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February 12, 2004
L-04-016

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Subject: Beaver Valley Power Station, Unit No. 1
Docket No. 50-334, License No. DPR-66
Response to Steam Generator Request for Additional Information

On July 24, 2003, by letter L-03-113, FirstEnergy Nuclear Operating Company (FENOC) submitted the Beaver Valley Power Station (BVPS) Unit No. 1 Cycle 16 Voltage-Based Repair Criteria, 90-Day Report (90-Day Report). The Nuclear Regulatory Commission has identified that it needed additional information to complete its review of the BVPS Unit 1 90-Day Report and provided a Request for Additional Information (RAI) in a letter dated November 20, 2003.

Enclosed are the FENOC responses to the questions provided in the Nuclear Regulatory Commission RAI with regard to the BVPS Unit 1 Cycle 16 steam generator 90-Day Report. Enclosure 1 provides the responses to the questions specific to the 90-Day Report, and Enclosure 2 provides the responses to the questions specific to Appendix A of the 90-Day Report.

There are no new regulatory commitments contained in this submittal. If there are any questions concerning this matter, please contact Mr. Larry R. Freeland, Manager, Regulatory Affairs/Performance Improvement at 724-682-5284.

Sincerely,

L. William Pearce

Enclosures

c: Mr. T. G. Colburn, NRR Senior Project Manager
Mr. P. C. Cataldo, NRC Sr. Resident Inspector
Mr. H. J. Miller, NRC Region I Administrator
Mr. L. E. Ryan (BRP/DEP)

ENCLOSURE 1

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI) CONCERNING THE BEAVER VALLEY POWER STATION UNIT 1 "CYCLE 16 VOLTAGE BASED REPAIR CRITERIA - 90 DAY REPORT"

NRC RAI #1:

At Diablo Canyon, Unit 2, several large bobbin voltage indications were detected during its steam generator (S/G) tube inspections during its 2003 refueling outage. As a result of these findings, the licensee performed more extensive rotating probe inspections than previously performed so as to assist in determining whether certain axial outside diameter stress corrosion cracking (ODSCC) indications may be prone to significant bobbin voltage growth during the course of the next cycle (Refer to Information Notice (IN) 2003-13).

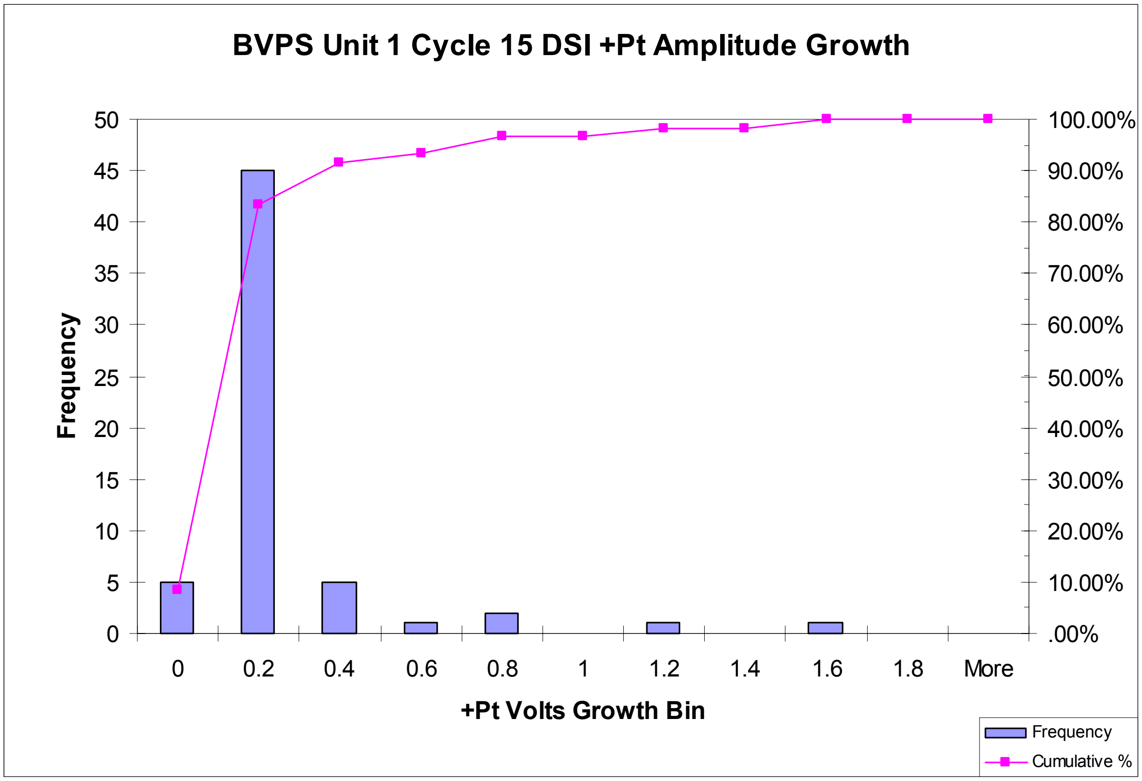
Given the findings at Diablo Canyon Unit 2, discuss the +Point results, if any, for the larger voltage indications left in service during the 2003 refueling outage (1R15). Also discuss whether the indications with the largest growth rates in Cycle 15 were inspected with a rotating probe during the current (2003) and/or the previous (2001) outage. Discuss any observations from the rotating probe profiling of these indications, the bobbin and rotating probe voltages of these indications, etc. For example did the indications with the largest bobbin voltage growth rates have large rotating probe amplitudes (when compared to the bobbin amplitude) at the beginning of the cycle (i.e., during the 2001 outage (1R14))? Did the rotating probe data acquired at the beginning of the cycle (i.e., during the 2001 outage) indicate the flaw was nearly through-wall and the subsequent rotating probe data at the end of the cycle (in 2003) indicate the flaw had penetrated through-wall?

FirstEnergy Nuclear Operating Company (FENOC) Response to NRC RAI #1:

Beaver Valley Power Station (BVPS) Unit 1 does not have a history of large numbers of tube support plate indications with large growth rates as does Diablo Canyon. Generic Letter (GL) 95-05 requires only those indications > 2.00 volts by bobbin to be RPC inspected. Since the implementation of GL 95-05 at BVPS Unit #1 (1R11 – 1996), BVPS has performed a Plus Point examination on a 20% sample of the largest Distorted Support Plate Intersection signals (DSI's) < 2.00 volts or a Plus Point examination of the 100 largest DSI's < 2.00 volts in *each* S/G. This assures that the degradation being observed remains consistent with the ODSCC database. In response to the Diablo Canyon, Unit 2, Spring 2003 issues, a 100 indication sample encompassing all bobbin coil DSI voltage ranges was examined with the Plus Point probe. As a result, the Plus Point amplitude growth statistics for Cycle 15 are limited. For the S/G "A" with regards to 1R15 DSI's Plus Point inspected in both 1R15 and 1R14, Figure 1 provides a cumulative probability distribution of the Plus Point amplitude growths. As seen from this plot, the overwhelming majority of the indications exhibit small Plus Point amplitude growth, and thus, small depth growth.

Bobbin growth data for all S/Gs were reviewed. Growth distributions for Cycle 15 are slightly reduced compared to Cycle 14, and likely due to the removal of deposits from crevice regions due to chemical cleaning at 1R14. All 1R15 DSI's with ≥ 1.00 volt growth were reviewed to determine if a Plus Point test was performed in 2003 (1R15) and 2001 (1R14). A total of 5 DSI's were found in this population. Two were not tested at 1R15, one had a 1R15 Plus Point amplitude of 0.77 volts but was not tested at 1R14, and the other two had Plus Point amplitude growths of 1.75 and 1.01 volts. For S/G "A", data for all DSI's >1.5 volts was reviewed. The average DSI growth for these (94) indications is 0.25 volts. The average Plus Point voltage growth (27 indications) is 0.25 volts.

Figure 1



S/G "A" contains the largest number of DSI's, and contained the largest singular DSI amplitude for 1R15. The average voltage growth was 0.25 volts for 1R15 DSI indications with ≥ 1.5 DSI volts. This includes one indication with bobbin voltage growth of 3.25 volts, and 2 indications with bobbin voltage growth of 1.01 volts. At 1R15, S/G "A" contained 94 indications with ≥ 1.5 DSI bobbin volts. Of these 94, the 1R15 and 1R14 data was reviewed to determine if a Plus Point examination occurred in each outage. For those indications with Plus Point exam in both outages, the average Plus Point amplitude growth was 0.25 volts. It should be noted that the 1R15 Plus Point reporting channel was 200 kHz due to a change in the EPRI Examination Technique Specification Sheets (ETSS) whereas the 1R14 Plus Point reporting channel was 300 kHz. The 1R15 200 kHz Plus Point amplitudes were reduced by 10% to account for the difference in amplitude responses between the two frequencies. The largest 1R15 DSI was reported at 4.57 volts, with a Plus Point amplitude of 2.12 volts. The bobbin growth for this indication was 3.25 volts, and the Plus Point growth was 1.51 volts. The largest Plus Point amplitude for a DSI was also reported in S/G "A", at 2.47 volts. The Plus Point growth for this indication was 0.76 volts while the bobbin growth was 1.01 volts. Based on the Plus Point amplitude to maximum depth correlation, this indication was approximately 95% through-wall (TW) at 1R14. For the most part, the 1R15 indications with > 1.5 DSI volts did not have Plus Point amplitudes that suggested 100% or near 100% TW degradation. Of the 1R15 DSI's Plus Point inspected, the only intersections with potentially 100% TW degradation are the two discussed above, and one other indication in S/G "A". The bobbin coil DSI amplitude for this indication is 1.93 volts with a 200 kHz Plus Point amplitude of 1.99 volts (1.79 volts measured in 300 kHz). The maximum depth from 300 kHz phase analysis was 94% TW, while the maximum depth from correlation of Plus Point volts was 89% TW. This tube (S/G "A" R22 C36) remains in service.

The following table presents the S/G "A", 1R15 bobbin and Plus Point data for DSI's ≥ 2.0 volts. As seen from this table, only 2 of the 10 DSI's > 2.0 volts at 1R15 had depths from Plus Point voltage that suggest 100%TW degradation. All locations listed below, with the exception of R6 C11, were plugged, consistent with the requirements of GL 95-05.

1R15	**S/G "A"**				
Row	**Col**	**Locn**	**Bobbin Volts**	**+Pt Volts**	**Max Depth from +Pt V**
6	11	02H	2.07	NDF	
7	80	01H	2.07	0.35	57
9	86	04H	2.08	0.62	68
10	**66**	01H	**2.23**	**2.74**	**100**
11	**77**	01H	**4.57**	**2.36**	**100**
17	19	02H	2.03	0.47	62
20	36	01H	2.37	1.00	78
21	33	01H	2.17	0.33	56
24	79	02H	2.10	0.56	66
35	35	02H	2.11	1.05	79

NDF – No Degradation Found

At BVPS Unit1, indication morphology is characterized by multiple sites of crack initiation. This tends to increase the bobbin amplitude more than the Plus Point amplitude. This morphology is based on the metallurgical results of tubes removed from the BVPS Unit 1 S/G's. Data from BVPS Unit 1 indicates that on average for bobbin coil DSI's > 2.00 volts, the Plus Point amplitude was about half of the bobbin coil amplitude.

NRC RAI #2:

According to the "[BVPS-1] Cycle 16 Voltage Based Repair Criteria 90-Day Report" (90 Day Report), the End of Cycle (EOC) 15 measured voltages were bounded by the voltage distributions projected using both probability of detection = 0.6 and probability of prior cycle detection, except for one indication in S/G "A". Discuss the reason for the voltage under prediction for this indication. Discuss any corrective actions that were taken in response to these findings.

FENOC Response to NRC RAI #2:

The EOC-15 voltages are predicted by the Cycle 15 90-Day Report (December 2001). As detailed in the Cycle 15 90-day report, the Cycle 13 composite growth rate bounded the Cycle 14 composite growth rate. See Figure 4-6 of the Cycle 15 90-Day Report. The average voltage growth for Cycle 14 was less than the average voltage growth for Cycle 13. See Table 4-5 of the Cycle 15 90-Day Report. The average voltage growth for Cycle 14 was 0.057 volts per EFPY while the average voltage growth for Cycle 13 was 0.101 volts per EFPY. Therefore, per GL 95-05, the Cycle 13 composite growth rate was used in the Cycle 15 90-day report to project EOC 15 voltage distributions. However, as stated in Section 7.3 of the Cycle 15 90-Day Report, "However, since the Cycle 14 distribution includes one relative large value in the tail (3.4 volts), it may yield a higher burst probability than the Cycle 13 growth distribution. Therefore, Cycle 15 operational assessment analysis was carried out using both Cycle 13 and Cycle 14 growth distributions and the larger SLB leak rate and tube burst probability values from the two sets of analysis are reported". Table 8-2 of the Cycle 15 90 Day Report, which was reproduced as Table 7-1 in the Cycle 16 90 Day Report (July 2003), shows that the largest predicted voltage in S/G "A" was 3.4 volts, based on Cycle 13 composite growth. Table 8-2 of the Cycle 15 90-Day Report (Table 7-1 of the Cycle 16 90-Day Report) also shows that the largest predicted voltage in S/G "A" using Cycle 14 S/G composite growth was 4.8 volts, thus the 4.57 volt indication observed in S/G "A" at 1R15 was predicted by the EOC 15 simulation that utilized the Cycle 14 composite growth distribution. It should be noted that Table 8-2 of the Cycle 15 90-Day Report (Table 7-1 of the Cycle 16 90 Day Report) indicates the largest predicted voltage in S/G "C" was 5.9 volts while the largest reported voltage in S/G "C" at 1R15 was 2.5 volts.

The Cycle 15 90-Day Report indicates that using Cycle 13 composite growth, for S/G "A", 45 indications greater than 2.00 volts were predicted using probability of detection (POD) = 0.6, and 26 indications greater than 2.00 volts were predicted using probability of prior cycle detection (POPCD). The actual count was 10.

No corrective action is necessary since the analysis accounted for, and conservatively predicted the EOC-15 voltage in S/G "A", S/G "B", and S/G "C".

NRC RAI #3:

Section 3.3 of the 90 Day Report, "Probe Wear Criteria," states that only 6 of the 628 new indications found in the EOC 15 inspection were in tubes inspected with a worn probe during the EOC 14. While this is a low absolute number of new indications in tubes previously inspected with a worn probe, compare the percentage of tubes that failed the probe wear check (in 1R14) and had new indications detected in the 1R15 inspection to the percentage of tubes that passed the probe wear check (1R14) and subsequently had new indications detected in the 1R15 inspection. The Nuclear Regulatory Commission (NRC) staff's concern is illustrated in the following hypothetical example. Suppose 20 new indications were detected during an outage. Further, suppose 10 of these new indications were associated with a probe that failed the probe wear check in the previous outage and 10 were associated with a probe that passed the probe wear check during the previous inspection. If 100 tubes were inspected with a worn probe and 10,000 tubes were inspected with a probe that passed the probe wear check, 10% of the intersections inspected with the worn probe contained indications at the next outage while only 0.1% of those inspected with a "non-worn probe" had new indications. This may indicate the alternate probe wear criteria is causing degradation to be missed. Were any new indications detected with new probes that were not detected with worn probes?

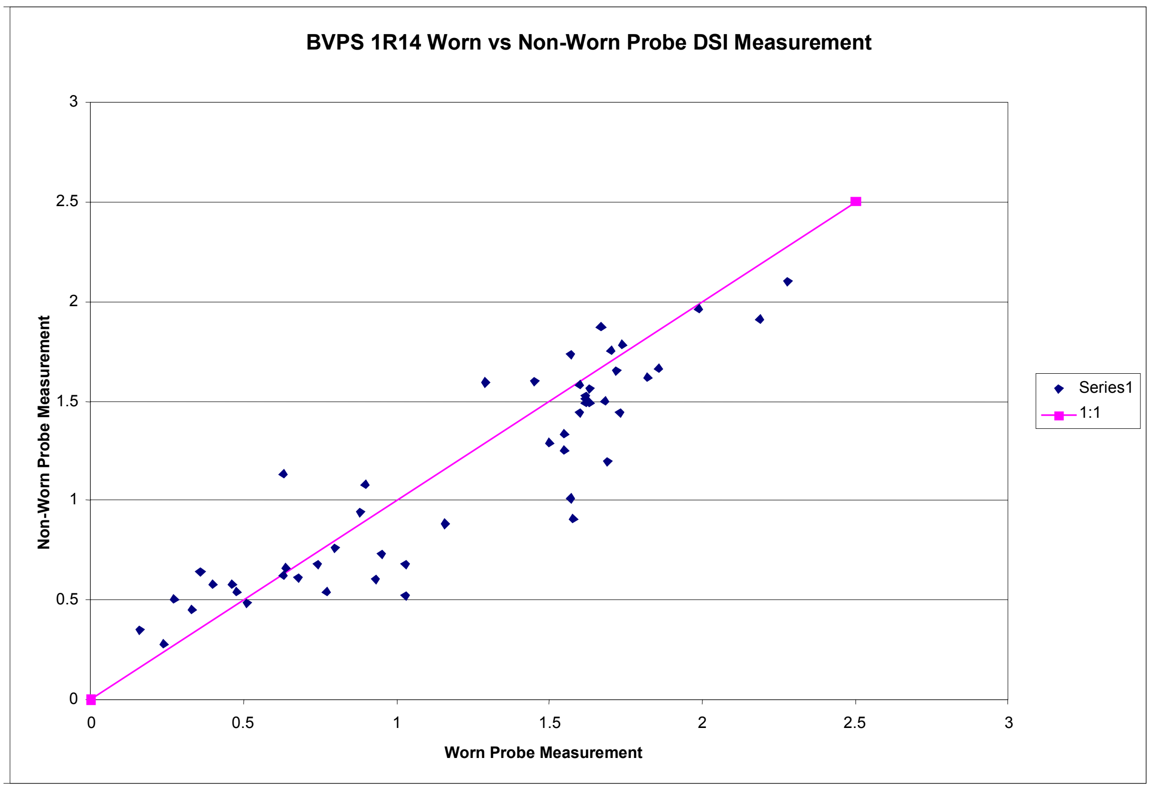
FENOC Response to NRC RAI #3:

Point of clarification: In the example above, 100 tubes tested with a worn probe would represent a total of 1400 intersections, thus the percentage of intersections with indications is 0.71%, not 10%.

The probe wear criteria is an established part of GL 95-05, and to date, has not resulted in the detection of significant indications at the next outage due to testing with a worn probe at the previous outage. The probe wear criteria are related more to measurement repeatability of meaningful indications than to the detection of insignificant indications. Any effect upon detection would be found in indications well less than 1.00 volt. The current 0.6 POD more than accounts for any influence of worn probes on detection of < 1.00 volt DSI's. For the 1R14 inspection, a comparison of amplitude responses for intersections affected by a worn probe was performed for the non-worn probe data. The average amplitude difference (non-worn minus worn) was found to be negative 0.08 volts, suggesting that the worn probe amplitude is generally larger than the non-worn probe amplitude.

Figure 2 presents this plot. For the 1R14 inspection, only one new DSI was reported as a result of testing with a non-worn probe. The DSI amplitude was 0.32 volts. For the 1R15 inspection, the amplitude of the largest DSI (of six) not reported from the worn probe test was 0.74 volts. The average difference (non-worn minus worn) was found to be negative 0.06 volts, indicating that the worn probe amplitude is generally larger than the non-worn probe amplitude.

Figure 2



Perhaps the most appropriate response to this question lies in inspection results from plants without alternate repair criteria. The standard in these cases is to operate the probe until failure. If there was a systematic issue with probe wear and detection of indications, it would be more readily apparent in non-alternate repair criteria plants as no probe wear criteria is applied. GL 95-05 provides specific guidance on re-testing criteria related to probe wear. If the probe wear criteria were flawed, evidence would have been accumulated by virtue of the number of plants that have applied the criteria. There have been no reports of large signals that were missed in the previous outage due to a worn probe.

NRC RAI #4:

In Figures 3-5 and 3-6 the cumulative probability distributions for the BVPS-1 Cycle 14 and Cycle 15 growth rate data are provided. These figures show, in part, the cumulative probability of observing various negative growth rates. Per Generic Letter (GL) 95-05, negative growth rates should be included as zero growth rates in the assumed growth rate distribution. Confirm that negative growth rates were included as zero growth rates in the growth rate distributions used in the Monte Carlo calculations.

FENOC Response to NRC RAI #4:

Negative growth rates were assigned zero growth in the simulation.

NRC RAI #5:

Table 7-1 provides a summary of calculations for tube leak rate and tube burst probability. The staff notes two burst probability values were inadvertently omitted from the table. Please provide these values. Table 7-1 indicates that leak rates and burst probabilities were calculated using both Cycle 13 and Cycle 14 growth rate data and the largest values for the burst probability and leakage were listed. Clarify why, in some instances, the largest values for the burst probability and leakage are not associated with the growth distribution that resulted in the largest EOC voltage.

In Table 7-1, the Addendum 4 database was used for determining the projected probability of burst (POB) and leakage values for EOC-15, and the Addendum 5 database was used for determining the actual POB and leakage values for EOC-15. Please discuss whether the use of these different databases had any affect on your assessment of whether the methodology is conservatively projecting the EOC conditions. If use of the different databases cannot be demonstrated to provide equivalent results, please provide a set of calculations in which the projected and actual EOC conditions are assessed using the same database.

The NRC staff recognizes your limiting projected leak rates and tube burst probability are well below the allowable main steam line break leakage and the NRC reporting guideline for tube burst probability. However, one of the purposes of this assessment is to evaluate whether the methodology is resulting in conservative projections so that timely corrective action can be taken.

FENOC Response to NRC RAI #5:

The exponent of the omitted values is 10^{-4}. As such, the value is insignificant since it is well below the limit of 1×10^{-2}. The missing values, reading from left to right are 2.5×10^{-4}, and 2.8×10^{-4}.

The burst and leak probabilities represent the value for the entire S/G. A single indication may not significantly influence the overall burst and leak values for an entire S/G unless the bobbin coil amplitude begins to approach the voltage based structural limit (approximately 9.00 volts).

At the time the EOC-15 projections were performed, the database of record was per Addendum 4. At the time of the 1R15 outage, the database of record was per Addendum 5. Database changes typically have a negligible impact upon these analyses. The regular database updates include a comparison of the old and new databases. The Plus Point inspection data suggests that the leakage assessment, in particular, is extremely conservative since only two DSI signals at 1R15 had a sufficient Plus Point amplitude to suggest a leakage potential at EOC-15 conditions. The EOC-15 actual predicted leakage of 5.0 gallons per minute (gpm) is inconsistent with only two potential indications that could contribute to leakage.

With regard to conservatism of the calculation, comparison of the number of > 2.00 volts indications predicted with POD = 0.6 (116), with the actual number of > 2.00 volts indications reported during the 1R15 inspection (19) demonstrates the inherent conservatism.

NRC RAI #6:

You indicated that the growth rate for a de-plugged tube returned to service shows an increased growth rate during the first cycle then exhibits normal growth thereafter. Please discuss whether you have any insight as to why this occurs.

FENOC Response to NRC RAI #6:

No de-plugged tubes were returned to service during the 1R15 outage. The growth rate discussed refers to the change in voltage between the time of plugging and the time of de-plugging. The voltage change for this case should be small, but in many cases is elevated compared to the active tube population. These indications typically show no phase change, i.e., no depth change. Thus, the voltage change for these indications is not indicative of a change in depth. The voltage response could be due to a change in deposit character, formation of oxides on the crack face, or an increase in initiation sites. The fact that the growth rates return to normal further suggests that the observed growth rate is not attributed to degradation of the tube wall.

Based on a review of Appendix A to the licensee's 90- Day Report, the Nuclear Regulatory Commission (NRC) staff has concluded that additional clarifications are necessary in order to ensure the NRC has a clear understanding of the licensee's technical basis for addressing mix residuals. We have attempted to summarize the issue from a broad perspective and then focus on some specific questions.

A large mix residual as defined by the NRC is one which can result in a 1-volt outside diameter stress corrosion cracking (ODSCC) indication (as measured by the bobbin coil) being missed or misread. As a result, a large mix residual represents a condition by which a 1-volt or greater flaw signal may not be detected or is misread by the bobbin coil analyst because of the residual signal. This appears to contradict the licensee's descriptions of a true mix residual as one in which a tube support plate intersection has a non- perfectly formed ODSCC signal in the mix channel but a signal response in the 200 kHz (page A- 2) or one that may contain ODSCC (page A- 4).

Since mix residuals can represent an inspection challenge to the bobbin coil, the NRC staff in Generic Letter (GL) 95- 05 indicated that all intersections with large mix residuals should be inspected with a rotating probe. The purpose of this guidance was to ensure that ODSCC indications (1 volt or greater) were being detected at these locations and subsequently repaired.

Based on the information you provided, it appears that at a support plate residual (SPR) amplitude of 1.5 volts can result in ODSCC indications in excess of 1 volt not being identified from the bobbin coil data analysis. This is supported by the solid diamonds in Figure A- 1. In other words, SPR amplitudes of 1.5 volts can mask ODSCC flaws in excess of 1.0 volts. These results appear to question the adequacy of the licensee's criteria for identifying intersections with large mix residuals as defined by the NRC. Certainly, these results indicate, at a minimum, the need to perform rotating probe inspections at all locations where the residual signal exceeds 1.5 volts to ensure that 1- volt flaws are being identified consistent with the guidance in GL 95- 05.

In order to assess the adequacy of the criterion being used at BVPS- 1, it would appear (based on the NRC staff's understanding of the data) that intersections with residual signals less than 1.5 volts should be inspected with a rotating probe to confirm that ODSCC indications in excess of "1 volt" (as measured by bobbin) are not being missed.

FENOC Comments to NRC Staff's Remarks:

FENOC maintains that mix residuals of the magnitude being observed at BVPS Unit 1 do not represent an inspection challenge to the bobbin coil for the specific conditions within the BVPS Unit 1 S/Gs. It has been previously noted that the largest mix residual signal for which ODSCC was identified was 2.82 volts. For a sample of 166 TSP intersections (out of over 3000) initially called DSI, the mix residual within these intersections was as large as 3.42 volts. Had all the TSP intersections with a DSI reported been evaluated for total mix residual, a value of > 3.42 volts would likely have been identified. Furthermore, discussion was presented that states that the database for EPRI ETSS 96007.1

indicates that TSP total residuals exceeding 3.00 volts are noted. The magnitude of mix residual signals at BVPS Unit 1 is judged not to be consistent with the initial intent of the mix residual sampling as noted in GL 95-05, i.e., that indications that could negatively affect the EOC projection are not included. BVPS Unit 1 does not contain residuals of the magnitude that lead to this result. At other plants with steam generators now replaced, mix residuals exceeding 6.00 volts were common. The effect of mix residuals is already contained within the indications and intersections found in the databases. As shown by the evaluation of the 166 DSI's at 1R15, a residual signal greater than the ODSCC measurement was found in nearly all the intersections examined. This occurrence is consistent with the flaws contained within the EPRI ETSS database as well as the ODSCC ARC database. Furthermore, the mandated POD more than accounts for any mix residual that was determined to be NDD by RPC and bobbin.

The solid diamonds of Figure A-1 suggest that a potential exists for ODSCC near 1.00 volt to be found in 1.5 volt support plate residual signals (SPR's). However, the average ODSCC measurement is 0.71 volts for SPR's (with confirming Plus Point examinations) from 1.5 to 1.75 SPR volts. The number of 1.00 volt ODSCC indications found within a 1.5 volt SPR is statistically insignificant with regard to the EOC projection. The 200 kHz bobbin data for these intersections clearly shows a signal response. Thus, the indication is not masked. The issue then becomes one of analyst performance and POD, not the masking of the (ODSCC) signal due to presence of the mix residual.

The BVPS Unit #1 analysis guidelines stress flaw identification from either the mix channel or differential channels. The 200 kHz channel will be utilized to aid in defining the ODSCC signal if the mix channel response is less than optimal. Sizing will be performed in the mix channel, consistent with past practices. This has been shown to produce similar ODSCC measurements for those intersections called DSI's and those intersections called SPR with a subsequent Plus Point confirmation. These results show the measurements to be essentially equal, thus no ODSCC indications are being missed or misread and the analysis process is valid. Enhanced analyst sensitivity to reporting of small (< 1.00 volt) ODSCC signals at 1R16 should reduce the potential for an ODSCC signal of about 1.00 volt from not being identified. In addition, for mix residuals at < 1.5 volts, the probability of detection for a 1.00 volt ODSCC signal should be high. If the NRC staff's position that residual amplitude can affect detection, then decreasing residual amplitude increases ODSCC detection capabilities. Note that for those intersections initially called SPR and subsequently determined to contain ODSCC based on supplemental Plus Point examination, the average ratio of residual amplitude to ODSCC amplitude for residuals between 1.5 and 1.75 volts is 2.89 (i.e., the average ratio of residual voltage divided by ODSCC voltage was 2.89). For the ODSCC within these intersections, the average maximum depth determined by a correlation of Plus Point amplitude to maximum depth is 55% TW.

Historical information (CRGR comments to the draft Generic Letter) suggests that the intent of this (large mix residual) RPC testing was to ensure that indications that could influence the burst and leakage analyses were included in these calculations. Since the initial issue of GL 95-05, the pulled tube database has been expanded significantly. The relevance of a 1.00 volt ODSCC signal upon the EOC projection is negligible, particularly for the BVPS Unit 1 case, where 1319 > 1.00 volt indications were included in the BOC voltage distribution applied to the EOC projection. Note that there is a fundamental difference between a “masked” signal and a signal that is not reported (missed).

There is reference to the GL 95-05 discussion regarding misreading of ODSCC signals in mix residuals, however GL 95-05 does not specify a measure of "mis-reading". As the current ODSCC ARC database contains mix residual influence, the range of residual voltages are essentially equal for

DSI's and SPR's changed to DSI as a result of RPC testing performed at BVPS Unit 1. The supplemental analyses provided in the 90 Day Report indicate a consistent measurement of ODSCC between the two. FENOC does not consider the indications in question to be a large mix residual signal.

In regards to mix residual signals less than 1.5 volts being inspected with RPC, limited RPC examinations have been previously performed at BVPS Unit 1 with no degradation being observed. If mix residual amplitudes had an effect upon detection, the reduced residual amplitude (< 1.5 volts) would have a negligible impact on detection of a 1.00 volt ODSCC signal. Therefore, RPC testing of mix residuals < 1.5 volts is judged not necessary.

NRC RAI #1:

In the response to Question 1, a distinction is made between SPR signals and the residual component of a clearly formed ODSCC signal. It is not clear to the NRC staff why there is a distinction between these two categories as discussed below. It is the NRC staff's understanding that the computerized data screening (CDS) should be identifying all mix residual signals in excess of 1.5 volts. In addition, it is the NRC staff's understanding that the bobbin coil manual data analysis (primary and secondary analysis) may result in a distorted support plate intersection (DSI) being called at this location. As a result, the NRC staff would expect CDS to identify an SPR and the manual data analysis, when appropriate, to call a DSI. The SPR would then be converted to a DSI. In the cases where a DSI is called based on the manual analysis and an SPR is called CDS, it indicates (to the NRC staff) that the distortion introduced into the signal as a result of the residual (or other interfering signals) was not significant enough to prevent the detection of this particular flaw at this particular location. However, it does not indicate that this will always be the case. This is supported by the data in Figure A-1. Please clarify why you draw the distinction between these 2 cases. Are all support plate residual signals in excess of 1.5 volts being called by CDS? If not, why not.

FENOC Response to NRC RAI #1:

All TSP residual signals with amplitude greater than 1.5 volts will be called by CDS. Those intersections that are determined to have a DSI call subsequently have the SPR call removed from the database. The distinction between the two data sets in question is made to show that the magnitude of the residual components for the two data sets is not larger for SPR's (with confirming Plus Point examination) than for DSI's. Thus it can be judged that the residual components at BVPS Unit 1 are not sufficiently large enough to result in missing or misreading of the signal. It should be noted that the data of Figure A-1 were developed from those intersections in the first SPR sample, i.e., those SPR's that the lead analyst judged could contain a flaw.

The distinction made between SPR signals and the residual component of a clearly formed ODSCC signal is to demonstrate actual BVPS Unit 1 field conditions. It should not be construed that signals called DSI have completely "mixed out" TSP signals with only an ODSCC signal present while signals called SPR have no bobbin signal response other than that due to the TSP. The sampling of 166 DSI's shows that the DSI is found within a larger TSP residual signal. The distinction is further made to strengthen the point that the SPR signals at BVPS Unit 1 are not consistent with the definition of a large mix residual, as defined by GL 95-05.

NRC RAI #2:

The Question 1 response indicates that the 115 signals initially called SPR by CDS were reclassified as part of the manual analysis process. Please clarify whether these 115 signals were called DSI based on the original bobbin coil data analysis (consistent with the methodology described in question 1) or whether the SPR triggered another analysis of the bobbin coil data and this resulted in the indications called DSI's. If the latter was true, why were these indications missed during the initial bobbin coil data analysis and what actions were taken to prevent recurrences.

FENOC Response to NRC RAI #2:

The 115 indications referenced in the question were identified by manual analysis during the lead analyst resolution process, after initial production screening and prior to RPC testing of SPR signals.

All eddy current data is subject to a dual party independent analysis. Therefore, these signals underwent a review by at least two independent analysis teams that resulted in the signals not being reported. The cause for these signals not being reported in the initial bobbin screening is most likely due to analyst discretion/interpretation.

The number of indications (115) is small when compared to the total DSI population (> 3000) reported during the initial analysis process.

NRC RAI #3:

Appendix A indicates that 388 of the 1228 SPR's in excess of 1.5 volts were ultimately determined to contain flaws (i.e., DSI signals). Does the 388 include the 115 indications that were originally called DSI's based on the bobbin analysis? If so, is the NRC staff correct in assuming that 273 flaws were identified only after the Plus Point exams were performed? Is the NRC staff correct in assuming that since only 1056 SPR's were inspected with Plus Point that 57 were dispositioned as not containing a flaw based on bobbin coil data alone (1228 – 115 – 1056 = 57)?

FENOC Response to NRC RAI #3:

Yes, the total of 388 includes the 115 indications that were originally called DSI's based on the bobbin analysis. Yes, a total of 273 flaws were identified after Plus Point exam. The average DSI voltage determined from the 200 kHz analysis was 0.76 volts for these 273 indications. The 57 remaining signals were judged to not contain an ODSCC signal. The decision to not perform an RPC test was based on analyst discretion for these intersections that allowed the analyst to formulate this conclusion, such as probe wobble or a dent present within the TSP intersection.

NRC RAI #4:

In your response to question 2, please clarify the second sentence in the second paragraph. If the sentence is implying that the support plate residual is not affecting the voltage amplitude of the ODSCC flaw in SPR's subsequently reclassified as DSI's following Plus Point examination, it is not clear how this was determined from this figure. Figure A-1 appears to indicate to the NRC staff that the voltage of DSI's identified through Plus Point examination of SPR's are similar to the voltages of DSI's identified through bobbin analysis at SPR's. Since for any data point, the bobbin voltage may be affected by the support plate residual, it does not appear that any conclusion could be drawn on whether the voltages reported are not being misread (i.e., are consistent with the voltages used in the leakage and burst calculations). Please clarify.

FENOC Response to NRC RAI #4:

Figure A-1 compares the mix residual measurement for DSI's > 1.00 volt from the 166 DSI sample with the DSI measurement in intersections initially called SPR, and the magnitude of the mix residual. The spread of the data for both data sets in Figure A-1 is consistent. If residuals in the range of 1.5 to 1.75 volts are considered, the average ODSCC measurements are 1.25 and 1.28 volts for SPR's determined to contain ODSCC and for DSI's from initial analysis. Thus the two data sets can be judged to be consistent. ODSCC of similar magnitudes is reported for intersections initially called DSI and for intersections determined to contain ODSCC based on the result of the Plus Point exam, for equal mix residual levels. Again note that a DSI will be reported in an intersection that has a mix residual typically greater than the DSI report. It is incorrect to assume that the SPR can affect the ODSCC measurement at any point. The mix residual signals predominantly affect the edges of the TSP. The overwhelming majority of indications (DSI's) are observed about the center of the TSP.

Figures A-2 and A-5 also support the conclusion that the measurement of the ODSCC in intersections initially called SPR is being performed consistently with those intersections initially called DSI. The SPR's are not large mix residuals as defined by GL 95-05, and therefore, should not have been plugged at 1R15.

NRC RAI #5:

Please clarify that the “DSI volts” for the “DSI as Reported” indications in Figure A-2 are from the 400/100 kHz bobbin mix channel and that the voltages for the “DSI from SPR using 200 kHz” are from the 400/100 mix channel after locating the flaw on the 200 kHz bobbin channel.

FENOC Response to NRC RAI #5:

The "DSI Volts" are reported from the 400/100 kHz bobbin coil mix channel. The "DSI from SPR using 200 kHz" voltages are reported from the 400/100 kHz bobbin coil mix channel after locating the flaw on the 200 kHz bobbin channel.

NRC RAI #6:

In the response to question 3, it is indicated that the SPR measurement from the greater than 1 volt DSI's called from the SPR's (from either bobbin or Plus Point) ranged from 1.83 to 2.82 volts. This observation does not appear to match Figure A-1 in which the lower SPR voltage appears to be 1.5 volts. Please clarify.

FENOC Response to NRC RAI #6:

Review of the data used to develop the initial response indicates that the range was incorrectly listed as 1.83 to 2.82 volts. The correct range is 1.5 to 2.82 volts. The average was 1.83 volts.

NRC RAI #7:

In the response to question 3, it is indicated that the entire DSI population, excluding SPR's subsequently changed to DSI, consists of 3591 indications. Please clarify whether this population includes DSI's that were called from the bobbin data even though the residual voltage exceeds 1.5 volts (similar to questions 1 and 2). If it doesn't please clarify how a residual in the 166 tube sample discussed later in the question could have a residual of 3.42 volts.

FENOC Response to NRC RAI #7:

The total of 3591 DSI signals includes all signals (regardless of mix residual voltage) called DSI by the standard analysis.

The standard (field) analysis does not perform a measurement of the TSP residual. This analysis was done to show that the magnitude of the (BVPS Unit 1) SPR response is within the bounds of the residual measurements for those intersections called DSI. The magnitude of the (BVPS Unit 1) SPR's is not consistent with the NRC definition of a large mix residual, which would require repair of a 1.00 volt ODSCC signal. If an intersection is called DSI by primary/secondary, the magnitude of the underlying residual is lost when the signal is called DSI. Again, the 166 intersection sample was performed as a separate analysis to illustrate that DSI's (as reported by primary/secondary) are found within residuals that are consistent with the SPR population.

NRC RAI #8:

In the response to question 3, it is indicated that a negligible SPR signal can be considered one with no signal response in the 200 kHz bobbin channel. The basis for this statement is not clear. Per GL 95-05, a negligible mix residual would be one that would result in the identification of indications in excess of 1 volt and a reliable voltage measurement of indications greater than 1 volt. Please clarify the basis for your statement. For example, why weren't the DSI's called simply based on analysis of the 200 kHz bobbin data.

FENOC Response to NRC RAI #8:

Of the 388 SPR's subsequently determined to contain ODSCC, 6 had no signal response in 200 kHz. For these 6, the Plus Point amplitudes were sufficiently small (0.16 to 0.44 volts) such that the depth from Plus Point voltage was approximately 40% to 60% TW. Thus, a 200 kHz signal response can be judged to represent a condition where the maximum depth is at least 60% TW. If the intersections in the ODSCC database are considered, plotting flaw amplitude versus %TW, at about 0.4 volts by Plus Point (in 300 kHz), the %TW per the correlation gives a depth of about 63 to 65% TW. At 1.00 volt by bobbin, the %TW per the correlation gives a depth of about 65% TW. Therefore, a SPR with no bobbin signal likely does not contain an ODSCC signal of > 1.00 volt. A 1.00 volt DSI is negligible with regard to leakage or burst.

DSI's are not called from 200 kHz partly because sizing is based on the (400/100) mix channel. Again, any eddy current process has an associated POD. The number of signals involved (273) represents about 8% of the DSI population.

NRC RAI #9:

In the response to question 4, please clarify why the residual signals must always be larger than the DSI ODSCC voltage measurements? If this were the case, are all locations where the ODSCC indication voltage exceeds 1.5 volts (by bobbin) called SPR by CDS?

FENOC Response to NRC RAI #9:

If an intersection contained a DSI or any other signal in excess of 1.5 volts in the channel monitored by the Computerized Data Screening (CDS) system, it would have been identified as a SPR from CDS. CDS does not perform signal analysis, it simply reports an amplitude response above the reporting threshold. For the majority of DSI's, the residual is greater than the ODSCC since the mix residual is typically greater than 1.00 volt while most of the DSI's are < 1.00 volt. For those few cases where the DSI is large, the DSI can be larger than the residual. For the 166 random sample of DSI's, the average residual signal was 1.52 volts; the average ODSCC signal was 1.12 volts.

NRC RAI #10

The intent of question 4 was to ascertain whether there is a difference between the 200 kHz to 400/100 kHz "relationship" for indications with SPR's to those without SPR's. If there was no difference one could argue that the SPR had no effect on the mix voltage. If there was a difference between the relationship (if any), one could argue that the SPR was affecting the 400/100 mix voltage readings. It is not clear from the response why this is an "indirect" comparison. In addition, it is not clear what the intent of evaluating the ratio of the residual voltage to the ODSCC voltage for the two populations indicates with respect to whether 1 volt indications are being missed or misread. Please provide the originally requested plot.

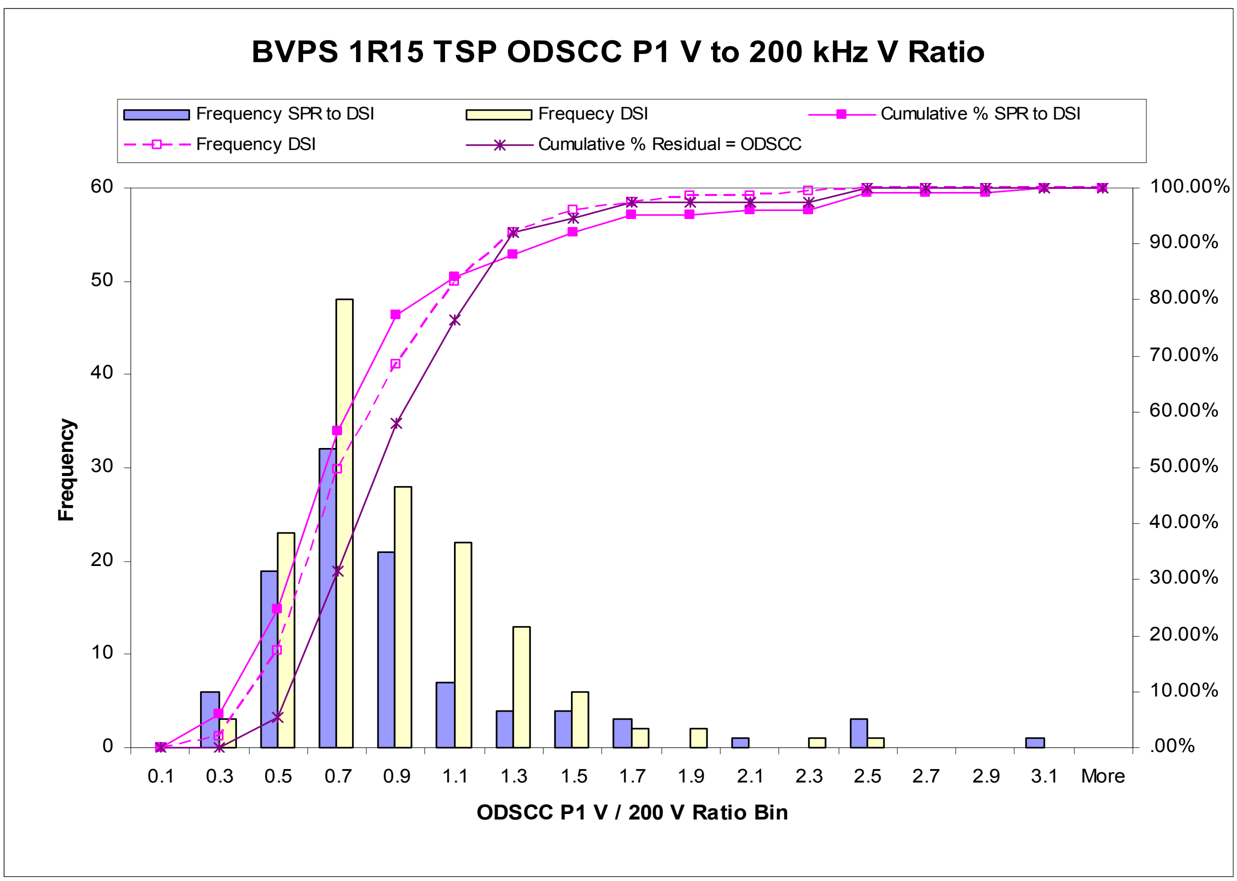
FENOC Response to NRC RAI #10:

Unless a DSI report is large (> 3.00 to 4.00 volts) such that it overwhelms the inherent residual, nearly all intersections called DSI contain a mix residual with an amplitude that exceeds the amplitude of the DSI. With the exception of large voltage DSI's, all indications within the existing ARC ODSCC database contain residual components and the effects of these components are present in the current methodology. Examining only those DSI's with no or negligible residual response is not representative of the entire ODSCC database, or the distribution of residual and ODSCC for either the DSI or SPR population at BVPS Unit 1.

Figure A-5 (of the 90 Day Report) shows that the ratio between 200 kHz and 400/100 mix channel amplitudes is consistent for indications initially called DSI and indications initially called SPR and subsequently changed to DSI based on Plus Point confirmation. Figure A-5 answers the question concerning SPR affect on measurement of the DSI amplitude. The SPR is not affecting the DSI amplitude measurement. If the residual were affecting the measurement of the ODSCC amplitude, the two data sets would be significantly different. The existing database contains any effect of mix residual upon voltage measurement. In lieu of reevaluation of all of the 1R15 bobbin data, which would incur significance expense without providing any additional pertinent information, the 166 intersection sample used to develop Figure A-5 was reviewed and those intersections where the mix residual to ODSCC measurement ratio was < 1.1 were considered. Note that the maximum ratio for the entire 166 intersection sample is 5.125 (0.82 volt residual with a 0.16 volt ODSCC measurement). Figure 3 provided herein is Figure A-5 of the 90 Day Report, with those intersections with a residual to ODSCC ratio of < 1.1 plotted separately. For the entire 166 intersection sample, the average P1 to 200 kHz voltage ratio is 0.803, whereas for the subset of intersections with residual to ODSCC ratio < 1.1 is 0.908. A total of 38 intersections are found in this subset. For those intersections initially called SPR, the P1 to 200 kHz average ratio is 0.788. Figure 3 shows that the distribution of P1 to 200 kHz voltage ratios is essentially equal to the same ratios for the 166 DSI sample and SPR confirmed to contain ODSCC based on +Pt examination.

For intersections called DSI, there is a wide spread between the residual (which is not reported as part of the normal field analysis) and the ODSCC amplitude. This spread is similarly wide for those intersections called SPR and subsequently determined to contain ODSCC from Plus Point testing. To compare the SPR data with only those DSI intersections with residual signals of nearly equal amplitude to the ODSCC is not a comparison of the entire data sets, but a comparison of a small portion of one dataset to a second entire dataset. Thus, the comparison is indirect.

Figure 3



NRC RAI #11

In the response to question 4, it is indicated that for the initial SPR sample, the ODSCC component was generally closer to the SPR amplitude than the remainder of the SPR data set. The basis for this observation is not evident from the evaluation of Figure A-3. If this were the case, wouldn't the line with the open square in Figure A-3 always be greater (i.e., to the left) of the lines for the other two data sets?

FENOC Response to NRC RAI #11:

The answer to the question cannot be obtained from the figure referenced. The answer lies in the average residual to ODSCC ratio for the 166 DSI sample and the first SPR sample. For the 166 DSI sample, the average residual to ODSCC ratio was 1.54. For the first SPR sample, the same ratio was 2.33. For all SPR's, the same ratio was 2.81. For those SPR's determined to contain ODSCC > 1.00 volt, the same ratio is 1.42. Note also that the first SPR sample included all SPR's > 2.00 volts, so the data set is somewhat skewed to the right. Also, the data considered is generally less than 1.00 volt with regard to the ODSCC measurement. Therefore, small variances could produce larger than apparent swings in the ratio.

NRC RAI #12:

In the response to question 5 it is indicated that if an SPR is determined to have a flaw and the 200 kHz (bobbin) channel exhibited a signal that could be observed the indication was classified as a DSI. If there is an indication in the 200 kHz bobbin channel wouldn't it be reported as a DSI by the primary and/or secondary analyst? In other words, is the 200 kHz signal readily detectable and just not being reported or is the 200 kHz signal only "detectable" once the Plus Point data is available? If they are readily detectable, were all 73 indications originally called SPR's in 1R14 and subsequently classified DSI's identified by the primary/secondary analysis team (manual analysis) as DSI's in 1R15? If not, why not?

FENOC Response to NRC RAI #12:

The magnitude of the indications in question must be kept in perspective. None of the DSI signals reported from SPR's with confirming Plus Point signals are of a sufficient magnitude to impact the EOC projections which was the original intent of the mix residual RPC testing. FENOC has used an aggressive RPC testing campaign to ensure that pertinent ODSCC indications were included in the EOC projections. Both the 200 kHz response and mix channel response are considered as the analyst makes his/her determination. The aggressive RPC testing program employed at BVPS was used to supplement the bobbin analysis, thus ensuring an accurate assessment of the signal.

As stated in the response to RAI #2 (Enclosure 2), all eddy current data is subject to a dual party independent analysis. Therefore, these signals underwent a review by at least two independent analysis teams that resulted in the signals not being reported. The cause for these signals not being reported in the initial bobbin screening is most likely due to analyst discretion/interpretation. Many of the indications in questions have both a 200 kHz bobbin and mix channel response. The mix channel however is not perfectly formed.

For several outages, FENOC has employed an aggressive Plus Point inspection campaign targeted towards SPR signals. This campaign far exceeds what any other plant with ARC has performed. This campaign is aimed not only at obtaining the most appropriate call for a given intersection (Plus Point is used as a supplemental analysis tool), but is also used to ensure that a large number of overcalls are not made.

All 1R14 SPR's changed to DSI were reported as DSI's in 1R15.

NRC RAI #13:

Please clarify that the beginning of cycle (BOC) voltage and EOC average voltages for the SPR/DSI's are correct. That is, was the BOC 15 average voltage 0.93 volts and the average EOC 15 average voltage 0.92 volts?

FENOC Response to NRC RAI #13:

The EOC 14 average voltage for 73 1R14 DSI's contained within SPR's is 0.93 volts. Some of these indications were plugged (for a number of reasons, some of which are not related to the TSP indications) at 1R14. If the indications plugged at 1R14 are removed, the average BOC 15 voltage is 0.88 volts. The average voltage of these indications at 1R15 was 0.92 volts. The response to Question 6 indicates that the average growth of these 73 indications was consistent with the entire DSI population.

NRC RAI #14:

Within the population of SPR signals flagged by CDS there is a set of indications called DSI during the manual analysis of the bobbin coil data. Another subset of the SPR signals includes indications not called DSI during the initial bobbin coil manual analysis but changed to DSI based on subsequent Plus Point probe inspection. Discuss whether the detection of the ODSCC indications at SPR locations with a bobbin coil probe is a result of the ODSCC indication being far enough away from the mix residual signal. In addition, discuss whether there is any relationship between the magnitude of the residual signal at the ODSCC indications identified through bobbin coil analysis to the magnitude of the mix at the ODSCC indications identified through Plus Point data analysis at SPR locations.

FENOC Response to NRC RAI #14:

The mix residual is not a localized effect. Its response encompasses the entire TSP, but has its greatest influence at the edges of the TSP with a significantly reduced influence at the center of the TSP. As such, localized indications can be detected at levels less than the associated mix residual response. The Plus Point testing program and past tube pulls at BVPS Unit 1 has shown the elevation of the ODSCC indications to be concentrated at the center of the TSP.

The original responses contained within the 90 Day Report provide the answers to the second question. See Figure A-3, A-4, and A-5. In summary, this data shows that the mix residual magnitude is consistent for those intersections called DSI and for those intersections initially called SPR and subsequently changed to DSI based on RPC results. This data also shows that the measure of the ODSCC is similar for both for equal residual levels.

NRC RAI #15:

Regarding the effects of mix residuals on the ability to size ODSCC indications, discuss what testing has been performed to confirm that the mix residual criteria ensures that the voltages of indications greater than 1 Volt are not affected by the residual. For example, have the various flaw signals at an intersection with a small mix residual and at a large mix residual been tested to determine the effects on the voltage of the indication.

FENOC Response to NRC RAI #15:

The effect of mix residual on the ability to size ODSCC is contained within the current ODSCC ARC database. The 166 DSI sampling shows that each contained a mix residual equal to or greater than the measure of the ODSCC. Previously provided data indicates that whether the ODSCC is measured directly from the mix or whether the 200 kHz bobbin channel is used to identify the extent of the signal, that the ODSCC measure is consistent.

No specific testing as described has been performed. Again, the breadth of the ODSCC database likely contains DSI reports in intersections where the residual is only slightly larger than the DSI and intersections where the residual is significantly larger than the DSI. Any effects are then included in the current database.