Commonwealth Edison Company
Byron Generating Station
4450 North German Church Road
Byron, IL 61010-9794
Tel 815-234-5441

ComEd

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

ATTN: Document Control Desk

SUBJECT: Information Pertaining to the Effects of Chemical Cleaning on Byron Unit 1 Steam Generators

Byron Nuclear Power Station Unit 1
NRC Docket Number 50-454

REFERENCES:

1. G. Dick letter to D. Farrar dated October 24, 1995, transmitting the Safety Evaluation Report for 1 Volt Interim Plugging Criteria for Byron Unit 1 Steam Generators

2. D. Saccomando letter to W. Russell dated September 17, 1994, transmitting Additional Information Regarding Steam Generator Chemical Cleaning

Reference 2 transmitted Commonwealth Edison Company's (ComEd) basis for deciding to perform a hot chemical cleaning of the Byron Unit 1 steam generators. This letter discussed the evaluation of the impact of chemical cleaning on the subsequent implementation of the voltage-based repair criteria. This letter content was referenced in the Nuclear Regulatory Commission's (NRC) Safety Evaluation Report (SER) as transmitted via Reference 1.

The SER stated, "The staff notes however, that the continued adequacy of the conservatism of the voltage growth rate distribution and the tube repair criteria will need to be evaluated for any subsequent voltage-based repair criteria requests because of the chemical cleaning performed during the present refueling outage. The staff also notes that further quantitative evaluation to support the licensee's conclusion that any decrease in voltage readings following chemical cleaning is most likely attributable to normal eddy current variability, may be required for future analyses." In response to these concerns, Byron Station is providing the attached information.

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Attachment A concludes that the results of the Byron Unit 1 Refuel Outage (Fall 1994) B1R06 inspection and subsequent evaluation confirms the conclusions as stated in Reference 2: that chemical cleaning had insignificant impact on eddy current sizing, and that the chemical cleaning process performed during B1R06 is not expected to adversely impact future inspections.

Sincerely,

for Denise M. Saccomando
Nuclear Licensing Administrator

DMS/LJZ/rp

Attachment

cc: D. Lynch, Senior Project Manager-NRR
G. Dick, Byron Project Manager-NRR
H. Peterson, Senior Resident Inspector-Byron
H. Miller, Regional Administrator-RIII
Office of Nuclear Safety-IDNS

ATTACHMENT A

Background

During the Byron Unit 1 Cycle 6 Refuel Outage in the Fall of 1994 (B1R06), a high temperature chemical cleaning was performed on the steam generators. The cleaning process was based on a modified EPRI Steam Generator Owner's Group cleaning process that targeted removal of deposits at the tube support plate crevice regions. The chemical cleaning was performed in Mode 4 during unit shutdown allowing plant heat to be used to maintain the high temperature.

Since eddy current could not have been performed prior to the cleaning, an evaluation was performed to determine the effects, if any, the cleaning would have on the eddy current results. The results of this evaluation was transmitted to the Staff in Reference 2, which concluded that the cleaning process would not adversely affect eddy current results. The evaluation also concluded that any variations in indication voltage amplitude would be expected to result from normal eddy current variability.

The October 24, 1994, Safety Evaluation Report (SER) that approved a 1.0 volt IPC for Byron Unit 1 Cycle 7 (Reference 1), required that the effects of chemical cleaning on growth rate distributions and the repair criteria must be evaluated for any subsequent application of a voltage-based repair criteria due to the chemical cleaning performed in B1R06. Further evaluation to support the conclusion that voltage decrease in voltage readings following chemical cleaning is most likely attributable to normal inspection variability may also be required.

As further discussed below, it can be shown that the chemical cleaning performed during B1R06 did not affect the eddy current voltages or growth rates and that voltage decreases were attributable to normal eddy current variability. Furthermore, the results of the B1R06 inspection and subsequent evaluation confirms the above conclusions in Reference 2.

Eddy Current Voltage and Growth Rate Assessment

Historically, the Byron and Braidwood Unit 1 steam generators have experienced similar voltage and growth distributions. The units also have used identical eddy current inspection guidelines and evaluation techniques. Because Byron has performed chemical cleaning and Braidwood has not, an opportunity exists to compare the Byron post-cleaning results to the Braidwood results to determine the effect of chemical cleaning on eddy current results. Inspection results of the Byron Cycle 6 (post-cleaning) were compared to no-cleaning results from the Byron Cycle 5

(B1R05), Braidwood Cycle 4 (A1R04), and Braidwood Cycle 5 mid-cycle (A1M05) inspections. Note that B1R06 and A1R04 were the first outages that each site implemented a 1.0 volt IPC and inspections prior to these did not employ inspection techniques and guidelines to limit voltage variability.

Figures 1 and 2 show the total as-found voltage distributions from B1R05, B1R06, A1R04 and A1M05. These figures indicate that the voltage distributions are very similar. The B1R06 post-cleaning voltage distribution on a percentage basis is bounded by the no-cleaning distributions. The variations of voltage distributions between steam generators during a single inspection are nearly identical to the variations between inspections, as shown in Figure 3. The voltage distributions continue to be similar between Byron following chemical cleaning and Braidwood , indicating that the cleaning process did not affect the as-found voltage amplitudes. Consequently, the voltage growth rates determined by the post-cleaning inspection would also not be affected by the cleaning process. This conclusion is supported by Figures 4 and 5, which show the respective voltage progression scatter plots for B1R06 and A1R04 normalized to a per EFPY progression for a direct comparison. These two voltage progressions are nearly identical. In terms of negative growth rates, the scatter plots show that there is virtually no difference between the Byron (post-cleaning) and the Braidwood (no-cleaning) results. Since the inspections employed the same inspection guidelines and techniques, it can then be concluded that normal eddy current variability was experienced at Byron following the chemical cleaning.

Figures 6 and 7, show the growth rate distributions for B1R06, A1R04 and A1M05 in cumulative percentage and bar chart formats. These distributions indicate similar voltage growth patterns with B1R06 experiencing a slightly lower incidence of zero to negative growth than Braidwood. This could possibly be due to less distortion in the signals as a result of the cleaning. Lower signal distortion increases the signal-to-noise ratio, thus reducing the variability of detection and sizing. This results in an increased detection sensitivity to lower voltage indications, but also reduces the number of false indications due to signal distortion. This is demonstrated by Figure 8, which shows that the RPC confirmation rate of B1R06 (post-cleaning) is significantly higher for lower amplitude indications than the B1R05 (pre-cleaning) confirmation rates. The increased detection sensitivity and reduction of false calls result in a net cancellation effect of the number of indications detected. The total number of indications detected following chemical cleaning continued to follow the pre-cleaning degradation curve with no unexpected increases or decreases in the number of indications detected, as shown in Figure 9. As previously discussed, the post-cleaning voltage distributions were consistent with the pre-cleaning or no-cleaning distributions, which indicates that chemical cleaning did not globally affect defect sizing.

A study was performed by ComEd in conjunction with BWNT to determine the effects of the Byron chemical cleaning on eddy current bobbin coil voltage signals by comparison of manufacturing burnish marks (MBMs) found during B1R05 and the same MBMs in B1R06. Direct comparison of ODSCC indications before and after the cleaning was not possible since the only pre-cleaning data is from the previous refueling outage inspection and the indications would have grown over the operating cycle. MBMs were chosen because these indications typically do not change over time and therefore, any changes would be due to the chemical cleaning and eddy current variability. Table 1 and Figures 10 through 12 show the change in voltage amplitude in the MBMs from B1R05 to B1R06 versus Cycle 5 voltage for the 550 kHz differential, 130 kHz differential, and 550/130 kHz mix frequencies. These frequencies are the frequencies used for sizing ODSCC at support plates. The 550 kHz and 130 kHz frequency plots indicate a scatter centered at nearly zero growth. The 550/130 kHz mix indicates a slight (-0.05 volt average with a 0.08 standard deviation) skew towards a negative growth. However, a 0.05 volt difference in eddy current sizing is considered insignificant and well within eddy current variability. It can be concluded that the chemical cleaning had insignificant impact on eddy current sizing.

Impact on Future Inspections

Since B1R06 inspection results serve as a new baseline for future inspections and growth rates for IPC implementation, the effects of re-deposition of corrosion products on the tubes or in the crevices on eddy current were evaluated.

As discussed above, the removal of corrosion product deposits from six cycles of operation did not result in an adverse effect on detection or sizing eddy current signals. The chemical cleaning provided a higher signal-to-noise ratio which resulted in a more accurate assessment of the steam generator condition. Although the chemical cleaning enhanced the eddy current inspection due to bulk deposit removal, ultrasonic inspections indicated that deposits are still existing to some degree within the support plate crevices. Therefore, re-deposition of corrosion products is not expected to significantly impact eddy current results. In addition, as required by implementation of the voltage-based repair criteria for ODSCC at support plates, the growth rates used for tube leakage and burst considerations will be the most conservative growth rates of the previous two inspection periods. Also required by the freespan-based voltage repair criteria, the growth rate used for determining the upper repair limit is the larger of 30% or the site-specific growth.

Byron has undertaken secondary chemistry measures to maintain and prolong the post-cleaning condition of the tubes and support plate crevices. Iron transport is being controlled to low levels by alternate amines. The use of alternate amines are being evaluated to further reduce iron transport. By minimizing the iron transported to the steam generators, tube surface fouling and deposit formations within the

support plate crevices are reduced. The deposition rate at which the fouling is deposited is also reduced, thus maintaining the post-cleaning condition of the tubes.

With the reduced iron transport any additional deposits on the tubes or crevices would be minimal and would be not be different than the additional deposition on tubes in plants that did not chemically clean. Therefore, the chemical cleaning process performed during B1R06 is not expected to adversely impact future inspections.

TABLE 1
BYRON UNIT 1 MBM COMPARISON
PRE/POST CHEMICAL CLEANING

All values in volts peak-to-peak.

B1R06 550 kHz Differential	B1R05 550 kHz Differential	550 kHz Differential Delta (R06-R05)	B1R06 130 kHz Differential	B1R05 130 kHz Differential	130 kHz Differential Delta (R06-R05)	B1R06 550/130 kHz Differential Mix	B1R05 550/130 kHz Differential Mix	550/130 kHz Differential Mix Delta (R06-R05)
0.18	0.17	0.01	1.73	1.62	0.11	0.34	0.4	-0.06
0.14	0.1	0.04	1.39	1.33	0.06	0.31	0.31	0
0.19	0.15	0.04	1.26	1.21	0.05	0.34	0.36	-0.02
0.12	0.43	-0.31	1.21	1.4	-0.19	0.15	0.34	-0.19
0.36	0.46	-0.1	1.11	0.79	0.32	0.28	0.41	-0.13
0.21	0.25	-0.04	1.4	1.36	0.04	0.12	0.15	-0.03
0.28	0.11	0.17	1.44	1.9	-0.46	0.2	0.23	-0.03
0.38	0.08	0.3	0.98	1.1	-0.12	0.31	0.21	0.1
0.37	0.43	-0.06	1.91	1.96	-0.05	0.28	0.32	-0.04
0.49	0.41	0.08	3.21	3.79	-0.58	0.4	0.39	0.01
0.47	0.49	-0.02	1.2	1.4	-0.2	0.62	0.76	-0.14
	Average:	0.01		Average:	-0.09		Average:	-0.05
	Standard Deviation:	0.15		Standard Deviation:	0.26		Standard Deviation:	0.08

FIGURE 1

BYRON/BRAIDWOOD VOLTAGE DISTRIBUTION

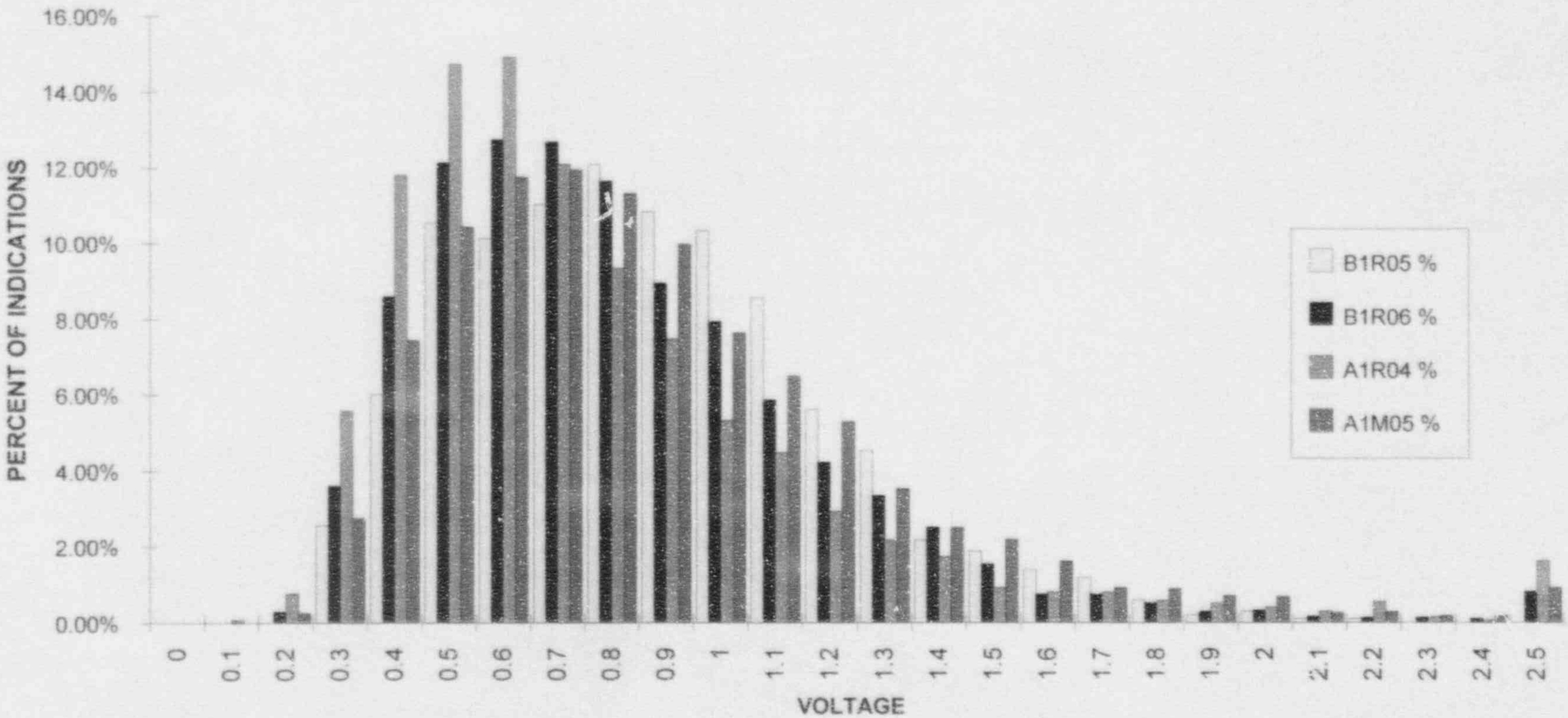


FIGURE 2

BYRON/BRAIDWOOD CUMULATIVE VOLTAGE PERCENTAGE

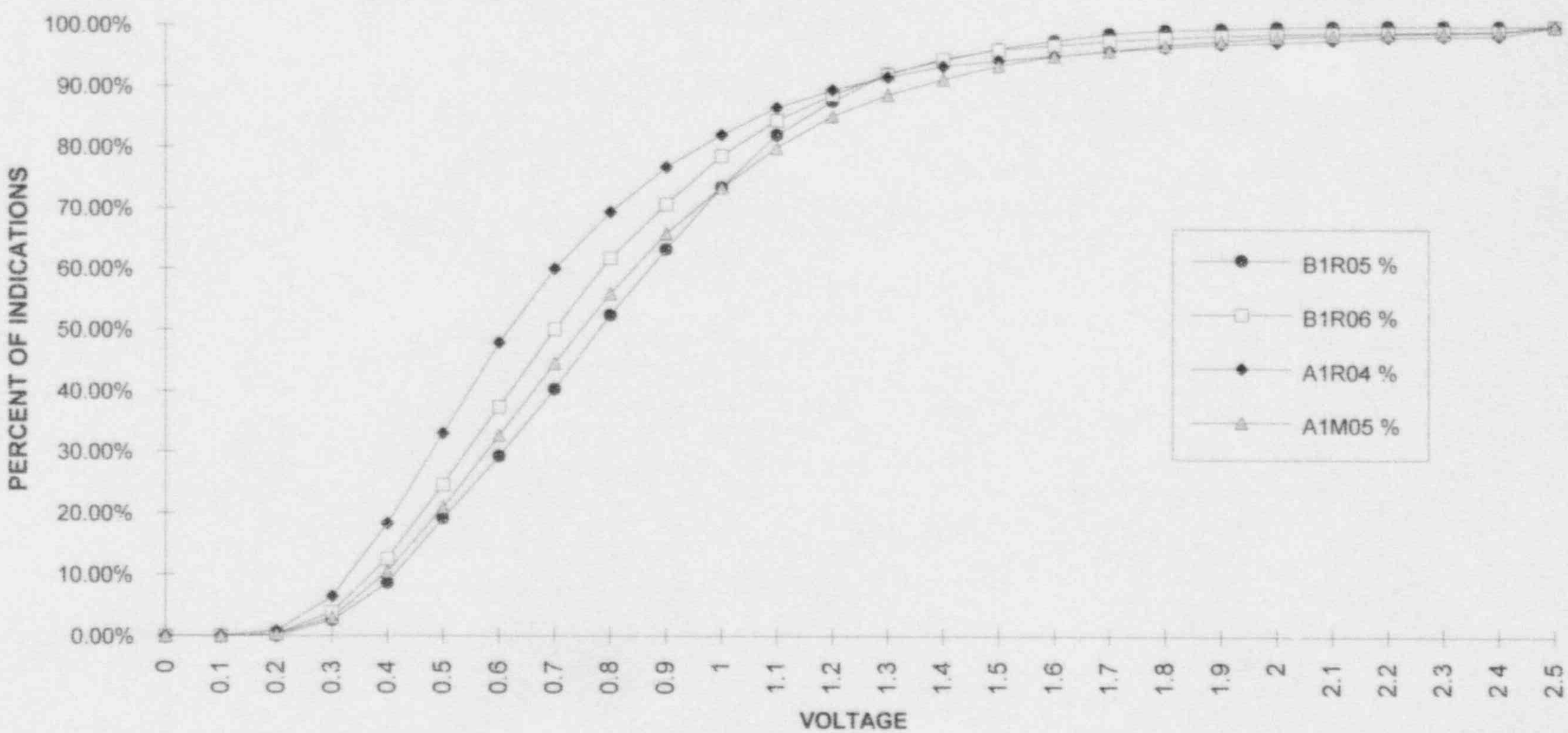


FIGURE 3
BYRON CYCLE 6 VOLTAGE DISTRIBUTION

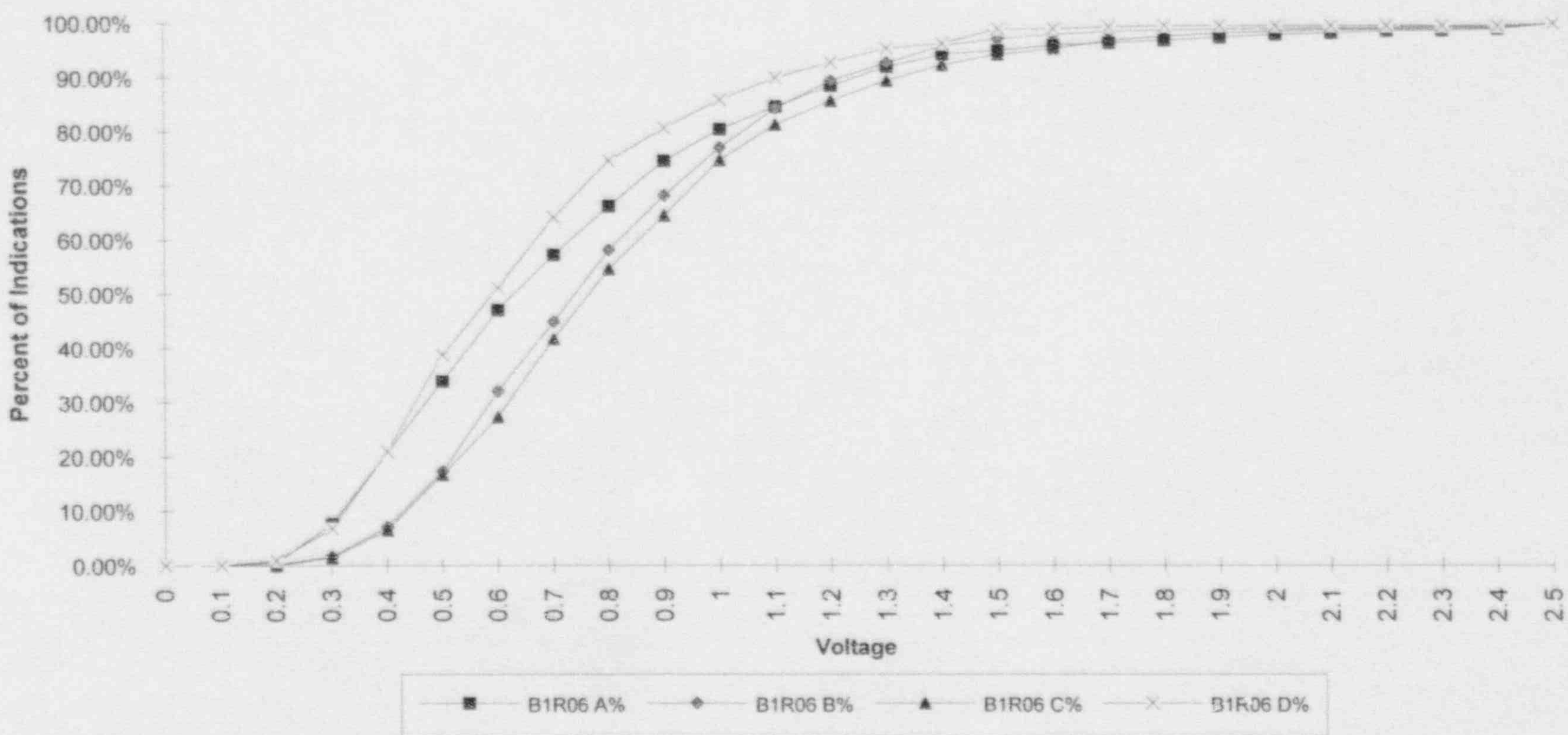
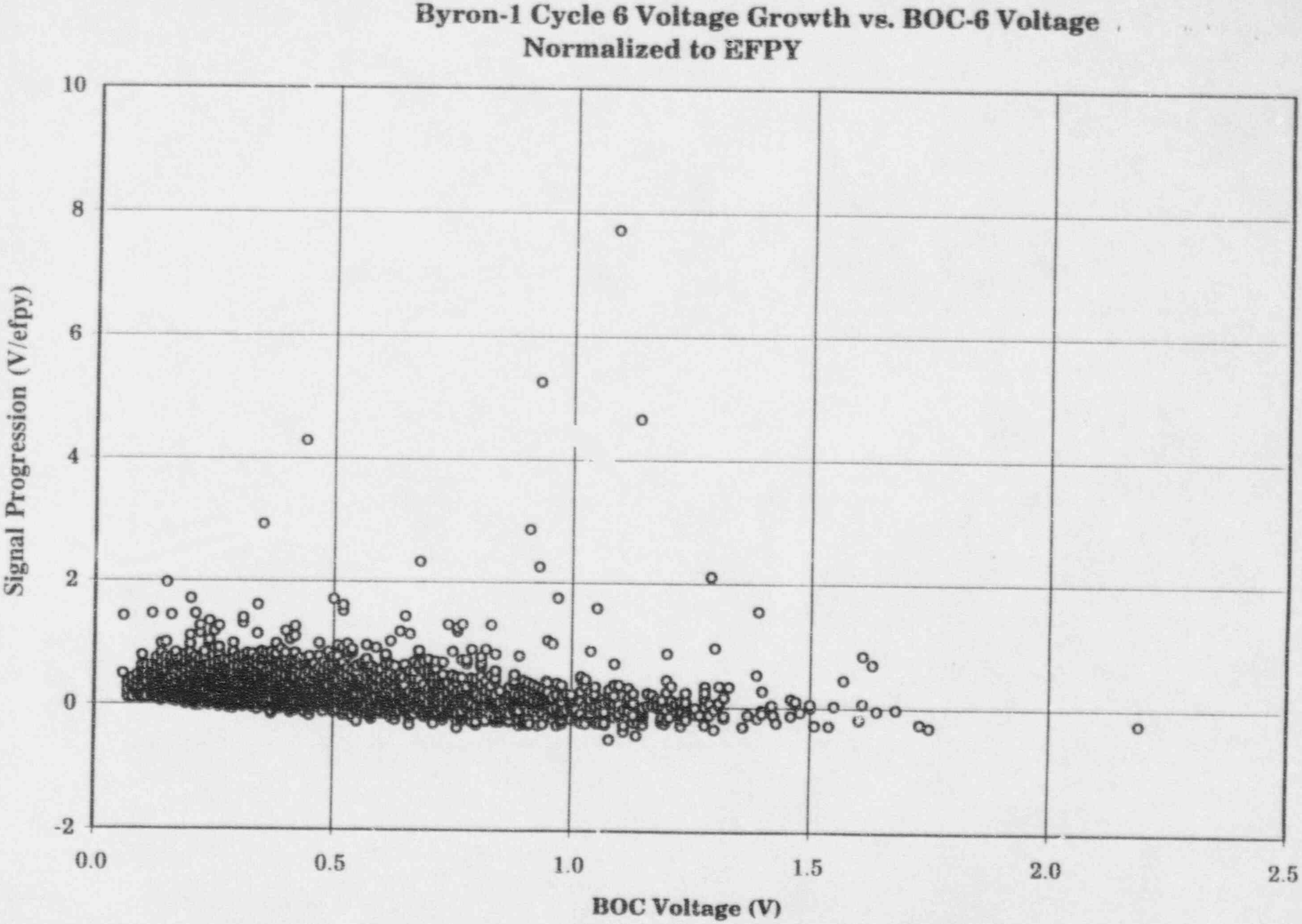


FIGURE 4



[SCATTERK.XLS] Fig 4-13N

FIGURE 5

Braidwood Unit 1 1994 Inspection, Support Plate ODSCC Signal Progression

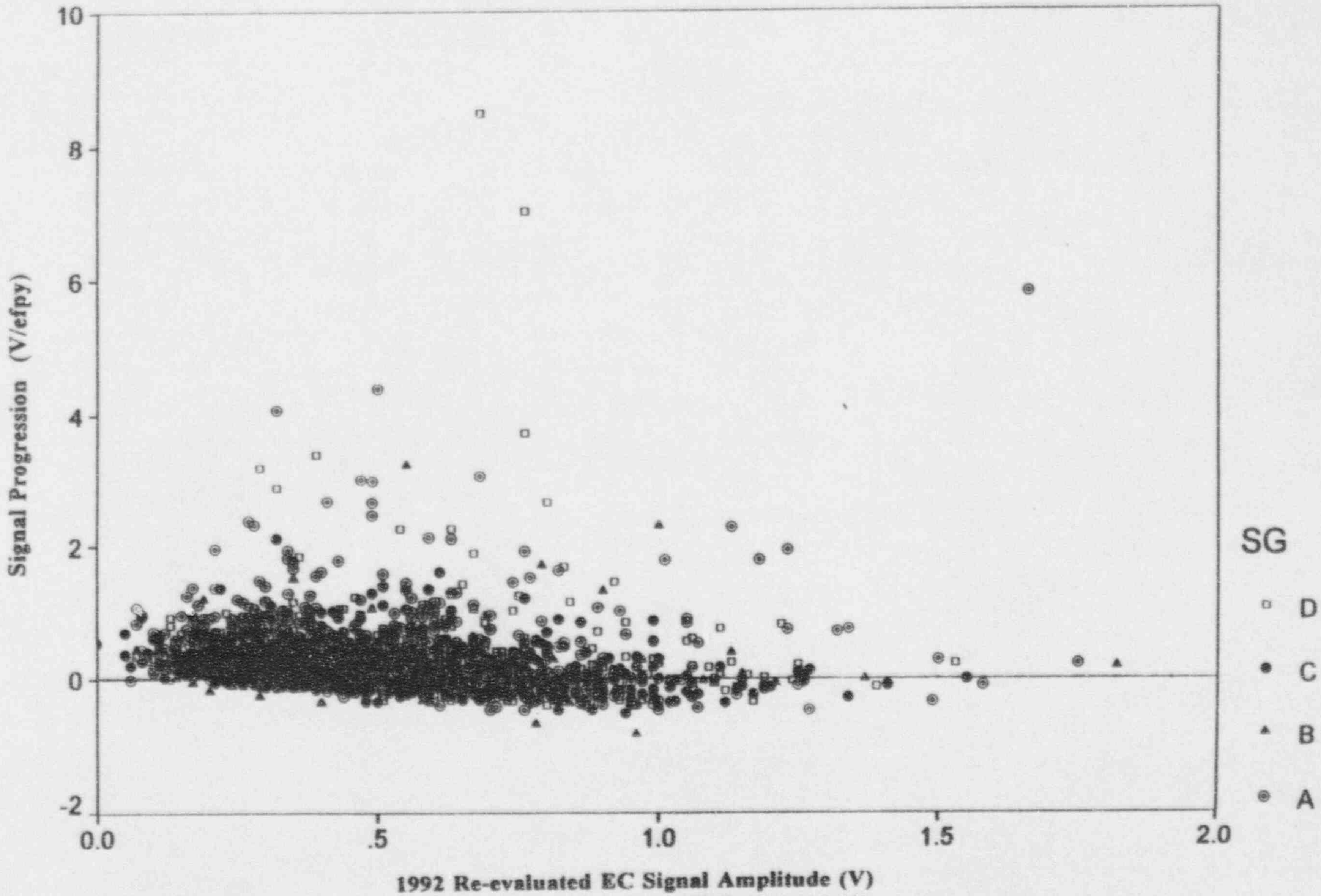


FIGURE 6

BYRON/BRAIDWOOD GROWTH RATE DISTRIBUTION

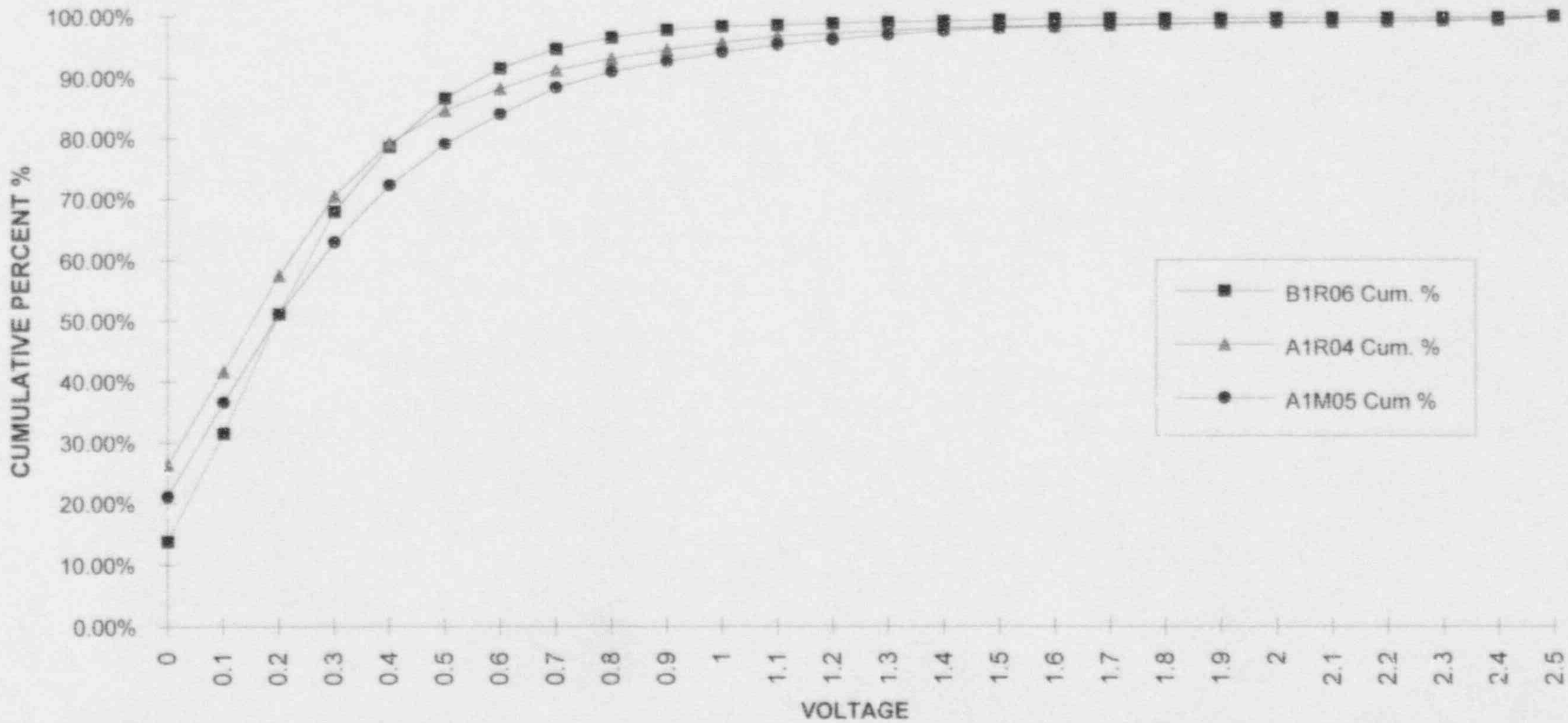
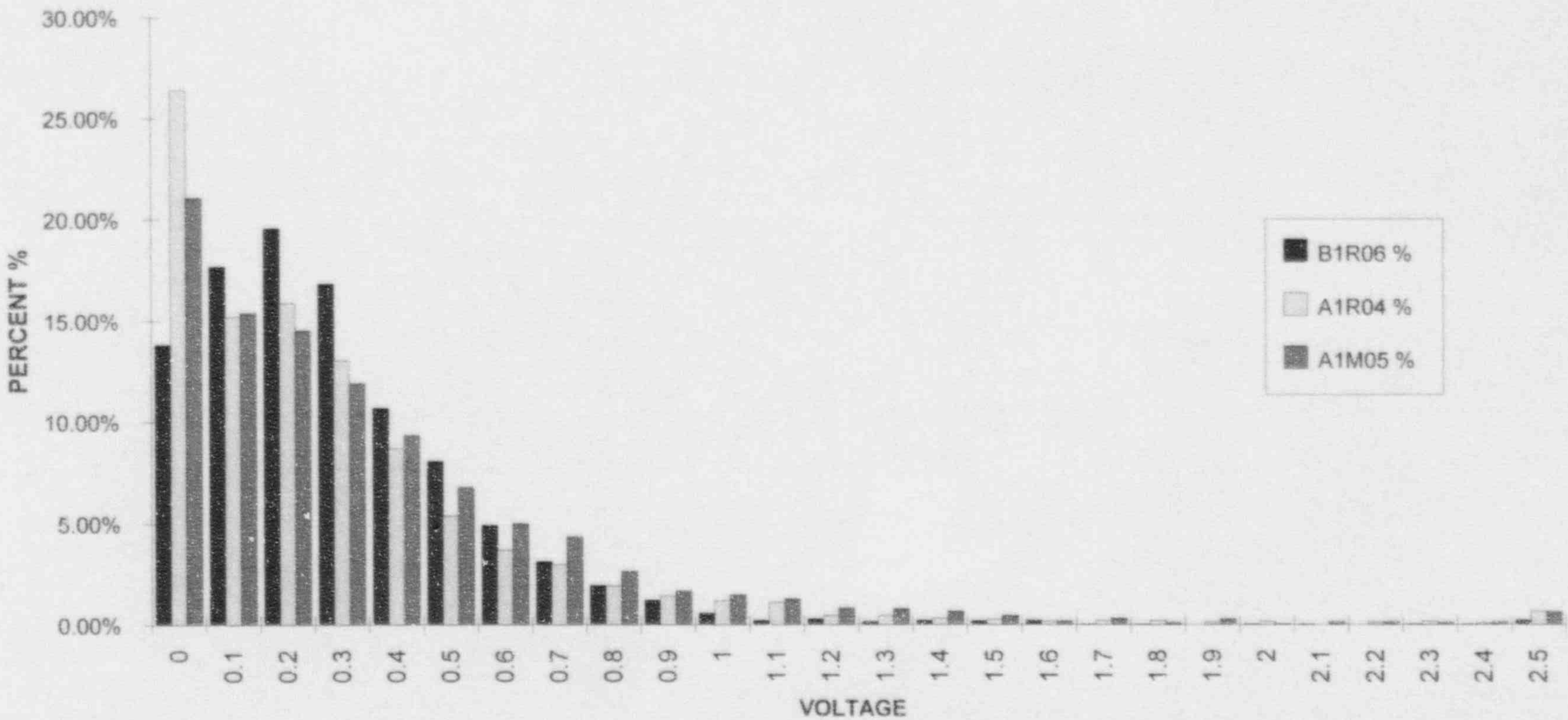
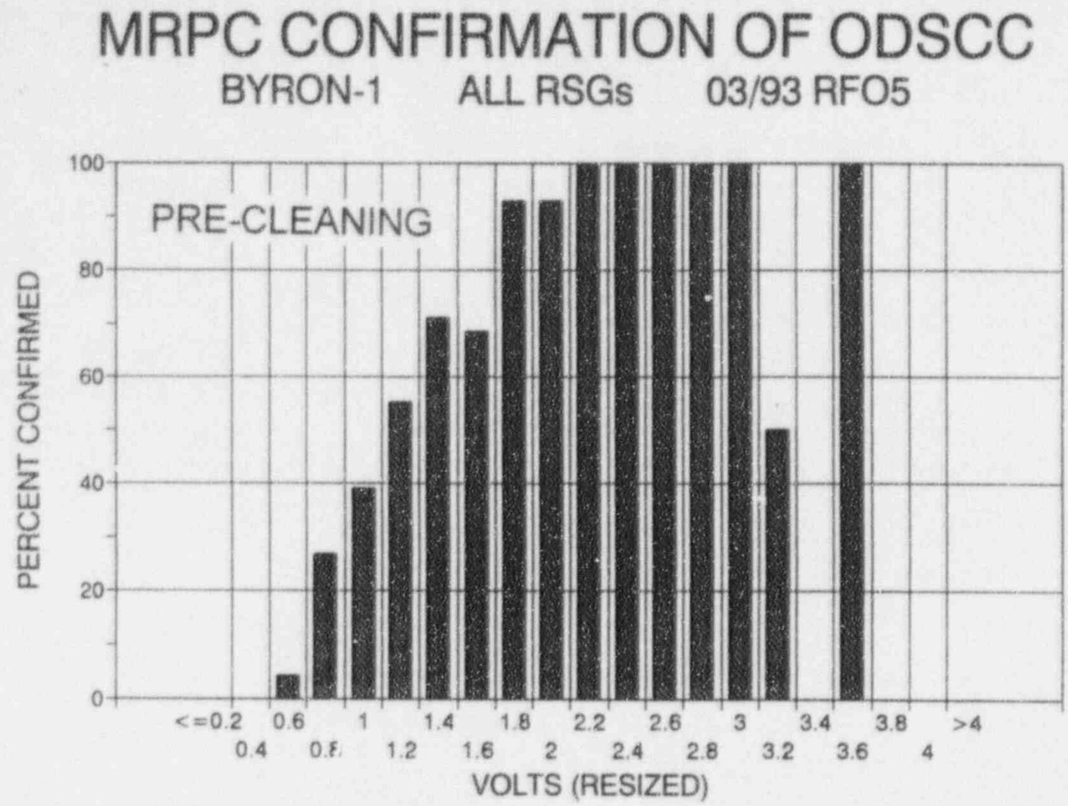


FIGURE 7

BYRON BRAIDWOOD GROWTH RATE DISTRIBUTION





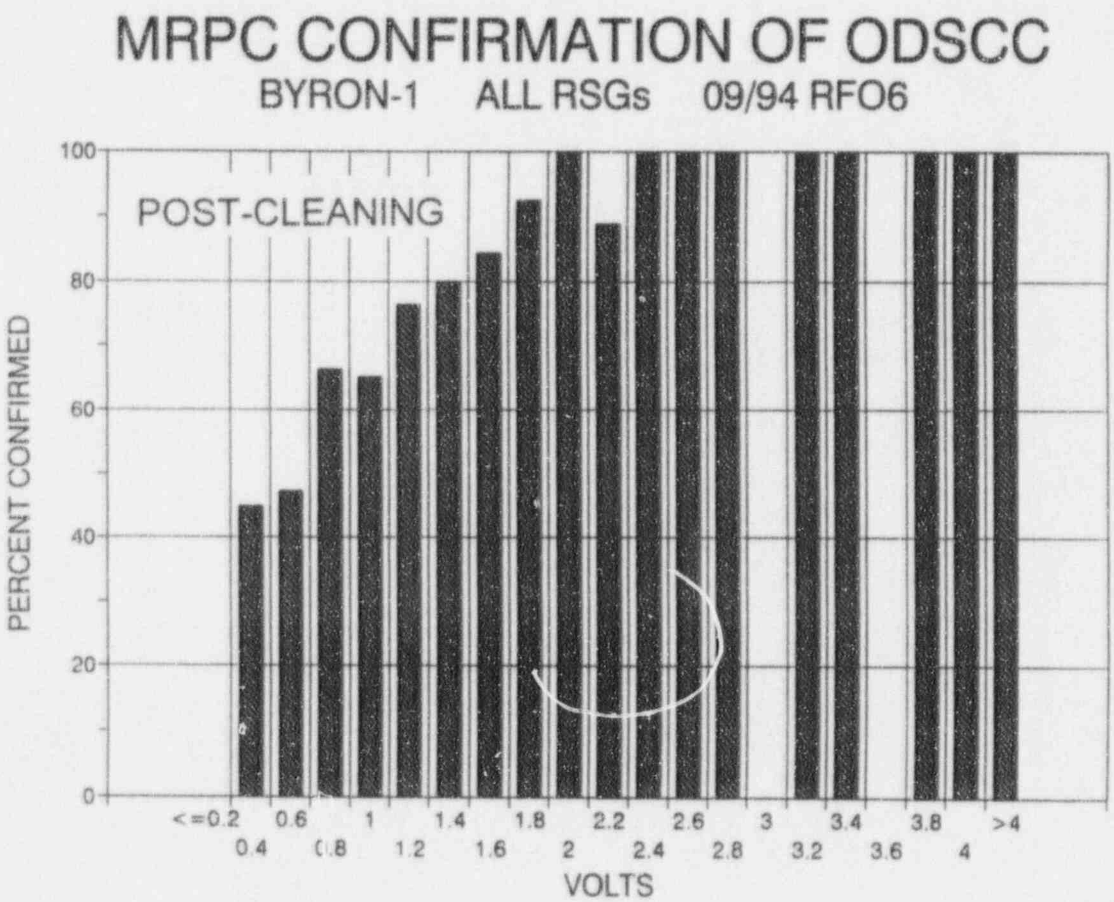


FIGURE 8
PRE/POST CHEMICAL CLEANING
MRPC CONFIRMATION RATES

FIGURE 9

BYRON UNIT 1 ODSCC

CUMULATIVE ODSCC INDICATIONS

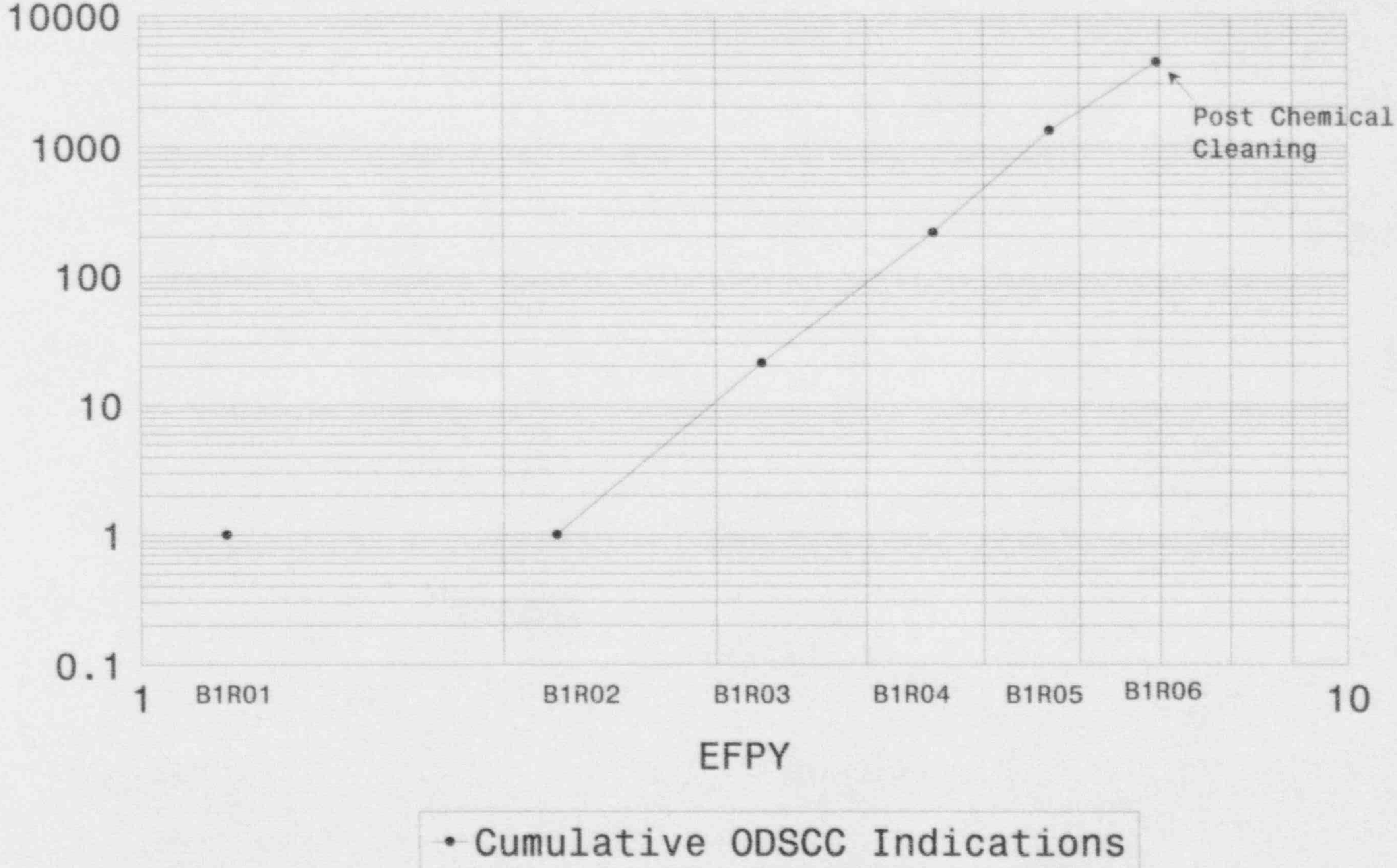


FIGURE 10

BYRON PRE/POST CHEMICAL CLEANING MBM COMPARISON

550 kHz Differential Delta (B1R06-B1R05)

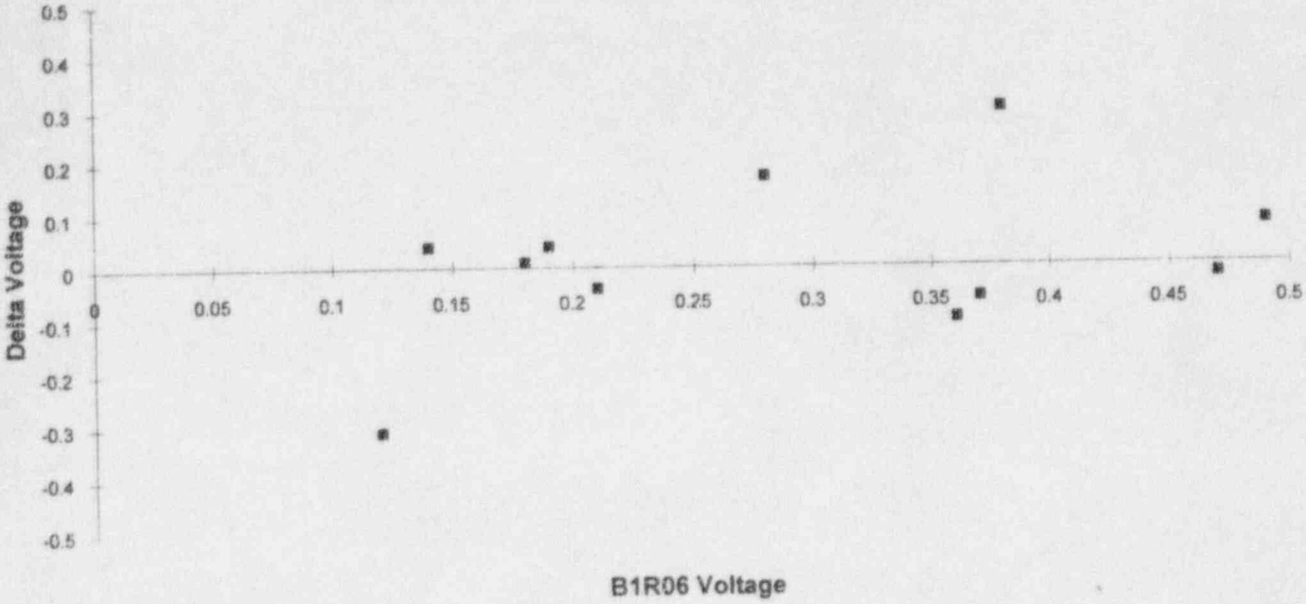


FIGURE 11

BYRON PRE/POST CHEMICAL CLEANING MBM COMPARISON

130 kHz Differential Delta (B1R06-B1R05)

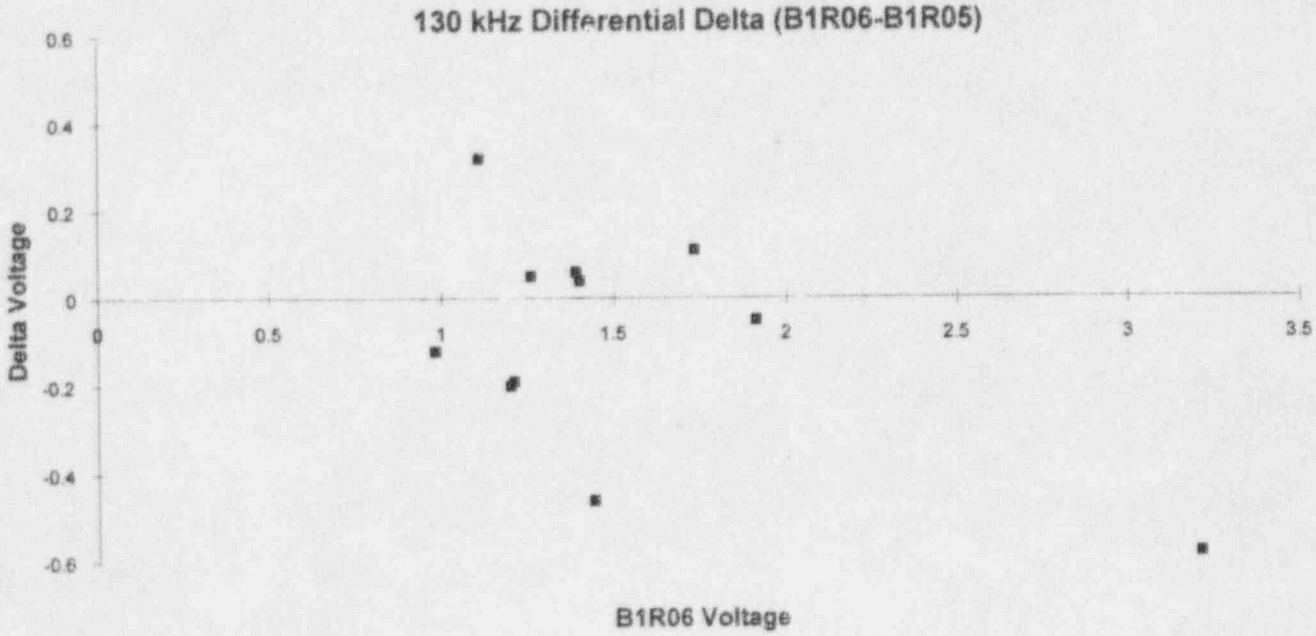


FIGURE 12

BYRON PRE/POST CHEMICAL CLEANING MBM COMPARISON