.777
0.8-1.0	902	4851	270			199	958			6023	1157	0.839
1.0-1.2	645	2204	1032			120	358			3881	478	0.890
1.2-1.4	504	915	597			51	157			2016	208	0.906
1.4-1.6	414	392	337			55	62			1143	117	0.907
1.6-1.8	225	139	190			26	21			554	47	0.922
1.8-2.0	111	32	127			15	15			270	30	0.900
2.0-2.2	31	0	128			9	0			159	9	0.946
2.2-2.5	17	0	110			9	1			127	10	0.927
2.5-3.2	15	0	124			5	0			139	5	0.965
3.2-3.3			6							6	0	1.000
3.3-3.4			6							6	0	1.000
3.4-3.5			3							3	0	1.000
3.5-3.6			7							7	0	1.000
3.6-3.7			6							6	0	1.000
3.7-3.8			4							4	0	1.000
3.8-3.9			2							2	0	1.000
3.9-4.0			6							6	0	1.000
4.0-4.1			6							6	0	1.000
4.1-4.2			3							3	0	1.000
4.2-4.3			5							5	0	1.000
4.3-4.4			1							1	0	1.000
4.5-4.6			3							3	0	1.000

Table 1. Industry Addendum 5 POPCD Data[1, 6]

A	B	C	D	E	F	G	H	I	J	K	L	M
	EOCn Bobbin Detected for POPCD Analysis[2]			EOCn Bobbin Detected Ind. Excluded from POPCD		New EOCn+1 (Undetected at EOCn) Ind. for POPCD Analysis			New EOCn+1 Excluded from POPCD	POPCD Calculation[1]		
Voltage Bin[3]	EOCn Bobbin Ind. RPC Confirmed at EOCn+1	EOCn Bobbin Ind. Not RPC Inspected at EOCn+1	EOCn Bobbin Ind. Detected & Repaired at EOCn	EOCn Bobbin Ind. RPC NDD at EOCn+1	EOCn Bobbin Ind. INR[4] at EOCn+1	New EOCn+1 Bobbin Ind. RPC Confirmed at EOCn+1	New EOCn+1 Bobbin Ind. Not RPC Inspected at EOCn+1	New EOCn+1 Ind. Found Only[5] by RPC Inspection	New EOCn+1 Bobbin Ind. RPC NDD at EOCn+1	EOCn Bobbin Detected Ind.	New EOCn+1 ODSCC Ind.	POPCD for Voltage Bin
4.7-4.8			1							1	0	1.000
4.8-4.9			2							2	0	1.000
4.9-5.0			1							1	0	1.000
5.0-5.1			2							2	0	1.000
5.1-5.2			1							1	0	1.000
5.2-5.3			1							1	0	1.000
5.4-5.5			1							1	0	1.000
5.5-5.6			1							1	0	1.000
5.9-6.0			1							1	0	1.000
6.3-6.4			1							1	0	1.000
6.6-6.7			1							1	0	1.000
6.7-6.8			1							1	0	1.000
7.0-7.1			2							2	0	1.000
7.1-7.2			1							1	0	1.000
7.6-7.7			1							1	0	1.000
8.3-8.4			1							1	0	1.000
8.8-8.9			1							1	0	1.000
10.1-10.2			1							1	0	1.000
10.4-10.5			1							1	0	1.000
10.9-11.0			1							1	0	1.000
13.6-13.7			1							1	0	1.000
TOTAL	4151	40157	4325			1735	22039			48633	23774	0.672

Table 1. Industry Addendum 5 POPCD Data[1, 6]

A	B	C	D	E	F	G	H	I	J	K	L	M
	EOCn Bobbin Detected for POPCD Analysis[2]			EOCn Bobbin Detected Ind. Excluded from POPCD		New EOCn+1 (Undetected at EOCn) Ind. for POPCD Analysis			New EOCn+1 Excluded from POPCD	POPCD Calculation[1]		
Voltage Bin[3]	EOCn Bobbin Ind. RPC Confirmed at EOCn+1	EOCn Bobbin Ind. Not RPC Inspected at EOCn+1	EOCn Bobbin Ind. Detected & Repaired at EOCn	EOCn Bobbin Ind. RPC NDD at EOCn+1	EOCn Bobbin Ind. INR[4] at EOCn+1	New EOCn+1 Bobbin Ind. RPC Confirmed at EOCn+1	New EOCn+1 Bobbin Ind. Not RPC Inspected at EOCn+1	New EOCn+1 Ind. Found Only[5] by RPC Inspection	New EOCn+1 Bobbin Ind. RPC NDD at EOCn+1	EOCn Bobbin Detected Ind.	New EOCn+1 ODSCC Ind.	POPCD for Voltage Bin

Notes:

1. POPCD for each voltage bin calculated as (EOCn Bobbin Detected for POPCD Analysis)/(EOCn Bobbin Detected for POPCD Analysis + New EOCn+1 Ind. for POPCD Analysis). By column, POPCD = (B+C+D)/[(B+C+D)+(G+H+I)]. Columns E, F, and I are not completed for the industry historical data because of the extensive effort required with negligible impact on POPCD.
2. EOCn detection based on inspection records for EOCn. Voltages obtained from EOCn inspection records.
3. Plant specific POPCD to be based upon voltage bins of 0.10-volt. Industry POPCD database may use 0.20 volt bins due to difficulty of adjusting existing database to smaller bins.
4. INR = bobbin indication found at EOCn but not reported at EOCn+1 including resolution analyst review to assign indication as INR. Bobbin indications found to be RPC NDD or INR are considered to be false calls and not included in the POPCD analysis.
5. Includes new indications at EOCn+1, not reported in the bobbin inspection, and found by RPC inspection of dents, mixed residuals or other reasons for the RPC inspection. These indications are included as new indications at each EOCn+1 found only by RPC inspection even if included as a new indication in previous POPCD evaluations. If the RPC inspection identifies more than one ODSCC indication at the same TSP intersection, the bobbin voltage assigned to the TSP is estimated as the square root of the sum of squares for the bobbin voltages inferred from the RPC indications.
6. The sum of all EOCn bobbin indications = sum of columns B through F. The sum of all EOCn+1 bobbin indications = sum of columns B+C+E+columns G through J.

Table 2. DCPP Final POPCD Data[1, 6]

A	B	C	D	E	F	G	H	I	J	K	L	M
	EOC_n Bobbin Detected for POPCD Analysis[2]			EOC_n Bobbin Detected Ind. Excluded from POPCD		New EOC_{n+1} (Undetected at EOC_n) Ind. for POPCD Analysis			New EOC_{n+1} Excluded from POPCD	POPCD Calculation[1]		
Voltage Bin[3]	EOC_n Bobbin Ind. RPC Confirmed at EOC_{n+1}	EOC_n Bobbin Ind. Not RPC Inspected at EOC_{n+1}	EOC_n Bobbin Ind. Detected & Repaired at EOC_n	EOC_n Bobbin Ind. RPC NDD at EOC_{n+1}	EOC_n Bobbin Ind. INR[4] at EOC_{n+1}	New EOC_{n+1} Bobbin Ind. RPC Confirmed at EOC_{n+1}	New EOC_{n+1} Bobbin Ind. Not RPC Inspected at EOC_{n+1}	New EOC_{n+1} Ind. Found Only[5] by RPC Inspection	New EOC_{n+1} Bobbin Ind. RPC NDD at EOC_{n+1}	EOC_n Bobbin Detected Ind.	New EOC_{n+1} ODSCC Ind.	POPCD for Voltage Bin
0.01-0.10	3	1	0	0	0	19	47	0	4	4	66	0.057
0.11-0.20	13	42	2	3	4	100	394	6	15	57	500	0.102
0.21-0.30	50	191	5	20	10	135	511	55	26	246	701	0.260
0.31-0.40	70	283	13	9	15	107	386	70	20	366	563	0.394
0.41-0.50	73	261	6	14	13	66	197	18	6	340	281	0.548
0.51-0.60	87	195	6	10	5	40	114	12	8	288	166	0.634
0.61-0.70	77	146	3	7	6	29	58	0	8	226	87	0.722
0.71-0.80	54	89	4	5	2	20	36	1	2	147	57	0.721
0.81-0.90	58	68	2	2	0	16	14	0	1	128	30	0.810
0.91-1.00	39	38	1	0	2	4	5	0	1	78	9	0.897
1.01-1.10	35	16	2	0	0	6	6	0	2	53	12	0.815
1.11-1.20	18	22	1	1	0	3	3	0	2	41	6	0.872
1.21-1.30	24	18	0	1	0	2	4	0	0	42	6	0.875
1.31-1.40	27	9	0	1	1	2	1	0	0	36	3	0.923
1.41-1.50	14	7	0	0	0	1	0	0	0	21	1	0.955
1.51-1.60	8	4	1	0	0	0	0	0	0	13	0	1.000
1.61-1.70	11	1	0	0	0	0	0	0	0	12	0	1.000
1.71-1.80	8	1	0	0	0	0	0	0	0	9	0	1.000
1.81-1.90	7	0	0	0	0	0	0	0	0	7	0	1.000
1.91-2.00	11	1	0	0	0	0	0	0	0	12	0	1.000
2.01-2.10	0	0	0	0	0	0	0	0	0	0	0	

Table 2. DCPP Final POPCD Data[1, 6]

A	B	C	D	E	F	G	H	I	J	K	L	M
	EOC_n Bobbin Detected for POPCD Analysis[2]			EOC_n Bobbin Detected Ind. Excluded from POPCD		New EOC_{n+1} (Undetected at EOC_n) Ind. for POPCD Analysis			New EOC_{n+1} Excluded from POPCD	POPCD Calculation[1]		
Voltage Bin[3]	EOC_n Bobbin Ind. RPC Confirmed at EOC_{n+1}	EOC_n Bobbin Ind. Not RPC Inspected at EOC_{n+1}	EOC_n Bobbin Ind. Detected & Repaired at EOC_n	EOC_n Bobbin Ind. RPC NDD at EOC_{n+1}	EOC_n Bobbin Ind. INR[4] at EOC_{n+1}	New EOC_{n+1} Bobbin Ind. RPC Confirmed at EOC_{n+1}	New EOC_{n+1} Bobbin Ind. Not RPC Inspected at EOC_{n+1}	New EOC_{n+1} Ind. Found Only[5] by RPC Inspection	New EOC_{n+1} Bobbin Ind. RPC NDD at EOC_{n+1}	EOC_n Bobbin Detected Ind.	New EOC_{n+1} ODSCC Ind.	POPCD for Voltage Bin
2.11-2.20	0	0	5	0	0	0	0	0	0	5	0	1.000
2.21-2.30	0	0	3	0	0	0	0	0	0	3	0	1.000
2.31-2.40	0	0	2	0	0	0	0	0	0	2	0	1.000
2.41-2.50	0	0	0	0	0	0	0	0	0	0	0	
2.51-2.60	0	0	2	0	0	0	0	0	0	2	0	1.000
2.61-2.70	0	0	0	0	0	0	0	0	0	0	0	
2.71-2.80	0	0	3	0	0	0	0	0	0	3	0	1.000
2.81-2.90	0	0	3	0	0	0	0	0	0	3	0	1.000
2.91-3.00	0	0	0	0	0	0	0	0	0	0	0	
3.01-3.10	0	0	1	0	0	0	0	0	0	1	0	1.000
3.11-3.20	0	0	1	0	0	0	0	0	0	1	0	1.000
3.21-3.30	0	0	0	0	0	0	0	0	0	0	0	
3.31-3.40	0	0	2	0	0	0	0	0	0	2	0	1.000
3.41-3.50	0	0	1	0	0	0	0	0	0	1	0	1.000
3.51-3.60	0	0	0	0	0	0	0	0	0	0	0	
3.81-3.90	0	0	2	0	0	0	0	0	0	2	0	1.000
4.01-4.10	0	0	1	0	0	0	0	0	0	1	0	1.000
4.11-4.20	0	0	1	0	0	0	0	0	0	1	0	1.000
4.31-4.40	0	0	2	0	0	0	0	0	0	2	0	1.000
5.01-5.10	0	0	1	0	0	0	0	0	0	1	0	1.000
5.21-5.30	0	0	1	0	0	0	0	0	0	1	0	1.000
5.41-5.50	0	0	1	0	0	0	0	0	0	1	0	1.000

Table 2. DCPP Final POPCD Data(1, 6)

A	B	C	D	E	F	G	H	I	J	K	L	M
	EOC_n Bobbin Detected for POPCD Analysis(2)			EOC_n Bobbin Detected Ind. Excluded from POPCD		New EOC_{n+1} (Undetected at EOC_n) Ind. for POPCD Analysis			New EOC_{n+1} Excluded from POPCD	POPCD Calculation(1)		
Voltage Bin(3)	EOC_n Bobbin Ind. RPC Confirmed at EOC_{n+1}	EOC_n Bobbin Ind. Not RPC Inspected at EOC_{n+1}	EOC_n Bobbin Ind. Detected & Repaired at EOC_n	EOC_n Bobbin Ind. RPC NDD at EOC_{n+1}	EOC_n Bobbin Ind. INR(4) at EOC_{n+1}	New EOC_{n+1} Bobbin Ind. RPC Confirmed at EOC_{n+1}	New EOC_{n+1} Bobbin Ind. Not RPC Inspected at EOC_{n+1}	New EOC_{n+1} Ind. Found Only(5) by RPC Inspection	New EOC_{n+1} Bobbin Ind. RPC NDD at EOC_{n+1}	EOC_n Bobbin Detected Ind.	New EOC_{n+1} ODSCC Ind.	POPCD for Voltage Bin
TOTALS	687	1393	78	73	58	550	1776	162	95	2158	2488	

Notes:

1. POPCD for each voltage bin calculated as (EOCn Bobbin Detected for POPCD Analysis)/(EOCn Bobbin Detected for POPCD Analysis + New EOCn+1 Ind. for POPCD Analysis). By column, POPCD = (B+C+D)/[(B+C+D)+(G+H+I)].
2. EOCn detection based on inspection records for EOCn. Voltages obtained from EOCn inspection records.
3. Plant specific POPCD to be based upon voltage bins of 0.10-volt. Industry POPCD database may use 0.20-volt bins due to difficulty of adjusting existing database to smaller bins.
4. INR = bobbin indication found at EOCn but not reported at EOCn+1 including resolution analyst review to assign indication as INR. Bobbin indications found to be RPC NDD or INR are considered to be false calls and not included in the POPCD analysis.
5. Includes new indications at EOCn+1, not reported in the bobbin inspection, and found by RPC inspection of dents, mixed residuals or other reasons for the RPC inspection. These indications are included as new indications at each EOCn+1 found only by RPC inspection even if included as a new indication in previous POPCD evaluations. If the RPC inspection identifies more than one ODSCC indication at the same TSP intersection, the bobbin voltage assigned to the TSP is estimated as the square root of the sum of squares for the bobbin voltages inferred from the RPC indications.
6. The sum of all EOCn bobbin indications = sum of columns B through F. The sum of all EOCn+1 bobbin indications = sum of columns B+C+E+columns G through J.

Table 3. DCPP Benchmark Analyses for POPCD and POD of 0.6
2R10 OA Analyses vs. 2R11 As-Found CM

DCPP POPCD							POD 0.6	
SG	Calc. Description	POB	Leak Rate (gpm)	Differences Between OA and CM Results (OA-CM)			OA POB	OA Leak Rate (gpm)
				ΔPOB	ΔLeak Rate	Significance of Differences[1]		
2-1	**2R11 As-Found**	**1.18E-03**	**6.82E-01**					
	Calc. with Cycle 10 VD Growth[6]	5.80E-04	6.19E-01	-6.0E-04	-6.3E-02	Insignificant: Both ΔPOB and ΔLR differences < 10 percent of reporting thresholds		
	Calc. with Cycle 11 VD Growth[7]	1.08E-03	7.36E-01	-1.0E-04	+5.4E-02			
2-2	**2R11 As-Found**	**5.66E-04**	**3.62E-01**					
	Calc. with Cycle 10 VD Growth[6]	2.92E-04	2.96E-01	-2.74E-04	-6.6E-02	Insignificant: Both ΔPOB and ΔLR differences < 10 percent of reporting thresholds		
	Calc. with Cycle 11 VD Growth[7]	4.67E-04	3.50E-01	-9.9E-05	-1.2E-02			
2-3	**2R11 As-Found**	**1.58E-04**	**2.11E-01**					
	Calc. with Cycle 10 VD Growth[6]	2.53E-04	2.64E-01	+9.5E-05	+5.3E-02	Insignificant: Both ΔPOB and ΔLR differences < 10 percent of reporting thresholds		
	Calc. with Cycle 11 VD Growth[7]	1.73E-04	2.45E-01	+1.5E-05	+3.4E-02			
2-4	**2R11 As-Found**	**3.84E-03[2]**	**3.21[2]**					
		2.38E-02[3]	**3.72[3]**					
	Calc. with Cycle 10 VD Growth[6]	2.75E-03[2]	2.58[2]	-1.09E-03	-0.63	ΔPOB slightly significant, ΔLR insignificant. Review required.[4]	6.46E-03[2]	4.51[2]
	Calc. with Cycle 11 VD Growth[7]	3.47E-03[2]	3.24[2]	-3.7E-04	+0.03	Insignificant: Both ΔPOB and ΔLR differences < 10 percent of reporting thresholds	9.97E-03[2]	5.67[2]
		2.18E-02[3]	3.76[3]	-2.0E-03	+0.04	ΔPOB significant, ΔLR insignificant. Review required.[5]	5.06E-02[3]	6.49[3]

Notes:
1. Significant differences defined in Section 4.6 as 10% of reporting thresholds or -1.0E-03 for POB and -1.05 gpm for SLB leakage (allowable limit of 10.5 gpm). A review of the analysis methods is required when these criteria are exceeded.
2. CM and OA results exclude R44C45 from as-found voltage distribution and growth distribution.
3. CM and OA results include R44C45 in as-found voltage distribution and in growth distribution.
4. The differences between the CM and OA results can be attributed to the assignment of 10% NDE analyst variability uncertainties to indications > 2 volts in the CM analysis and to about a 5% increase in growth rates above about 0.6 BOC volts for Cycle 11.
5. Differences in the CM as-found calculations and the projected calculations utilizing cycle 11 actual growth rates are partially attributable to the NDE analyst uncertainties that are applied to the higher voltage indications at EOC conditions. By recalculating the EOC-11 as found conditions with the analyst uncertainty for indications >2 volts reduced to 5%, the CM POB is reduced to 2.23E-02, which leads to an insignificant ΔPOB of –5.0E-04. This result demonstrates the sensitivity of the as-found calculation to the application of the uncertainties in the Monte Carlo codes. The NDE uncertainties in the OA analyses are assigned to indications predominantly below the ARC repair limit for which the 10% NDE uncertainty was developed. In the CM analyses, an assignment of 10% NDE analyst variability uncertainties to indications > 2 volts is excessively conservative (see Section 4.5 and NUREG/CR-6791)
6. The 2R10 OA calculations with Cycle 10 VDG used statistically developed growth rate breakpoints at 0.69v and 1.17v. SG 2-4 primarily dominates the growth rates in Cycle 10, and as such the curves used in the calculations were composite in all bins.
7. The 2R10 OA calculations with Cycle 11 VDG used statistically developed growth rate breakpoints at 0.59v and 1.66v. The upper bin (>1.66v) for the SG 2-3 calculation used a Cycle 11 growth rate including indications from all steam generators except for R44C45 in SG 2-4. The other 'Cycle 11 Growth' runs used SG-specific growth.

Table 4. Comparison of 2R11 As-Found and Projected Voltages Using 2R11 Growth Rates									
Voltage Category	SG 2-1		SG 2-2		SG 2-3		SG 2-4		
	As-Found	Projected	As-Found	Projected	As-Found	Projected	As-Found	POPCD Projected	0.6 POD Projected
≤1v	304	292.63	249	204.11	229	176.29	753	566.82	415.24
>1v	46	59.58	29	31.22	34	40.80	229	281.69	376.47
>2v	10	12.33	5	4.84	5	6.74	68	86.36	131.94
>5v	3	2.31	1	1.18	0	0.05	9	7.64	18.30
>20	0	0	0	0	0	0	1	1.00	2.20
All	350	352.21	278	235.32	263	217.09	982	848.50	791.71

Notes:
1. Projected voltages are based on a recalculation of the 2R10 OA using the DCPP-specific POPCD and Cycle 11 voltage-dependent growth with statistically based breakpoints at 0.59v and 1.66v.
2. All calculations used SG-specific Cycle 11 voltage dependent growth except for the upper bin (>1.66v) in SG 2-3, where no indications existed. The SG 2-3 case used a composite growth rate from all SGs that excluded the 11.9 volts/EFPY growth rate from SG 2-4 R44C45.
3. <1 volt flaws do not significantly contribute to POB and Leak rate total.

Table 5. Comparison of 2R11 As-Found and Projected Voltages Using 2R10 Growth Rates									
Voltage Category	SG 2-1		SG 2-2		SG 2-3		SG 2-4		
	As-Found	Projected	As-Found	Projected	As-Found	Projected	As-Found	POPCD Projected	0.6 POD Projected
≤1v	304	283.51	249	191.75	229	177.07	753	589.55	446.26
>1v	46	68.80	29	43.59	34	40.02	229	258.71	345.45
>2v	10	12.95	5	6.24	5	5.61	68	59.87	99.26
>5v	3	1.31	1	0.45	0	0.39	9	5.96	13.93
All	350	352.31	278	235.35	263	217.09	981(4)	848.27	791.71

Notes:
1. Projected voltages are based on a recalculation of the 2R10 OA using the DCPP-specific POPCD and Cycle 10 voltage-dependent growth with breakpoints at 0.69v and 1.17v.
2. All calculations used composite SG Cycle 10 growth in each bin because of the small number of flaws that existed in the upper and middle bins.
3. <1 volt flaws do not significantly contribute to POB and leak rate total.
4. R44C45 in SG 2-4 was excluded from the as-found and projected distributions since the benchmark was performed to evaluate the methods for projections and as-found analyses excluding the limitations on predicting the large flaw.

Table 6. DCPP POPCD LogLogistic Parameters	
Parameter	**LogLogistic**
Number of Data Points	4646
a.0	1.7673
a.1	4.7049
V11	0.00546
V12	0.01078
V22	0.02687
Deviance	5188.56
MSE	0.1895
Binary	TRUE
Chi Sqr	879.82
DoF	4644
p-Value	< 2.9E-07

Figure 1

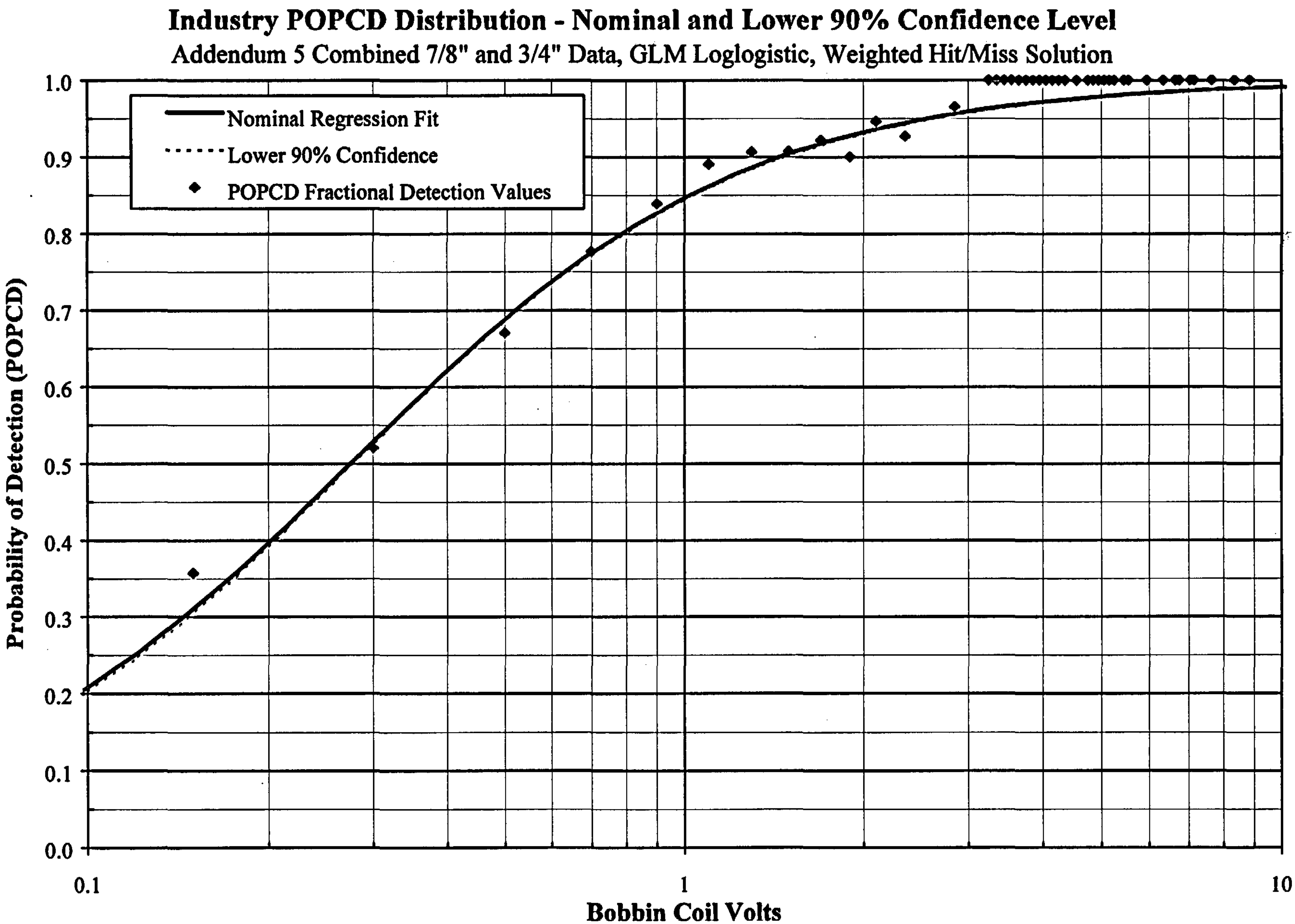

Industry POPCD Distribution - Nominal and Lower 90% Confidence Level
Addendum 5 Combined 7/8" and 3/4" Data, GLM Loglogistic, Weighted Hit/Miss Solution
Nominal Regression Fit
Lower 90% Confidence
POPCD Fractional Detection Values
Probability of Detection (POPCD)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1
10
Bobbin Coil Volts

Figure 2

DCPP Final POPCD Distribution - Nominal and Lower 90% Confidence Level

GLM Loglogistic Fit Weighted by Number of Indications Per Voltage Bin - Final POPCD Data (5/12/03)

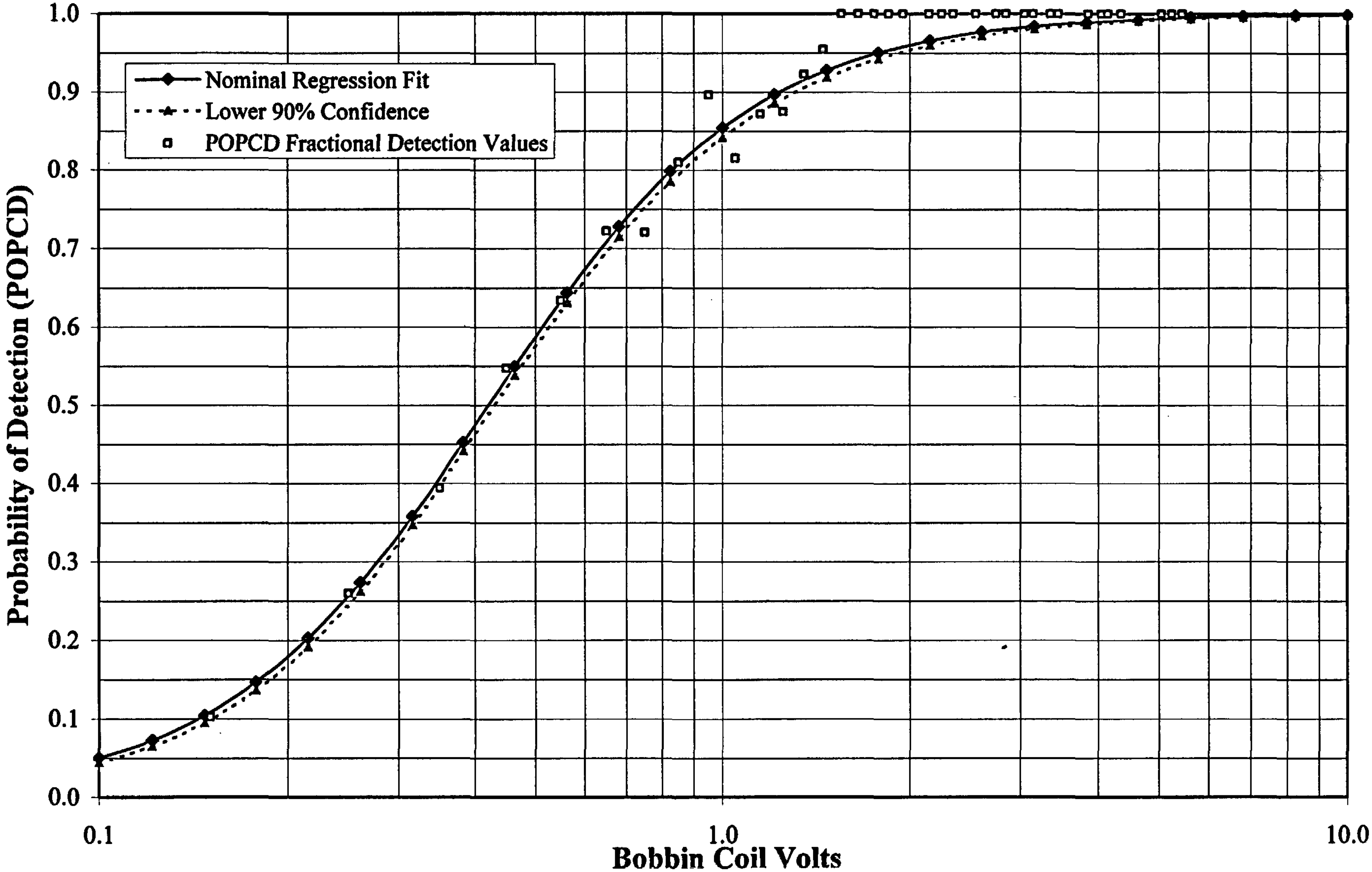


Figure 3

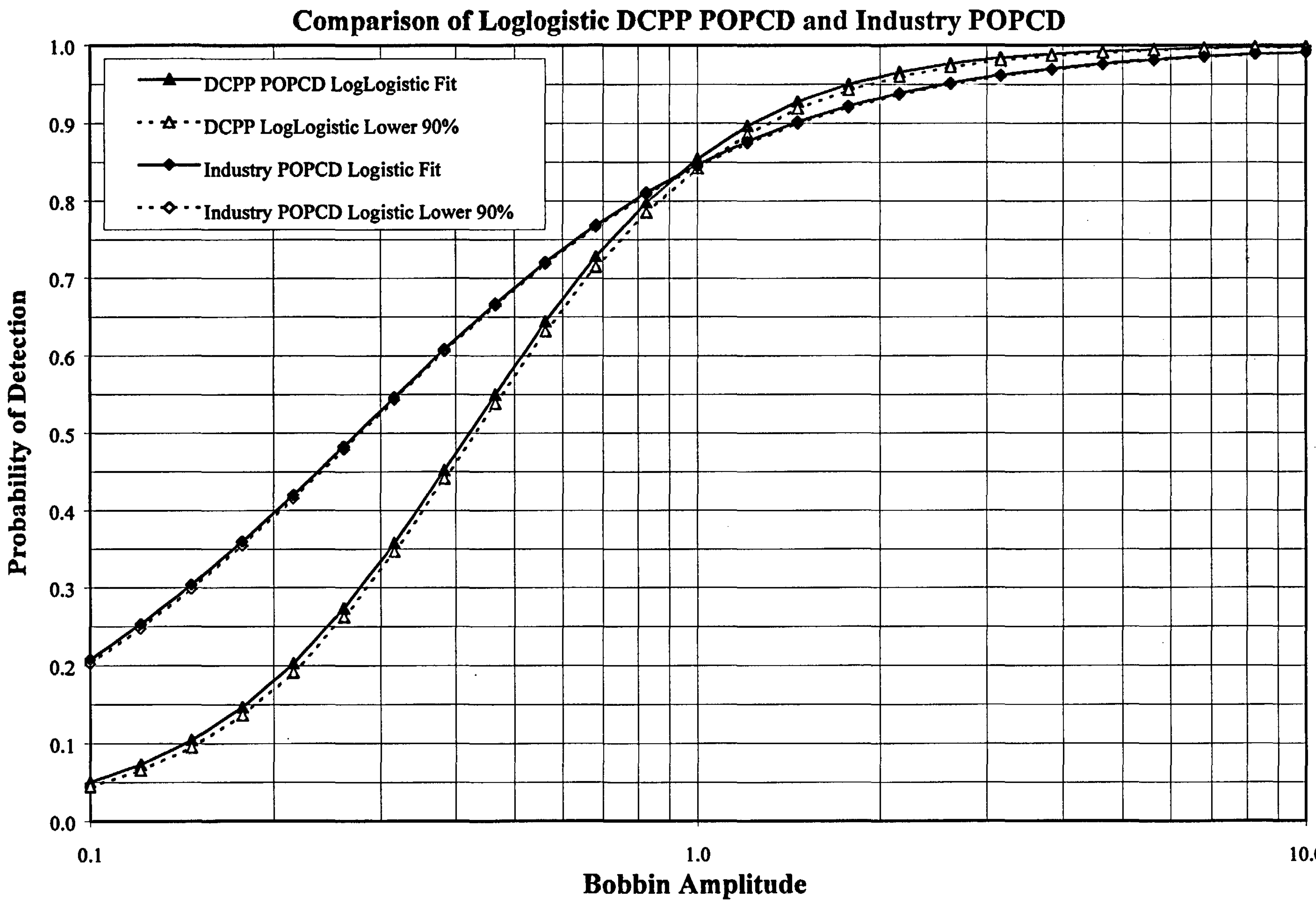

Comparison of Loglogistic DCPP POPCD and Industry POPCD
DCPP POPCD LogLogistic Fit
DCPP LogLogistic Lower 90%
Industry POPCD Logistic Fit
Industry POPCD Logistic Lower 90%
Probability of Detection
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1.0
10.0
Bobbin Amplitude

Figure 4

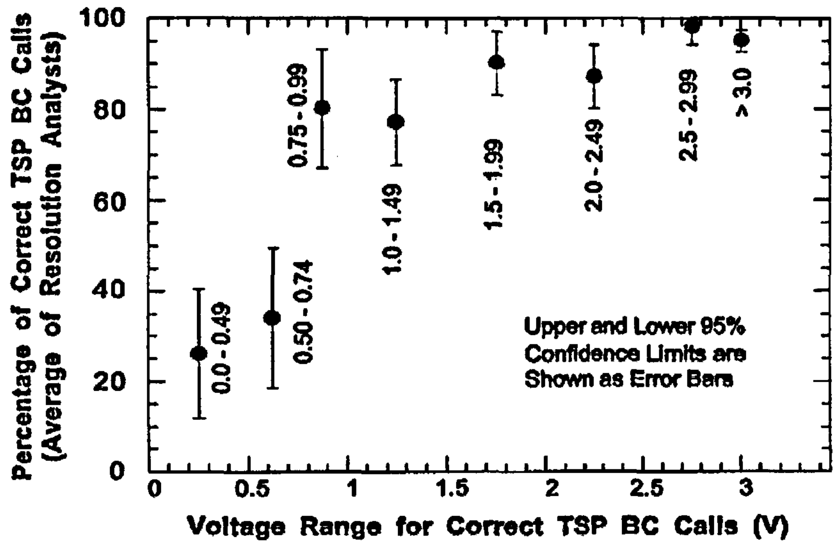


Figure 4 (Percent of Correct TSP BC Calls) Results as a function of BC voltage for TSP crack. The BC POD has been evaluated for LODSCC at the TSP. Depths are determined with the mulitparameter algorithm.

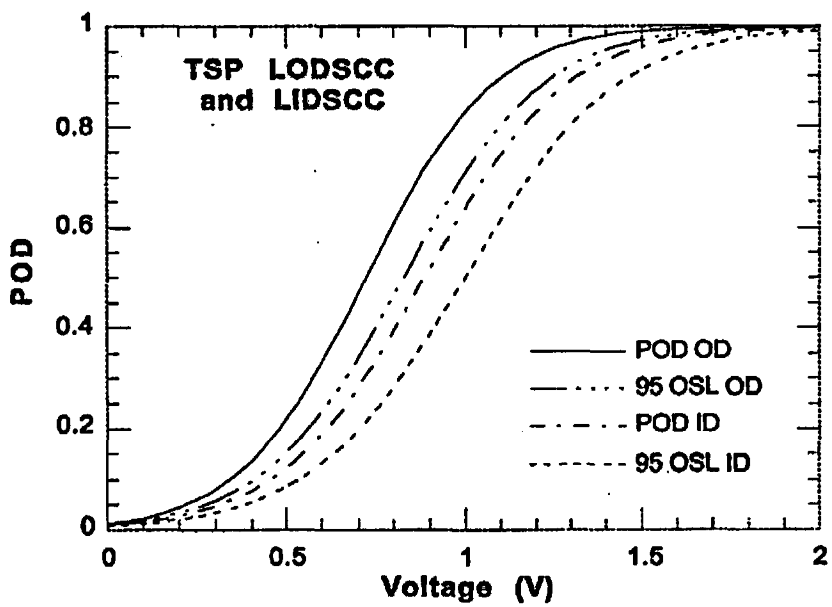


Figure 4 (POD) Logistic fit curves for BC POD as a function of voltage for LODSCC and LIDSCC in TSP.

Figure 5

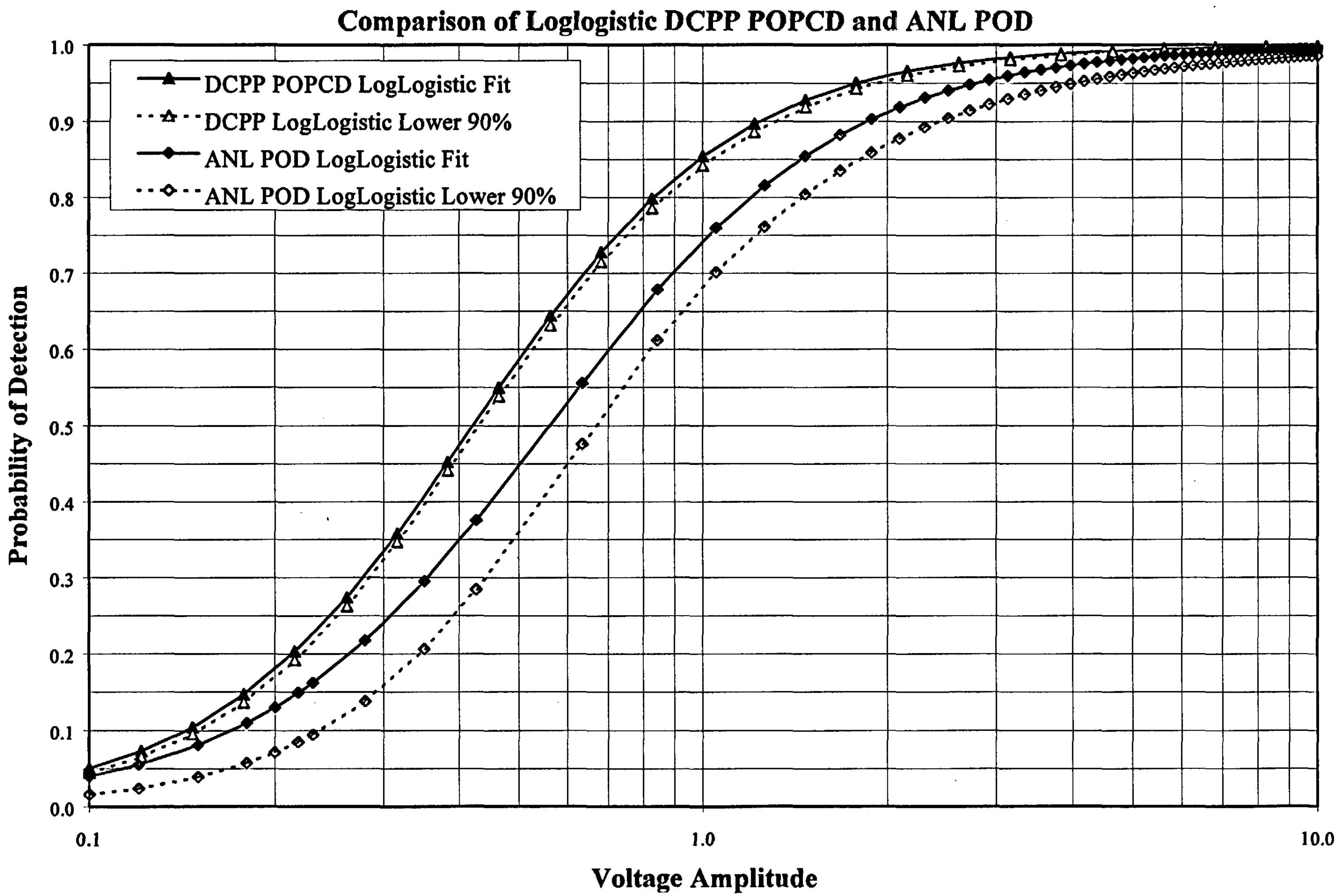
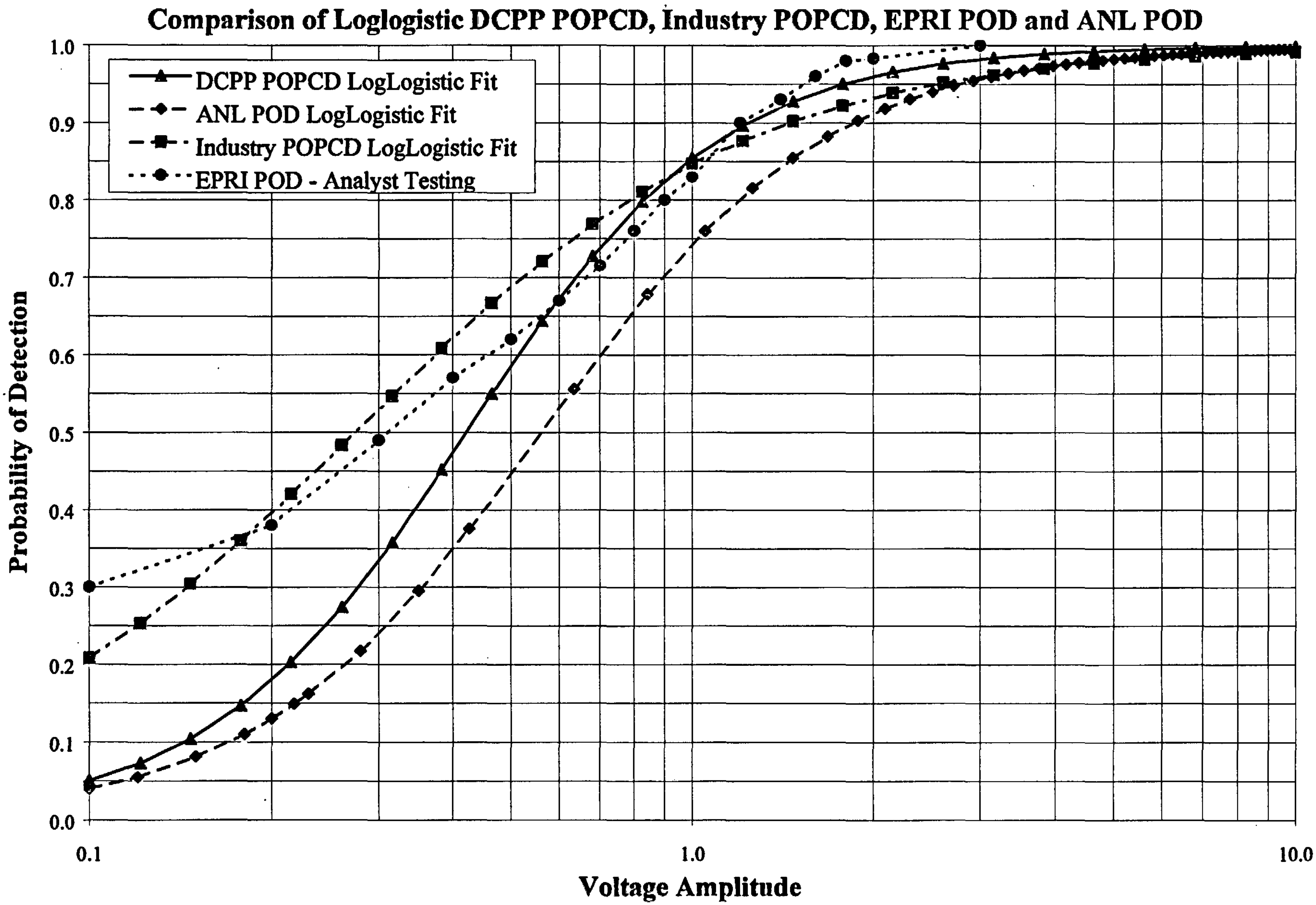

Comparison of Loglogistic DCPP POPCD and ANL POD
DCPP POPCD LogLogistic Fit
DCPP LogLogistic Lower 90%
ANL POD LogLogistic Fit
ANL POD LogLogistic Lower 90%
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Probability of Detection
0.1
1.0
10.0
Voltage Amplitude

Figure 6


Comparison of Loglogistic DCPP POPCD, Industry POPCD, EPRI POD and ANL POD
DCPP POPCD LogLogistic Fit
ANL POD LogLogistic Fit
Industry POPCD LogLogistic Fit
EPRI POD - Analyst Testing
Probability of Detection
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
1.0
10.0
Voltage Amplitude

Final Safety Analysis Report Update Markups
(For information only)

5.5.2.5.4 Voltage-Based Alternate Repair Criteria

The voltage-based repair limits in the Technical Specifications implement the guidance in GL 95-05 and are applicable only to Westinghouse-designed SGs with outside diameter stress corrosion cracking (ODSCC) located at the tube-to-tube support plate intersections. The voltage-based repair limits are not applicable to other forms of SG tube degradation nor are they applicable to ODSCC that occurs at other locations within the SG. Additionally, the repair criteria apply only to indications where the degradation mechanism is dominantly axial ODSCC with no significant cracks extending outside the thickness of the support plate. Refer to GL 95-05 for additional description of the degradation morphology.

The lower voltage repair limit for 7/8 inch diameter SG tubing is 2.0 volts in accordance with GL 95-05. Calculation of the upper voltage repair limit requires a derivation of the voltage structural limit from the burst versus voltage empirical correlation and then the subsequent derivation of the upper voltage repair limit from the structural limit.

The voltage structural limit is the voltage from the burst pressure/bobbin voltage correlation, at the 95 percent prediction interval curve reduced to account for the lower 95/95 percent tolerance bound for tubing material properties at 650°F (i.e., the 95-percent LTL curve). The voltage structural limit must be adjusted downward to account for potential flaw growth during an operating interval and to account for NDE uncertainty. The upper voltage repair limit, V_{URL}, is determined from the structural voltage limit by applying the following equation:

$$V_{URL} = V_{SL} - V_{GR} - V_{NDE}$$

where V_{GR} represents the allowance for flaw growth between inspections and V_{NDE} represents the allowance for potential sources of error in the measurement of the bobbin coil voltage. Further discussion of the assumptions necessary to determine the upper voltage repair limit are discussed in GL 95-05.

The upper voltage repair limit mid-cycle equation in GL 95-05 and in the Technical Specifications should only be used during unplanned inspections in which eddy current data is acquired for indications at the tube support plates.

For the operational assessment for Unit 2 Cycle 12 only, the Probability Of Prior Cycle Detection (POPCD) voltage-based probability of detection (POD) method, as described in letter DCL-03-078, is used to determine the beginning of cycle voltage distribution for the DCPP Unit 2 cycle 12. The POPCD method is an exception to the GL 95-05 guidance that requires the application of a POD of 0.6 to all previous bobbin indications. The use of the POPCD method for the Unit 2 Cycle 12 operational assessment was approved by the NRC in amendment ??? to the Unit 2 Operating License.

The Technical Specifications implement several reporting requirements recommended by GL 95-05 for situations which the NRC wants to be notified prior to returning the SGs to service. For the purposes of this reporting requirement, leakage and conditional burst probability can be calculated based on the as-found voltage distribution rather than the projected end-of-cycle voltage distribution (refer to GL 95-05 for more information) when it is not practical to complete these calculations using the projected EOC voltage distributions prior to returning the SGs to service. Note that if leakage and conditional burst probability were calculated using the measured EOC voltage distribution for the purposes of addressing the GL Section 6.a.1 and 6.a.3 reporting criteria, then the results of the projected EOC voltage distribution should be provided per the GL Section 6.b(c) criteria.