Braidwood Unit 1 Cycle Length Assessment Report Supplement

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Executive Summary

In a meeting with the NRC on May 14, 1996, Commonwealth Edison presented the results of a look-back study that demonstrates inspection transients occurred during the Byron Unit 1 1995 and 1996 outages. Additionally, the results of two blind tests performed to assess the eddy current data analyst consistency and to support the results of the look-back were presented. The conclusions of the look-backs and the blind tests are that a significant number of top of the tubesheet circumferential indications detected in 1995 and 1996 were in fact present in previous inspections. Improvements in eddy current analyst awareness of circumferential indications, analysis software and eddy current probe designs has created two inspection transients at Byron Unit 1.

To justify an increased cycle length for Braidwood it must be demonstrated that the tubes will maintain structural and leakage integrity at the end of the operating period. The following conclusions demonstrate the structural and leakage integrity for Byron Unit 1 and therefore support an increased cycle length for Braidwood Unit 1 based on the technical basis that Byron bounds Braidwood.

Conclusions:

1. The number of indications detected during the Byron Unit 1 1995 and 1996 are due to an inspection transient.
2. Improvements in eddy current analyst awareness of circumferential indications, analysis software and eddy current probe designs has created two inspection transients at Byron Unit 1.
3. The growth of indication voltages for 3 consecutive inspections is small.
4. Eddy current analysts had high consistency in identifying circumferential indications in the "blind test" using 1996 training standards and software.
5. Structural integrity is assured based on 1994 and 1995 tube pulls and 1996 insitu pressure tests.
6. Conservative calculation of MSLB leakage is low compared to allowable limits.
7. The largest Braidwood Unit 1 indication is half the size of the largest Byron Unit 1 1994 indication.

These conclusions support the technical basis that Byron Unit 1 bounds Braidwood Unit 1 reported in the Braidwood Unit 1 Cycle Length Assessment Report submitted to NRC February 23, 1996. Braidwood Unit 1 can operate for a duration equivalent to the period of Byron Unit 1 operation between the 1994 refuel inspection and the 1995 mid-cycle inspection.

1.0 Introduction

The purpose of this report is to supplement information included in the February 1996 Braidwood Unit 1 Cycle Length Assessment Report (Reference 1). This supplement will address the issue of the large number of Byron Unit 1 Spring 1996 refueling outage (B1R07) steam generator (SG) tube eddy current testing (ECT) indications. This supplement will show that the number of circumferential indications identified during B1R07 and the fall 1995 midcycle inspection (B1P02) are the result of inspection transients. The inspection transients are primarily the result of the use of different eddy current probes, analysis software and increased analyst sensitivity to circumferential indications. Additionally, this report will demonstrate that the circumferential indications at Byron Unit 1 do not challenge the structural integrity of the steam generator tubes and therefore do not change the conclusions in the Reference 1 report that the cycle length of Byron Unit 1 bounds Braidwood Unit 1.

On February 6, 1996, ComEd presented the results of the Byron Unit 1 tube pull analysis and the Braidwood Unit 1 Cycle Length Assessment. This information was then documented in the Reference 1 report dated February 23, 1996 and submitted for review and concurrence. The report concluded that a basis exists for Braidwood Unit 1 operation for a period equivalent to the Byron Unit 1 period between the 1994 refueling outage (B1R06) and the Byron Unit 1 midcyle outage.

The technical basis for the Braidwood Unit 1 cycle length assessment included in the Reference 1 report is primarily four items.

1) Byron Unit 1 tubes had structural integrity, with margin, after the period of operation (342 days) as demonstrated by tube pull results.
2) A conservative leakage analysis for Braidwood Unit 1 demonstrates margin to the site allowable leakage limits.
3) Braidwood Unit 1 indications are significantly smaller than indications found in Byron Unit 1.
4) Braidwood Unit 1 fall refueling outage (A1R05) inspection improvements over the Byron Unit 1 B1R06 inspection

The details of this technical basis are documented in the Reference 1 report.

After completion of the Braidwood Unit 1 Cycle Length Assessment report, a question arose regarding the impact of the large number of indications found during the Byron Unit 1 spring refueling outage inspection (B1R07). The primary focus of this report is to demonstrate that the indications identified are the result of an inspection transient. The inspection transient was the result of the use of different eddy current probes, analysis software and increased analyst sensitivity to circumferential indications.

2.0 Byron Unit 1 Indication Look-Back

A discussion of the look back of steam generator tube TTS circumferential indications identified during the last two Byron Unit 1 outages is presented here. A look-back refers to re-analyzing previous outage ECT data for tubes repaired during the subject outage. For Byron Unit 1, inspection with an RPC probe (probe which can detect circumferential indications) began in 1994. Subsequent inspections with probes sensitive to circumferential indications were performed in 1995 and 1996. Two look-backs have been completed at Byron Unit 1. The first being a look back of indications found in 1995 to the 1994 ECT data for the same tubes. The second look-back is a re-analysis of the 1996 indications in the 1995 and 1994 ECT data for the same tubes. Further discussion of the look-back objectives, scope, results and conclusions are presented in this section.

The look-back data was used to select the tubes for a "blind test" which is discussed later in this report. The major difference between the look-back and the "blind test" is the look-back is an important tool to detect the presence of an indication at an earlier inspection. The protocol of the blind test is set-up to assess the ECT data analyst probability of detection of an indication in a tube with similar conditions to the initial tube ECT analysis. The "blind test" does not allow the analyst to use the previous inspection data to determine the presence or location of an indication.

2.1 Look-Back Objectives

The objectives of the look-back program are to: 1) determine if the number of indications detected and repaired at Byron Unit 1 in 1995 and 1996 were the result of an inspection transient, and 2) determine the relative growth rates between inspections. Having knowledge of the distribution of indications over the three Byron Unit 1 outages (for which circumferential indications were detected) provides growth information to further support the basis of the proposed Braidwood Unit 1 cycle length, that Byron bounds Braidwood. By identifying indications in previous inspection data and assessing the detectability of those indications, such as through a blind test, the number of indications identified in the subject outage can be redistributed to the previous outages. If a significant portion of the indications are found to have been present at an earlier outage, the current outage number of indications is the result of an inspection transient.

2.2 Look-Back Scope

Figure 1 diagrams the scope of the 1995 and 1996 indication look-backs.

All the re-analysis was performed using the EddyNet95 software, with filters.

Voltages for all the data within the look-back scope were normalized to the same size calibration standard flaw in order to provide consistent results. The plus point probe voltage for 1996 was set to a circumferential calibration standard flaw, where as the 1995 plus point probe voltage was set to an axial calibration standard flaw. The variation in plus point voltages between 1995 and 1996 due to the calibration process ranged from approximately 2% to 12.5 %.

Byron Unit 1 1995 Look-Back

In 1995, 2578 tubes with circumferential indications were detected and repaired in Byron Unit 1. Of this population, 993 tubes were selected for the look-back. Nine hundred and seventy eight of the tubes were from SG B, this represents the population of TTS circumferential indications repaired in 1995 in this SG. Ten tubes which were pulled from SG A in 1995 were included in the population in order to assess whether the largest tube was pulled. Based upon 0.080 RPC voltages, the tubes pulled had the largest voltage of the indications included in the scope of the look-back. Six tubes from SG C were selected because there was RPC data from 1993 for these tubes. The 1994 RPC data for the same 993 tubes was re-analyzed using EddyNet95 and ECT data analysts trained to 1995 guidelines.

Byron Unit 1 1996 Look-Back

In 1996, 3487 circumferential indications were detected and repaired in Byron Unit 1. Of this population 1274 tubes were selected for the look-back. One thousand twenty three of the tubes were from SG C, this represents the 1996 population of tubes with TTS circumferential indications in this SG. The remaining tubes represent 10% of the tubes with the largest voltages in the remaining 3 SG's. The breakdown of tubes included is: 48 from SG A, 87 from SG B, and 116 from SG D. The 1995 and 1994 RPC data for the same 1274 tubes was re-analyzed using EddyNet95 and ECT data analysts trained to 1996 guidelines.

The 1996 look-back data re-analysis for 1994, 1995 and 1996 were performed by independent analysts. However, the analysts were encouraged to use the 1996 inspection data to aid in locating the indication.

Byron Unit 1 1994 Re-analysis

In addition to the 1995 and 1996 look-back sample, the 0.080 RPC and circumferential coil data for 1994 repaired indications was re-analyzed in order to have consistent voltage results from three consecutive Byron Unit 1 inspections to use for growth analysis. One hundred thirty two tubes were included in the re-analysis.

Braidwood Unit 1 2/95 and 10/95 Re-analysis

Braidwood Unit 1, 0.080 RPC and circumferential coil data from the Spring (15 tubes) and Fall, (25 tubes) 1995 outages was re-analyzed to assure consistent voltage results for comparison to the Byron Unit 1 inspections.

2.3 Byron Unit 1 Indication Look-Back Results

2.3.1 1995 Byron Unit 1 Indication Look-Back Results

The results of the 1995 look-back with regards to the presence of indications in 1994 is presented in Table 1. The results indicate that 67% of the 1995 Plus Point indications were also present in 1994 from the 0.080 RPC data. This demonstrates that if the 1995 analysis methods and analyst sensitivity of circumferential indications were present in 1994, 67% of the 1995 circumferential indications would have been detected in 1994.

Seventy Six (76%) percent of the 1995 Plus Point indications were detected with 0.080 RPC in 1995. If the Plus Point probe were available in 1994, 24% of the 1995 indications would have been detected in 1994.

2.3.2 1996 Byron Unit 1 Indication Look-Back Results

The results of the 1996 look-back with regards to the presence of indications is presented in Table 2. The results demonstrate that 78% of the 1996 Plus Point indications were present in 1995. The results also demonstrate that 24% of the 1996 Plus Point indications were present in 1994 with the circumferential coil. If the 1996 analysis methods and analyst sensitivity of circumferential indications were present in 1995, 78% of the 1996 circumferential indications would have been detected in 1995. If the 1996 analysis methods and analyst sensitivity of circumferential indications were present in 1994, 23% of the 1995 circumferential indications would have been detected in 1994.

2.3.3 Byron Unit 1 Inspection Transients Discussion

The results discussed in sections 2.3.1 and 2.3.2 can be used to redistribute the circumferential indications found in the 1996 and 1995 inspections to the previous inspections. The redistribution of indications is diagrammed on Figure 2. The detailed calculation is included below:

Redistribution to 1995:

(# 1996 Inds x % redistributed to 1995) - (# 1996 Inds x % redistributed to 1994) + (# 1995 Inds x 1-% redistributed to 1994) = Number of tubes which could have been detected in 1995

(3487 * .78) - (3487 * .24) + 2578 * (1 - .67) = 2733 1995 Indications

Redistribution to 1994:

(# 1996 Inds x % redistributed to 1994) + (#1995 Inds x % redistributed to 1994) + 132 = Number of tubes which could have been detected in 1994

(3487 * .24) + (2578 * .67) + 132 = 2696 1994 Indications

Remaining 1996 Indications:

(# 1996 Inds) - (# Inds redistributed to 1994 & 1995) = 1996 Inds

3487 * (1 - .78) = 768

Further Redistribution of 1995 Inds for use of Plus Point in 1994:
(# of Inds in 1995) x (% not seen with RPC) = Additional 1994 Inds if Plus Point used in 1994

2733 * .24 = 656
656 + 2696 + 132 = 3484

The final result represents the total number of indications which would have been detected in 1994 if the analyst sensitivity to circumferential indications, analysis software and plus point probe were present in 1994.

A summary of the above redistribution of indications is presented in Table 3 with information regarding the software and probes that were used in the three inspections.

Conclusion:

Based upon results from the Byron Unit 1 1995 and 1996 indication look-backs it is apparent that a significant number of indications would have been detected in previous inspections if the analysis software, probes, and analyst awareness were the same. **Therefore, the majority of 1995 and 1996 indications are the result of an inspection transient and do not represent significant growth of indications between inspections. While the look-backs show significant differences in the analyst, software and probe, SG tube integrity is not challenged.**

2.3.4 Byron Unit 1 Look-Back Indication Growth

As a part of the look-backs performed on Byron Unit 1 1996 indications, 0.080 RPC indication voltages for each year were binned in 0.1 Volt bins and plotted Vs. cumulative distribution frequency (Figure 3). This was done to show the relative change in the voltage distribution of indications for the same tube in the previous inspections. The 0.080 RPC was used because it is the only coil for which data is available for 3 consecutive inspections.

The maximum voltage of the indications has grown from 0.55 Volts in 1994 to 0.98 Volts in 1995 and 1.11 Volts in 1996. This represents a total growth of the maximum voltage from 0.55 volts to 1.11 volts from 1994 to 1996. This period represents an entire operating cycle of approximately 1.1 EFPY. The growth of 0.56 Volts over an operating cycle of 1.1 EFPY does not challenge the structural integrity of the tubes when compared to the limiting tube of 5.5 Volts.

2.3.5 Braidwood Unit 1 Comparison

The Braidwood Unit 1 indications detected in the spring and fall of 1995 outages were re-analyzed with Byron Unit 1 data. These voltages, as well as the Byron Unit 1 1994 refueling outage indication voltages are shown in Figure 4. A comparison of the data in Figure 4 leads to the following results.

1. The largest Braidwood 10/95 indication voltage is less than 25% of the largest voltage indication detected during the Byron 1994 outage.

2. The largest Braidwood 2/95 indication voltage is less than 50% of the largest voltage indication detected during the Byron 1994 outage.

As discussed above, although there is presently no direct correlation between voltage and burst pressure and/or leakage, voltage does represent material loss and does relate to the structural integrity of the tube. With the significant margin between the largest Byron 1994 indication voltage (which was shown to have structural integrity) and the Braidwood Unit 1 indications, it can be concluded that Byron bounds Braidwood and the voltages being seen during recent inspections do not challenge the structural integrity of the SG tubes.

3.0 Byron Unit 1 Blind Test

The blind test program was developed by selecting tubes from the look-back data results that were discussed in Section 2.0. The most significant difference between the blind test and look-backs was the blind test did not allow the analysts to use

the previous years inspection data to determine the presence or location of the circumferential indications.

3.1 Objectives

The objectives for the Byron Unit 1 1996 Blind test program was to: 1.) validate the conclusion that the Byron Unit 1 1995 and 1996 eddy current data are inspection transients by supporting look-back results, and 2.) demonstrate the analysts consistency in detecting and reporting the circumferential indications.

3.2 Blind Test Scope

The project scope consisted of developing two blind tests to support the conclusion that the 1995 and 1996 eddy current inspections are inspection transients. The tubes selected came from Steam Generator C, 1996 look-back population. The two tests that were created are identified as Blind Test 1 and Blind Test 2. Blind Test 1 is made up of 100 tubes and Blind Test 2 is made up of 200 tubes. Three inspection data sets 1994, 1995, and 1996 were included in both blind tests. Figure 1 diagrams the scope for how the blind tests were developed, based on the results of the Byron Unit 1 look-back.

3.3 Blind Test Development

Blind test development for the 100 and 200 tube tests were tubes with indications from the 1996 Look-Backs from Steam Generator C. A total of 1,023 tubes were in the 1996 Look-Back population. A representative range of indication sizes were selected from the Plus Point probe voltages. The Plus Point probe voltages were ranked in three groups as large (>=0.81 volts), medium (0.80-0.51) and small (0.50-0.30).

After the tubes were selected the EPRI "site shell" program built the tests to include the minimum number of flaws and NDD tubes for each data set. No summary information in the way of site name, owner name, steam generator identification, times and dates were copied onto the tests. The analyst was provided no information to directly determine where the data came from or what year the data was acquired in.

The 100 tube test was created in a joint effort with the Electric Power Research Institute (EPRI). The site-shell program allows for developing a practical as well as a written exam. An inclusive grading method was used for the 100 tube test. This inclusive grading method takes into account the number of flaws that are selected for the test and graded as a whole. The test was statistically derived to meet a 90% probability of detection POD with a 95% confidence level (CL). For the 100 tube test, ninety six (96) tubes with indications were chosen from the results of the 1996 look -back and grouped into thirty two large indications, thirty

two medium indications and thirty two small indications. Four tubes that were identified as not having indications, NDD, were included to achieve the 100 tube total. The 96 indications selected are from the tubes that were repaired during the Byron Unit 1 1996 eddy current inspection. These 96 indications are called "truth flaws." For grading purposes, the truth flaws are the flaws that are required to be reported by the analysts.

The 100 tubes that were selected from the 1996 data were also included in the 1995 and 1994 data sets. The 1996 circumferential indications in some cases were NDD in the 1995 and 1994 data sets; therefore, the number of NDD tubes is greatest in the 1994 data set.

After the 100 tube blind test was created and the 1996 data set was built by the EPRI site shell program, a total of thirty large, thirty two medium, thirteen small and four NDD tubes were copied into the 1996 data set for a combined seventy nine tubes. The size of the 100 tube blind test was slightly smaller than initially designed due to data copying.

For the 1995 data set the EPRI site shell program copied a total of one large, nine medium, twenty nine small and sixty three NDD's for a total of one hundred and two tubes.

For the 1994 data set the EPRI site shell program copied a total of two large, one medium, two small and ninety seven NDD's for a total of one hundred and two tubes.

The 200 tube test was developed with the same method, but was biased with the addition of more NDD tubes. The same scenario occurred when the 200 tube test was built by the EPRI site shell program.

For the 1996 data set, the EPRI site shell program copied a total of ninety three mediums, fifty three small. No large indications were copied, even though twenty six of the indications were chosen and seventy six NDD tubes were copied for a total of two hundred twenty two tubes.

For the 1995 data set, the EPRI site shell program copied a total of five large, thirty nine medium, one hundred five small and forty NDD tubes for a total of one hundred eighty nine tubes.

For the 1994 data set, the EPRI site shell program copied a total of five medium, sixty three small and one hundred thirty five NDD tubes. No large indications were present during the 1994 inspection for these selected 200 tubes. Therefore, no large indications were copied into the 1994 data set.

Figure 5 diagrams the blind test development process.

3.4 Blind Test Protocol

A total of four analysts participated in and completed the 100 tube blind test. Three analysts completed all three data sets in the 200 tube test. The fourth analyst also completed all data sets but his 1995 results were not included because the optical disk which contained the 1995 data set results became corrupted and could not be successfully graded.

To be consistent in identifying and reporting circumferential indications during the testing the 1996 Byron Unit 1 Steam Generator Circumferential Indication Look-Back analysis guidelines and Zetec EddyNet 95 analysis software were used.

The testing was proctored by the ComEd eddy current Level III to insure all data was analyzed using the appropriate guidelines and to observe that no indication results were being discussed between the analysts. The ComEd Level III controlled the security of the test answers.

The 100 tube test was administered first, and the analysts did not have knowledge of what years data set that they were being tested on.

The probe that was used in the 1994 data set was a 3-Coil motorized rotating pancake coil (MRPC) which included a .080" pancake coil, axial wound coil and a circumferentially wound coil. The rotating probe used for the 1995 and 1996 data sets consisted of a .080" pancake coil, a .115" pancake coil and a plus point coil. The analysts used all coils to aid in their analysis of detecting, quantifying and reporting the circumferential indications.

After the analyst completed the 100 tube test, the test was graded by the EPRI site shell program. When the grading was complete for the 100 tube test, the analyst was allowed to review his test results. When the analyst completed his review of the results he proceeded to the 200 tube test.

3.5 Blind Test Results

Definitions of terms used in Table 4 are summarized as follows:

Truth Flaws - are the number of tubes with indications times the number of analysts.
Student Flaws - are the number of truth flaws that the analysts detected.
Percent correct - is the number of student flaws divided by the total number of truth flaws.
POD - probability of detection was calculated by EPRI.
NDD overcalls/NDD - tubes on the test reported by the analyst as having an indication/actual NDD.

Actual number of tubes - the actual number of tubes for each data set.
Number of analysts - the actual number of analysts who completed each data set.

To determine the total number of possible calls for the 100 tube blind test; the following calculation was performed on the 1994 data as an example:

(actual total number of tubes x number of analysts), 102 x 4 = 408, is equivalent to NDD + truth calls = 388 + 20 = 408 total calls

The Byron Unit 1 1996 Biind Test Results are summarized in Table 4.

3.6 Blind Test Conclusions

Based upon the Byron Unit 1 100 and 200 tube tests results a high probability of detection (POD) with a high confidence level (CL) was demonstrated by the 1996 analysts training, experience, and sensitivity for detecting and reporting circumferential indications.

For the 100 tube test 98% of the truth flaws were reported correctly by the analysts to achieve a POD of 92% at a CL of 98%. This met the 90% POD at a 95% CL set up in the EPRI site shell program grading scheme.

For the 200 tube test 90% of the truth flaws were reported correctly by the analysts to achieve a POD of 88% at a CL of 98%.

The Blind Test validates the 1995 and 1996 look-back results. This demonstrates the analysts consistency and awareness in reporting circumferential indications which further supports the conclusion that the data for Byron Unit 1 1995 and 1996 are inspection transients.

4.0 Structural Integrity Basis

4.1 Byron Unit 1 Tube Pull Evaluations

The basis for the structural integrity of Byron Unit 1 tubes is the analysis and testing of twelve tubes pulled from Byron Unit 1 and insitu pressure testing of eight tubes at Byron Unit 1. The tubes pulled all had margin to the structural requirements of Regulatory Guide 1.121. Details of the tube pull structural integrity analysis are described in section 6.3 of the Reference 1 report. A summary of the results are presented here.

The Byron Unit 1 1995 tube pull results demonstrated that after operation for 342 days above 500°F the tubes had significant margin to the structural limit. Additionally, tube R23C44, which was pulled during the 1994 refueling outage was the first 100% top of the tubesheet (TTS) Rotating Pancake (RPC) inspection

performed, had structural integrity. This tube was the largest indication identified at Byron Unit 1 based upon 0.080 RPC voltage and confirmed by metallographic sizing (MET) to be the largest indication identified to date in Byron 1 or Braidwood 1. Based upon detailed analysis and burst testing of EDM simulations of the remaining tube area (without taking credit for small ligaments) this tube was found to meet structural requirements.

Of the twelve tubes pulled with circumferential indications five have been burst tested. The burst pressure for the five tubes is compared to the Regulatory Guide 1.121 requirements. The lowest burst pressure was 10,300 psi (Reference 1 Table 6.3-1, not including R23C44 which was an EDM simulation of the defect which separated during tube removal) more than a factor of two above Regulatory Guide 1.121 structural limits. None of the five tubes which were burst tested burst at the circumferential defect location. The remaining seven pulled tubes which were not burst tested had metallographic average crack depths less than the average crack depth for Byron tube R23C44. Structural analysis and burst testing of EDM simulations of the defect in tube R23C44 indicates that structural margin exists for this tube with an average crack depth of over 78%.

Tube R23C44 is the most limiting tube for structural integrity which has been found at Byron or Braidwood Unit 1. This tube had an 0.080 RPC voltage of 5.5 Volts and was determined by MET sizing to have an average crack depth of approximately 78%. This tube had margin to the structural integrity requirements of Regulatory Guide 1.121. Additionally, no measurable operational leakage from this tube was experienced.

Therefore, Commonwealth Edison has concluded that structural integrity is assured for indications smaller than R23C44 by pulled tube data.

4.2 Byron Unit 1 Insitu Pressure Testing

During B1R07 eight tubes were insitu pressure tested to a pressure of 5000 psi. The objectives of the insitu pressure test is to demonstrate the structural integrity of the steam generator tubes and to quantify any leakage. Selection criteria for the tubes to be tested were: largest +point vert max voltage, largest +point peak to peak voltage, largest +point call no 0.080 RPC confirmation, indications present in 1994, largest voltage growth, largest mixed mode, largest circumferential extent and a low voltage indication. None of the tested tubes leaked up to the maximum test pressure of 5000 psi.

The largest 0.080 RPC indication which was insitu pressure tested was 1.05 Volts a factor of four times smaller than the most limiting Byron and Braidwood Unit 1 tube (R23C44). Two of the tubes which were insitu pressure tested were present in 1994 indicating that the tubes had been inservice for an entire operating cycle and had significant structural margin.

The size of RPC voltage indications at Braidwood A1R05 (10/95) and those insitu pressure tested at Byron in 1996 are comparable. Therefore, Commonwealth Edison has concluded that Braidwood 1 tubes will not leak during a MSLB.

4.3 Structural Integrity Conclusions

Figure 6 shows the voltage versus test pressure of Byron Unit 1 tubes which have been pressure tested. This includes the insitu pressure test indications, the 1995 tube pulls which were burst tested and the predicted burst pressure of the most limiting Byron and Braidwood Unit 1 tube (Byron Unit 1 SG A R23C44). Also on the figure is the 0.080 RPC Voltage distribution of Byron Unit 1 indications seen in 1996, 1995, 1994 and the Braidwood A1R05 (last inspection, fall 1995) indications. This figure shows the significant margin between the tubes being detected, tested and repaired during recent inspections versus the most limiting tube (1994 R23C44) which has been shown to have structural integrity.

Eddy current voltage represents the amount of material loss in the tube. Therefore, there is some relationship between voltage and structural integrity. With the margin between the voltage of indications being detected in recent inspections at Byron and Braidwood Unit 1 and the most limiting tube (R23C44) Commonwealth Edison has concluded that the size of indications being repaired at Byron Unit 1 in 1996 do not challenge the structural integrity of the tubes.

A re-evaluation of the Braidwood Unit 1 spring and fall 1995 outages indications was performed using the same guidelines as was used in the Byron Unit 1 1995 and 1996 indication look-back. The following conclusions were made from the re-evaluation based upon indication voltage:

1) The most limiting tube (Byron Unit 1 R23C44) is two times the size of the largest Braidwood Unit 1 indication found in the spring 1995 outage,
2) and four times the size of the largest Braidwood Unit 1 indication found in fall of 1995,
3) Byron bounds Braidwood and there is significant margin for the indications being detected to the structural requirements of Regulatory Guide 1.121.

5.0 Leakage Integrity Basis

A conservative leak rate assessment was performed for Braidwood Unit 1 in Reference 1 section 8.5.

In addition to the structural integrity of steam generator tubes it must be demonstrated that leakage integrity is maintained consistent with the limits of 10CFR Part 100 and requirements of the Byron and Braidwood 3.0 V IPC.

Steam generator tube leakage from the different degradation mechanisms must be combined. The two present active degradation mechanisms at Byron and Braidwood Units 1 are circumferential ODSCC at TTS and ODSCC at the TSP. The maximum projected SLB leakage due to ODSCC at the TSP at the end of Braidwood Unit 1 Cycle 6 for one steam generator is 6.99 gpm (Reference 1). The acceptable site allowable leak rate calculated using 0.35 microCuries/gm dose equivalent I-131 is 26.8 gpm. This leakage also includes accident leakage and the allowed 0.1 gpm primary to secondary leakage for each of the three unfaulted SG's.

The number of circumferential indications potentially left in service at Braidwood Unit 1 during the A1R05 inspection based upon a Probability of Detection (POD) of 0.6 with a frequency distribution of indications actually detected of 25, is 17.

It is conservatively assumed that these 17 indications are in one SG and all have leakage of 0.5 gpm. The 0.5 gpm leak rate represents the approximate leak rate of the most limiting tube, ANO-2 for which the makeup pump capacity (approximately 0.5 gpm) could not maintain pressure in the tube. The maximum pressure achieved during this test was 3600 psi, well above the Braidwood Unit 1 SLB accident pressure of 2560 psi. After the maximum pressure was achieved a leak rate of 0.15 gpm was measured at 2000 psi. The remaining insitu pressure testing leak rate data is below this level.

Seventeen tubes with a leak rate of 0.5 gpm results in maximum leakage during a MSLB event of 8.5 gpm. The summation of TTS ODSCC leakage of 8.5 gpm in addition to the 6.99 gpm from one SG for TSP ODSCC plus the 0.3 gpm allowed for the unfaulted SG's results in a total leakage of 15.79 gpm, still well below the 26.8 gpm limit.

The analysis performed above includes the following conservatism's to account for the lack of data correlating an ECT parameter to leakage.

- Assumes all indications are from a single SG; and
- Assumes maximum leakage seen during insitu pressure testing at a pressure significantly greater than SLB pressure.

Conclusion :

Leakage conservatively estimated during a MSLB at Braidwood will not exceed site allowable leakage limits.

6.0 Conclusions

1. The number of indications detected during the Byron Unit 1 1995 and 1996 are due to an inspection transient.
2. Improvements in eddy current analyst awareness of circumferential indications, analysis software and eddy current probe designs has created two inspection transients at Byron Unit 1.
3. The growth of indication voltages for 3 consecutive inspections is small.
4. Eddy current analysts had high consistency in identifying circumferential indications using 1996 training standards and software, based on the blind test.
5. Structural integrity is assured based on 1994 and 1995 tube pulls and 1996 insitu pressure tests.
6. Conservative calculation of MSLB leakage is low compared to allowable limits.
7. The largest Braidwood Unit 1 indication is half the size of the largest Byron Unit 1 1994 indication.

These conclusions support the technical basis that Byron Unit 1 bounds Braidwood Unit 1 reported in the Braidwood Unit 1 Cycle Length Assessment Report submitted to NRC February 23, 1996. Braidwood Unit 1 can operate for a duration equivalent to the period of Byron Unit 1 operation between the 1994 refuel inspection and the 1995 mid-cycle inspection.

7.0 References

1. Braidwood Unit 1 Cycle Length Assessment Report, transmitted to U.S. NRC, February 23, 1996

Circumferential Indication 1995 Look-Back Results
Table 1

Steam Generator B

	Year	0.080 Coil	Circ Coil
Tubes Analyzed		978	359 Note 1
Number	1995	745	n/a
	1994	619	39

Note 1: Additional 1994 indications seen with MRPC Circ Coil only

Steam Generator A

	Year	0.080 Coil	Circ Coil
Tubes Analyzed		10	10
Number	1995	9	n/a
	1994	4	7

Steam Generator C

	Year	0.080 Coil	Circ Coil
Tubes Analyzed		5	n/a
Number	1995	5	n/a
	1994	5	n/a

All Steam Generators

	Year	0.080 Coil	Circ Coil
Tubes Analyzed		993	369
Number	1995	759	n/a
	1994	628	46

Percentage of Indications Present in 1994

628 + 46 / 993 = 0.679
or 67%

Percentage of 1995 Plus Point Indications Detected with 0.080 RPC in 1994
759/993 = 0.764
or 76%

Byron Unit 1 1996 Look-Back
Circumferential Indication 1996 Look-Back Results
Table 2

Steam Generator C

	Year	0.080 Coil	Plus Point	Circ Coil
Tubes Analyzed		1023	1023	1023
Number of Inds	1996	351	1023	n/a
	1995	150	795	n/a
	1994	78	n/a	234

Steam Generator A

	Year	0.080 Coil	Plus Point	Circ Coil
Tubes Analyzed		48	48	48
Number of Inds	1996	41	48	n/a
	1995	15	35	n/a
	1994	6	n/a	12

Steam Generator B

	Year	0.080 Coil	Plus Point	Circ Coil
Tubes Analyzed		87	87	87
Number of Inds	1996	45	87	n/a
	1995	20	73	n/a
	1994	17	n/a	37

Steam Generator D

	Year	0.080 Coil	Plus Point	Circ Coil
Tubes Analyzed		116	116	116
Number of Inds	1996	57	116	n/a
	1995	20	90	n/a
	1994	10	n/a	24

All Steam Generators

	Year	0.080 Coil	Plus Point	Circ Coil
Tubes Analyzed		1274	1274	1274
Number of Inds	1996	494	1274	n/a
	1995	205	993	n/a
	1994	111	n/a	307

Percentage of Plus Point Indications Present in 1995

993/1274 = 0.779
or 78%

Percentage of Circ Coil Indications Present in 1994

307/1274 = 0.241
or 24%

Table 3
Byron Unit 1 Look-Back Indication Redistributon Results

Year	Coil	Software	Actual Repaired	Look-Back Results	Plus Point
1996	+Pt, 0.080, 0.115	EddyNet95 w/Filters	3487*	768	
1995	+Pt, 0.080, 0.115	Anser	2578	2733	
1994	0.080, Circ Coil	EddyNet	132	2696	3484 *
					2733x .24 + 2696 +132
		Total	6197	6197	

Byron Unit 1 1996 Blind Test Results
Table 4

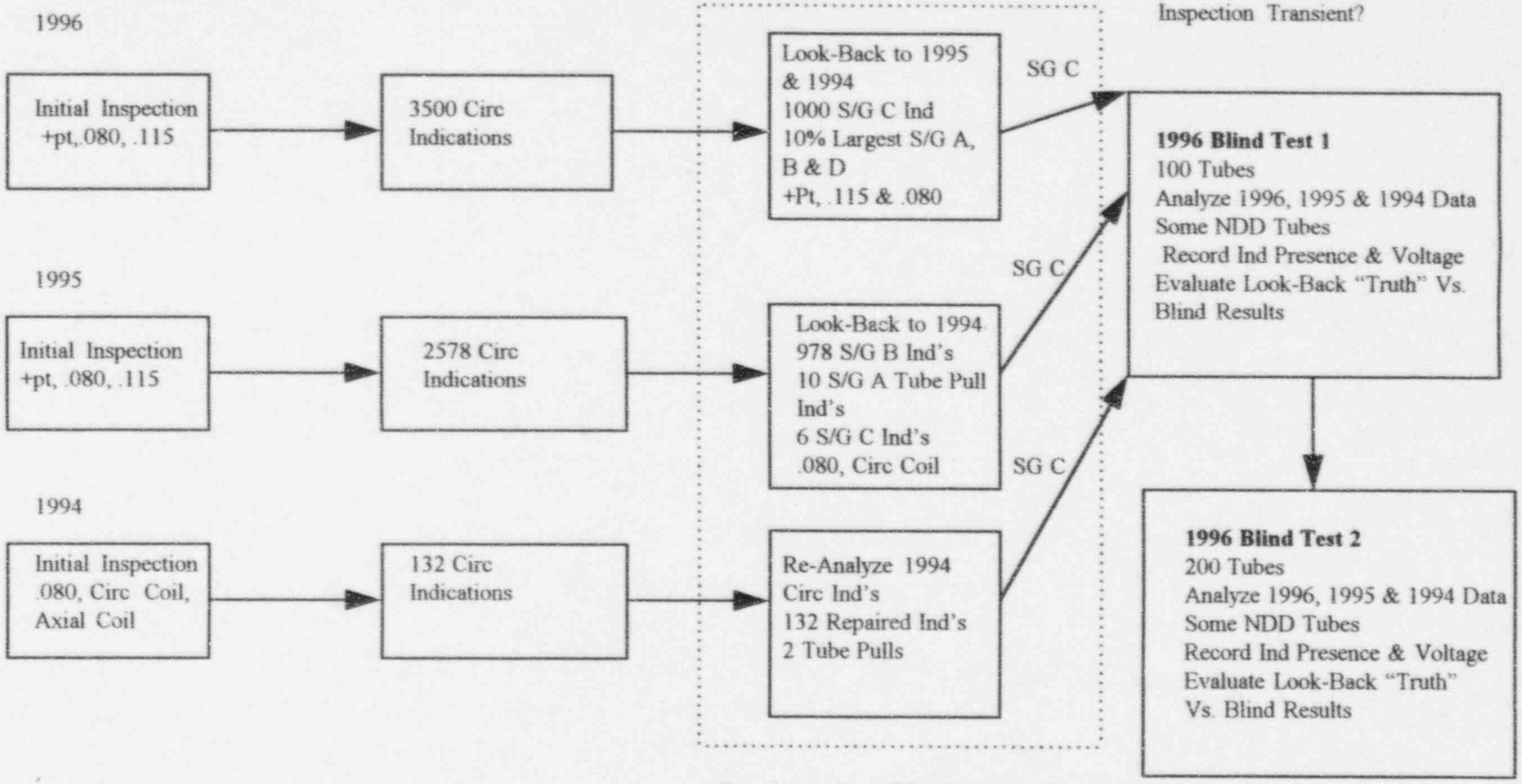
100 Tube Blind Test		200 Tube Blind Test	
1994		**1994**	
Truth Flaws	20.00	Truth Flaws	272.00
Student Flaws	20.00	Student Flaws	174.00
Percent Correct	1.00	Percent Correct	0.64
POD	0.86	POD	0.81
Confidence Level	0.95	Confidence Level	0.96
NDD Overcalls/NDD	101/388	NDD Overcalls/NDD	111/540
Actual # of Tubes	102.00	Actual # of Tubes	203.00
Number of Analysts	4.00	Number of Analysts	4.00
1995		**1995.00**	
Truth Flaws	156.00	Truth Flaws**	447.00
Student Flaws	150.00	Student Flaws	426.00
Percent Correct	0.96	Percent Correct	0.95
POD	0.92	POD	0.93
Confidence Level	0.97	Confidence Level	0.97
NDD Overcalls/NDD	53/252	NDD Overcalls/NDD	33/120
Actual # of Tubes	102.00	Actual # of Tubes	189.00
Number of Analysts	4.00	Number of Analysts	4.00
1996		**1996.00**	
Truth Flaws	300.00	Truth Flaws	584.00
Student Flaws	295.00	Student Flaws	567.00
Percent Correct	0.98	Percent Correct	0.97
POD	0.96	POD	0.95
Confidence Level	0.98	Confidence Level	0.99
NDD Overcalls/NDD	0/16	NDD Overcalls/NDD	31/304
Actual # of Tubes*	79.00	Actual # of Tubes	222.00
Number of Analysts	4.00	Number of Analysts	4.00
3 Year Total		**3 Year Total**	
Truth Flaws	476.00	Truth Flaws	1303.00
Student Flaws	465.00	Student Flaws	1167.00
Percent Correct	0.98	Percent Correct	0.90
POD	0.92	POD	0.88
Confidence Level	0.98	Confidence Level	0.98
NDD Overcalls/NDD	154/656	NDD Overcalls/NDD	175/964

* Due to data copying problems not all tubes were available

** One student did not complete 1995 test

Byron Unit 1 Circumferential Indication Studies

Question:
Byron 1996 # of Indications an Inspection Transient?



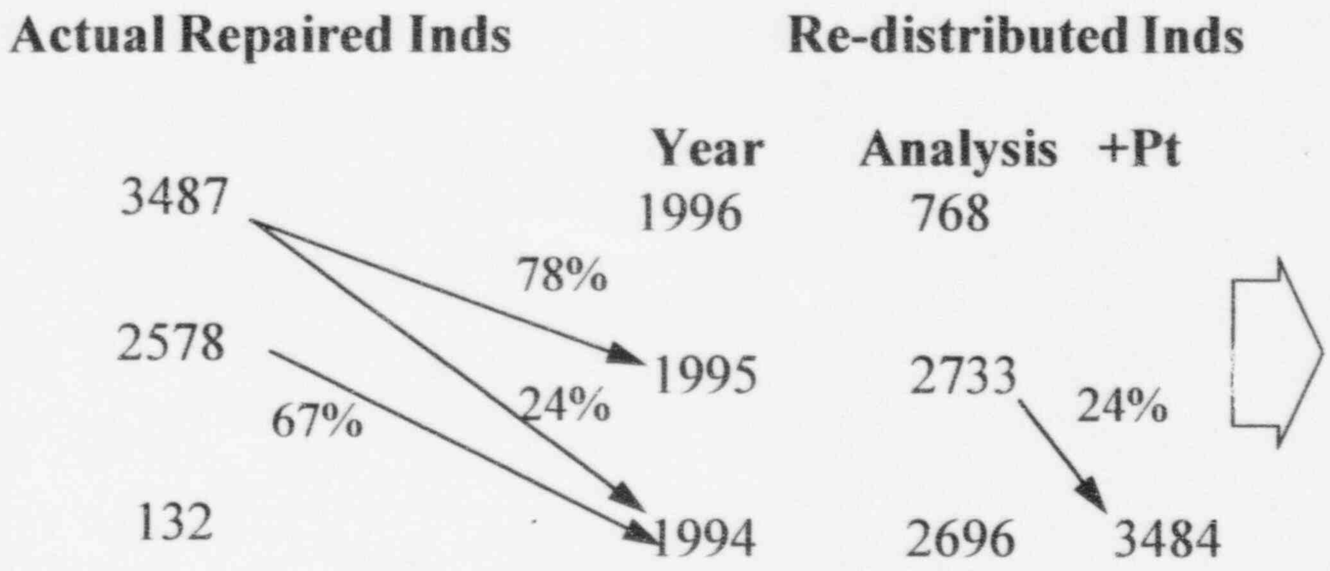
- Data Normalized With EddyNet 95

- Growth
- Indication Distribution

Figure 1

Byron Unit 1 Look-Back Indication Tracking

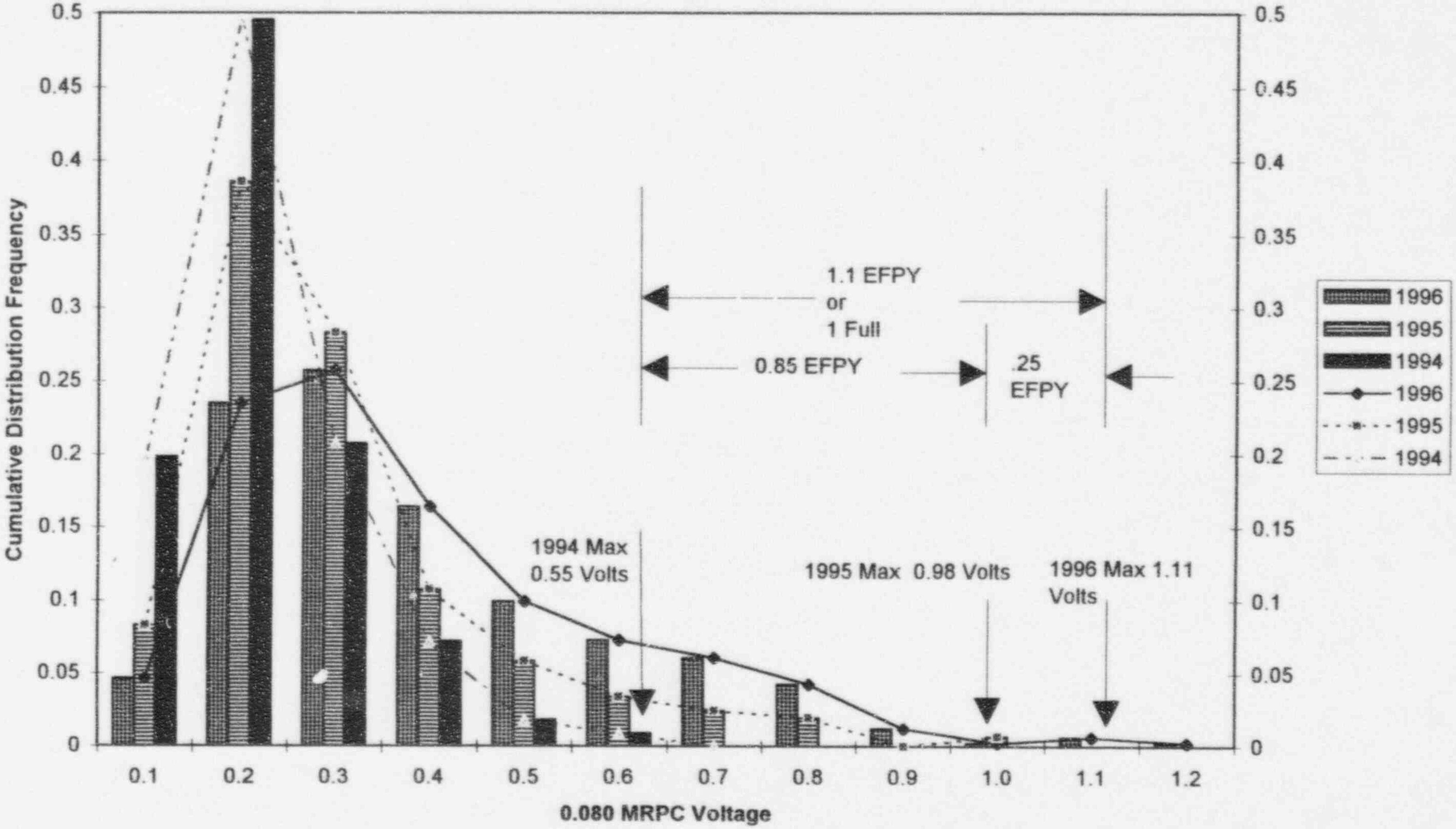
Figure 2



Distribution Inds Could Have Been Identified with Today's Inspection Process

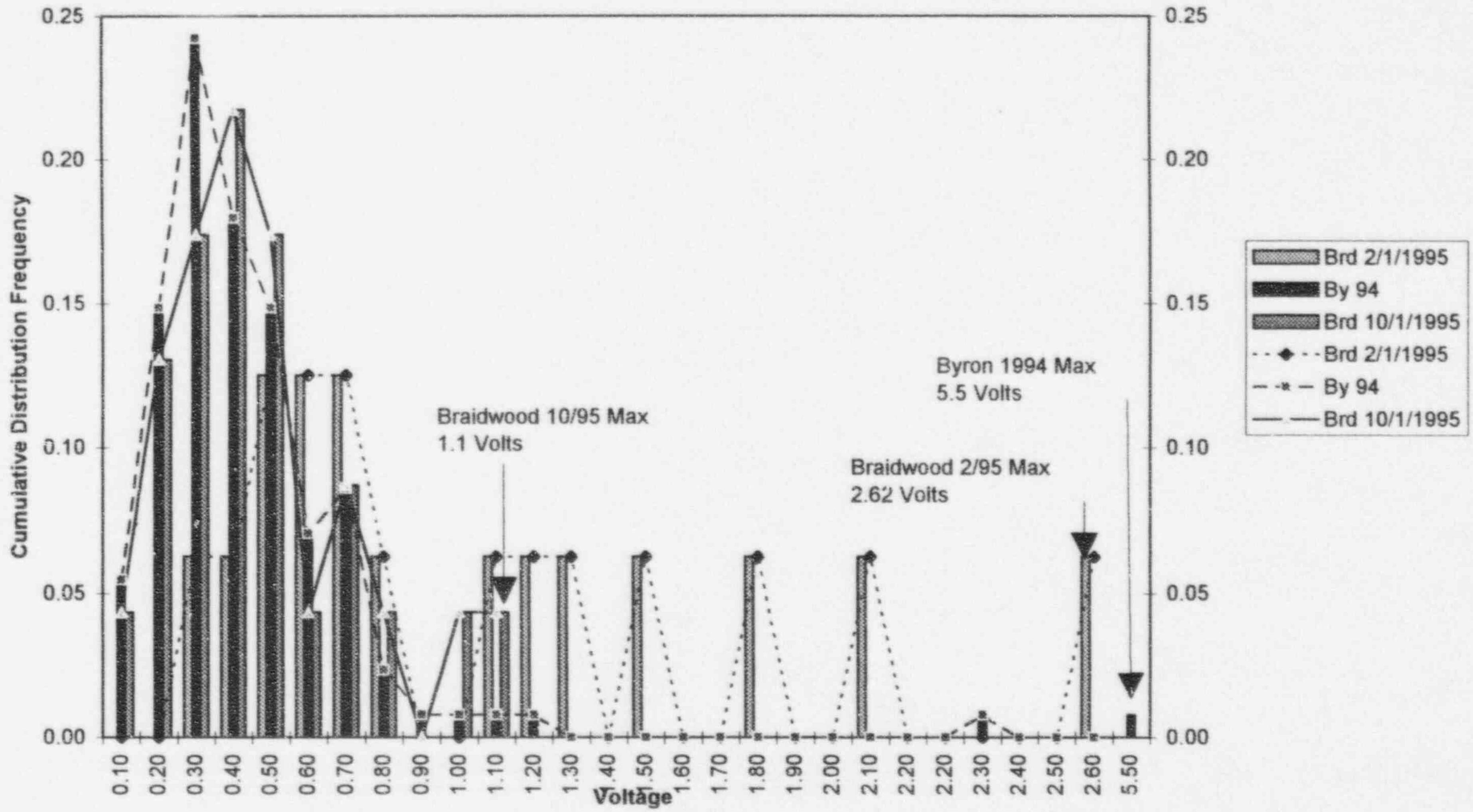
Byron Unit 1 1996 Look-Back Results for 0.080 MRPC Voltage Vs. Cumulative Distribution Frequency (Same Tubes)

Figure 3



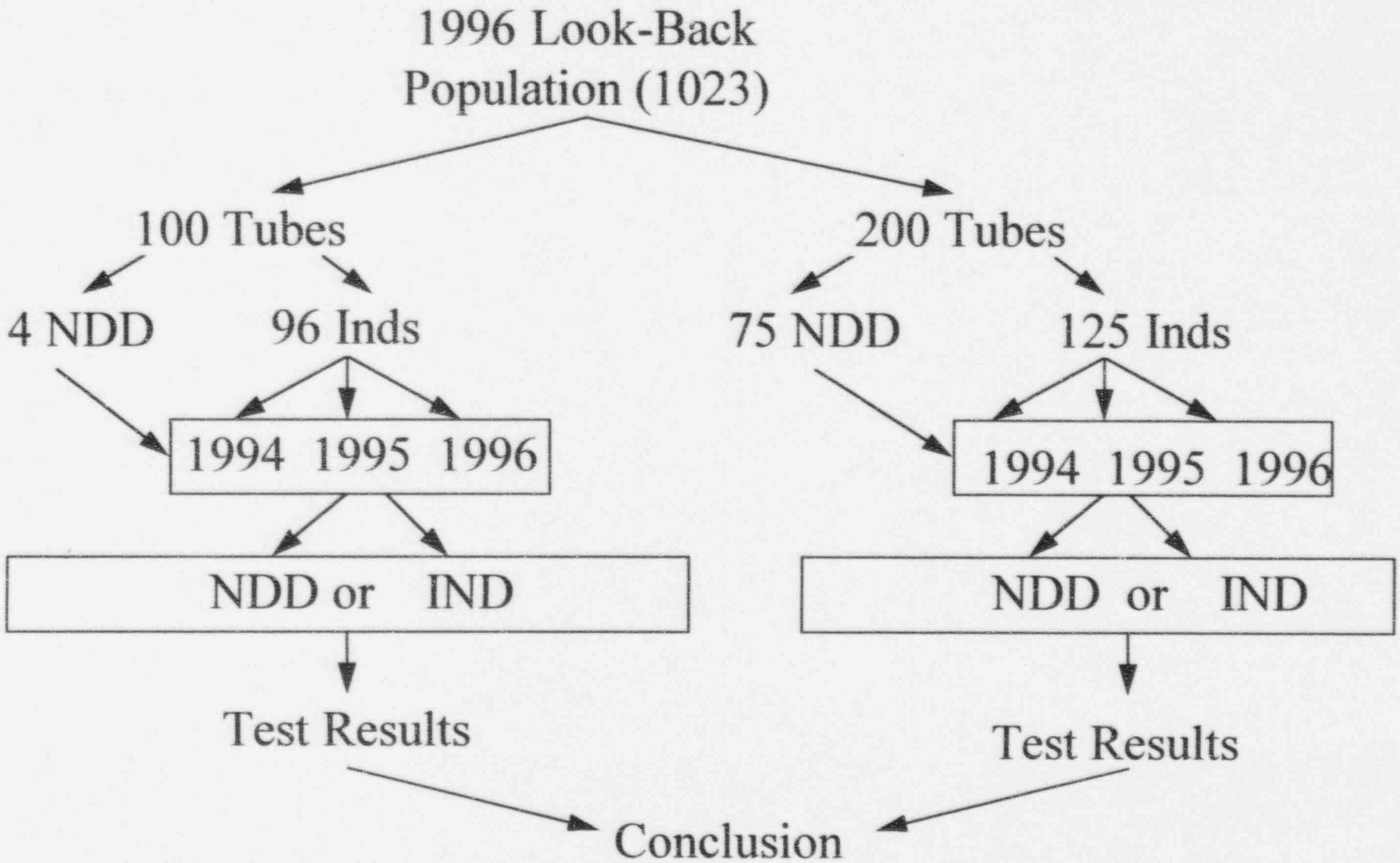
Braidwood & Byron Unit 1 0.080 MRPC Voltage Vs. Cumulative Distribution Frequency (Repaired Tubes)

Figure 4



Blind Test Development

Figure 5



Byron Unit 1 Voltage Vs Insitu and Burst Test Pressure

Figure 6