



UNITED STATES
NUCLEAR REGULATORY COMMISSION

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December 10, 1996

50-454
50-456

LICENSEE: COMMONWEALTH EDISON COMPANY
FACILITIES: BRAIDWOOD, UNIT 1, AND BYRON, UNIT 1
SUBJECT: SUMMARY OF A MEETING WITH THE COMMONWEALTH EDISON COMPANY ON
NOVEMBER 14, 1996, REGARDING THE STATUS OF THE ONGOING BRAIDWOOD,
UNIT 1, STEAM GENERATOR TUBE INSPECTION

A meeting was held on November 14, 1996, in Rockville, Maryland, between representatives of the Commonwealth Edison Company (ComEd) and the NRC staff. The purpose of the meeting was to discuss the status of the ongoing Braidwood, Unit 1, steam generator (SG) tube inspection as well as the repair program. A list of attendees is provided in Enclosure 1. A copy of the slides presented at this meeting is provided in Enclosure 2.

The present SG tube inspection at Braidwood, Unit 1, was initiated on October 11, 1996, and was conducted to determine whether there were circumferential indications at the top of the tubesheet (TTS) in the roll transition zone. The staff had previously taken the position in a letter dated May 22, 1996, that Braidwood, Unit 1, could operate until October 15, 1996, following restart of this unit after its fall 1995 refueling outage, before conducting an eddy current inspection (ECI) of the SG tubes at the TTS. This position was based on the results of the inspection program conducted in the last outage. This position also reflected the staff's concerns related to the large number of SG tubes at Byron, Unit 1, which had circumferential indications at the TTS. Both Byron, Unit 1, and Braidwood, Unit 1, have Westinghouse Model D4 SGs; the Byron, Unit 1, SGs have been in service for two more fuel cycles than those of Braidwood, Unit 1.

ComEd stated in the subject meeting that it had completed a 100 percent ECI of all SG tubes in the hot leg side of all four SGs using the plus point probe. All of the 1436 SG tubes with circumferential, axial and mixed mode indications found in this latest Braidwood, Unit 1, ECI have been repaired either by plugging or by inserting Westinghouse laser-welded sleeves.

A total of 23 SG tubes in the "A" and "B" SGs having the largest measured voltages were subjected to two sets of in-situ pressure tests to determine their leak-tightness under postulated accident conditions; i.e., a postulated main steam line break (MSLB). Four of the first ten SG tubes pressure tested leaked; ComEd estimated that two of these four SG tubes which leaked would have had very small leakage at MSLB conditions. For one of these four SG tubes, Row 22 Column 73 in the "B" SG (R22/C73 B), the initial measured in-situ leakage was 0.5 gallons per minute (gpm) at a differential test pressure of 1300 pounds per square inch (psid). The limited capacity of the pump which was used in the first set of tests did not allow a higher test pressure to be achieved. Subsequently, a test pressure of 2300 psid was achieved in the second set of in-situ pressure tests using a higher capacity pump resulting in a measured leak rate of 1.0 gpm for tube R22/C73 B. Correcting for the

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effects of temperature and pressure, ComEd estimated the potential leak rate for this tube under MSLB conditions for the first pressure test to be 2.1 gpm based on extrapolating the initial test data and 1.0 gpm from the data for the second set of leak tests. ComEd has conservatively assumed that the leakage under MSLB conditions for this particular SG tube is 2.1 gpm.

In light of the results of the first ten SG tubes pressure tested, ComEd pressure tested another 13 tubes from SGs "A" and "B." Only one of these SG tubes in the second set leaked. Of the five SG tubes that leaked, ComEd estimated that prior to the Braidwood, Unit 1, shutdown in mid-October 1996, the total potential leakage under MSLB conditions would have been 2.15 gpm from SG "B"; i.e., 2.1 gpm from R22/C73 B and 0.05 gpm from R21/C76 B.

All of the first ten SG tubes pressure tested were subsequently tested for structural integrity at a differential test pressure of 5100 psid; none of these burst. None of the second set of 13 SG tubes were tested for burst strength because the first set of SG tubes which were pressure tested for leakage were considered by ComEd to be the most likely candidates to burst.

On the basis of the foregoing discussion, ComEd concluded that the structural integrity requirements for the Braidwood, Unit 1, SG tubes were satisfied during the operating time of about ten months ending in fall 1996. ComEd also concluded that the potential leak rates under MSLB conditions for the worst SG were lower than the Braidwood Station site allowable leakage rate of about 27 gpm. With respect to the restart of Braidwood, Unit 1, ComEd stated that the Braidwood, Unit 1, SGs could be safely operated for an additional five months and based this conclusion on its evaluation of the data obtained in the present mid-cycle SG ECI and the results of the in-situ pressure tests.

During the visual inspection of the Braidwood, Unit 1, SGs, there appeared to be a potential leak past a plug in one of the 21 SG tubes which had been expanded into the tube support plates (TSPs), thereby making it function as an additional tie rod limiting the displacement of the TSPs under postulated accident conditions. These additional tie rods in the Byron, Unit 1, and Braidwood, Unit 1, SGs were a crucial element in the 3.0 volt alternate repair criteria (ARC) license amendments issued in fall 1995 for Byron, Unit 1, and Braidwood, Unit 1. ComEd stated that it had removed this plug and conducted an ECI of this subject tube; no defects in the tube were detected.

With respect to the pending request to delete a mid-cycle ECI in the present fuel cycle for Byron, Unit 1, ComEd stated that it would submit all of its responses to the prior requests for additional information (RAIs) by November 27, 1996. However, ComEd was not ready at this meeting to discuss the methodology it will propose for estimating the end of cycle (EOC) leakage rates under MSLB conditions. ComEd stated that its approach for estimating EOC leakage will be presented in its November 27, 1996, submittal. Accordingly, whereas ComEd had previously requested a staff decision by the end of November 1996 regarding its proposal to operate the Byron, Unit 1, SGs for 600 days without a mid-cycle ECI until their replacement in early 1998, ComEd now requested that the staff provide its decision on the pending proposal by mid-January 1997. This delay will allow the results of the present Braidwood, Unit 1, SG inspection, including the preliminary results of

the metallurgical examination of the four SG tubes pulled from one of the Braidwood, Unit 1, SGs, to be factored into ComEd's submittal on November 27, 1996.

At the end of the meeting, the staff provided a number of comments as follows:

1. ComEd had significantly expanded the database characterizing circumferential indications at the TTS in Westinghouse Model D4 SGs.
2. The staff noted that ComEd's approach for determining leakage presented during the meeting is inconsistent with that used previously in ComEd's cycle length assessment. Accordingly, the staff requested ComEd to consider analyzing the potential leakage for a postulated MSLB using a probability of leakage correlation incorporating all available industry data, including that obtained in the present Braidwood, Unit 1, inspection. The staff requested that this leakage evaluation be included in the forthcoming submittal on November 27, 1996.
3. The satisfactory inspection results of the SG tube expanded as part of the 3.0 volt ARC amendments issued in fall 1995 for both Byron, Unit 1, and Braidwood, Unit 1, provides assurance that the basis for the staff's acceptance of the 3.0 volt ARC license amendments is not affected by the results of this mid-cycle Braidwood, Unit 1, SG inspection.
4. The staff believes that one of the main issues related to the length of operating cycle between SG tube inspections at Byron, Unit 1, and Braidwood, Unit 1, continues to be an appropriate method for estimating the potential leakage at the end of the inspection interval under MSLB conditions.
5. Finally, the staff requested that the revised methodology for estimating leakage at the end of the inspection cycle be benchmarked by applying the circumferential indication growth rate observed in the most recent Byron, Unit 1, fuel cycles to the beginning of cycle (BOC) Braidwood, Unit 1, circumferential indications.

/s/

M. D. Lynch, Senior Project Manager
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Office of Nuclear Reactor Regulation

Docket Nos. STN 50-454, STN 50-456

Enclosures:

1. List of Attendees
2. Slides

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SUBJECT: SUMMARY OF A MEETING WITH THE COMMONWEALTH EDISON COMPANY ON
NOVEMBER 14, 1996

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MEETING ATTENDANCE

November 14, 1996

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**ComEd/NRC Steam Generator
Status Meeting
Braidwood Unit 1**

November 14, 1996

Agenda

- **Introduction** – John Blomgren
 - Meeting Objectives
 - Braidwood 1 Plan
 - Byron/Braidwood 1 Strategy
 - Braidwood Tube Pull Plan
- **Braidwood 1 Status** – Roman Gesior
 - Inspection and Repair Overview
 - Structural Assessment
 - Leakage Assessment
 - Locked Tube Inspection
- **Conclusions** – John Blomgren

Meeting Objectives

- Inform NRC Regarding the Results of Braidwood 1 Inspection
- Demonstrate Braidwood 1 Met Steam Generator Tube Integrity Requirements
- Define the Strategy for Cycle Length Assessment for Byron and Braidwood Unit 1

Braidwood 1 Plan

- 100% HL TTS +Point Probe Inspection of 4 SG's
- Repaired all Circumferential Indications
- Insitu Pressure Tested Largest Indications
- Pull Tubes with Circumferential Indications
- Run to Spring 1997 Refuel Outage
- Perform 100% HL & CL TTS +Point Inspection in Refuel

Conclusions

- In Situ Pressure Test Results of the Braidwood 1 Circumferential Indications Present for Over 496 Days Confirm Tube Integrity Requirements Maintained
- In Situ Tests of Circumferential Indications Which Grew Since 2/95 Did Not Leak

Byron/Braidwood Strategy

- Revise POL Curve with Insitu Data and Revised Voltage Adjustment Factors
- Recompute Leak Rate for Projected EOC Distribution with Insitu Leak Data
- Revise Burst Curve Based on Non-Burst Bound, Insitu Pressure Test Data, and Revised Voltage Adjustment Factors
- Recompute Structural Limit Based on Revised Burst Curve
- Analyze Pulled Tubes
- Perform Byron and Braidwood Cycle Length Assessment

Byron Strategy

- Schedule
 - RAI Response - 11/27/96
 - Meeting on RAI Response - Mid-December
 - Preliminary Tube Pull Results - Mid-December
 - NRC Cycle Length Review Completion - Mid-January

Braidwood 1 Tube Pull Plan

- Pull 4 Tubes
 - Largest Voltage Indication
 - Largest Leak Indication
 - Smaller Indication No Leakage
 - Indication with Large Max. Voltage Low Avg. Voltage
- Metallographic Analyses to Assess:
 - Morphology
 - Percent Degraded Area and 100% TW Area
 - Similar Analyses as Byron 1 Tube Pulls
 - Burst Testing of Flaws
 - Assess Voltage Sizing Techniques

Braidwood 1 Status

Inspection and Repair Overview

- Inspection Scope
 - 100% HL TTS
 - +Point Probe (+Point, 0.080" & 0.115" RPC)
 - EddyNet95 Analysis Software
- Voltage Screening Identified the Degradation in SG D to be Significantly Lower than in the Remaining 3 SG's
- Insitu Pressure Test 23 Circumferential Indications
- Pull 4 SG Tubes
- Sleeve or Plug all Circumferential and Axial Indications, Stabilize Circumferential Indications

Braidwood 1 A1P02 Inspection/Repair Overview

Indication	Number of Tubes With Indications				Total
	1A SG	1B SG	1C SG	1D SG	
Circumferential	221	276	610	293	1400
Axial	1	20	3	8	32
Mixed Mode	2	3	6	3	14
Total	224	299	619	304	1446
Total Repairable Tubes*	224	295	618	299	1436
Tubes Sleeved	181	0	443	272	896
Tubes Plugged and Stabilized	43	295	178	27	543
Total Equivalent Plugging %	13.2	9.3	20.6	9.6	13.2

898
538

* Some tubes have more than 1 indication

Braidwood 1 Assessment

Burst:

- 5 of the Largest Indications in SG A and 5 in SG B Insitu Pressure Tested to 5000 psi
- All Tubes Satisfied Structural Integrity Requirements
- 9 of 10 Indications Present in Look-Back to 2/95
- Period of Time from 2/95 to 10/96 is 496.5 Days > 500°F
- Significantly Improved Inspection Techniques in 10/96

Therefore Structural Integrity Requirements for Braidwood 1 Steam Generator Tubes are Met

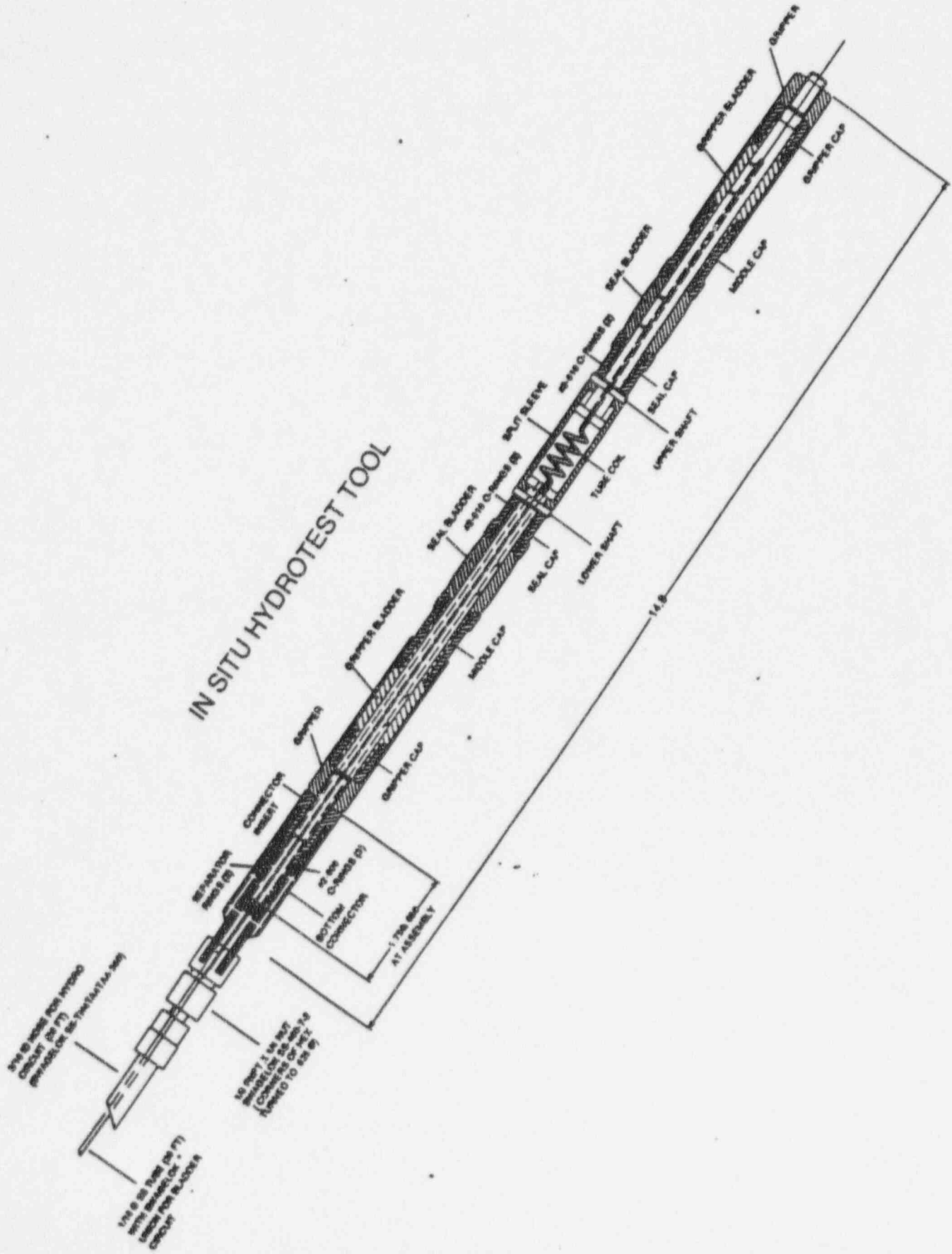
Braidwood 1 Assessment

Leak:

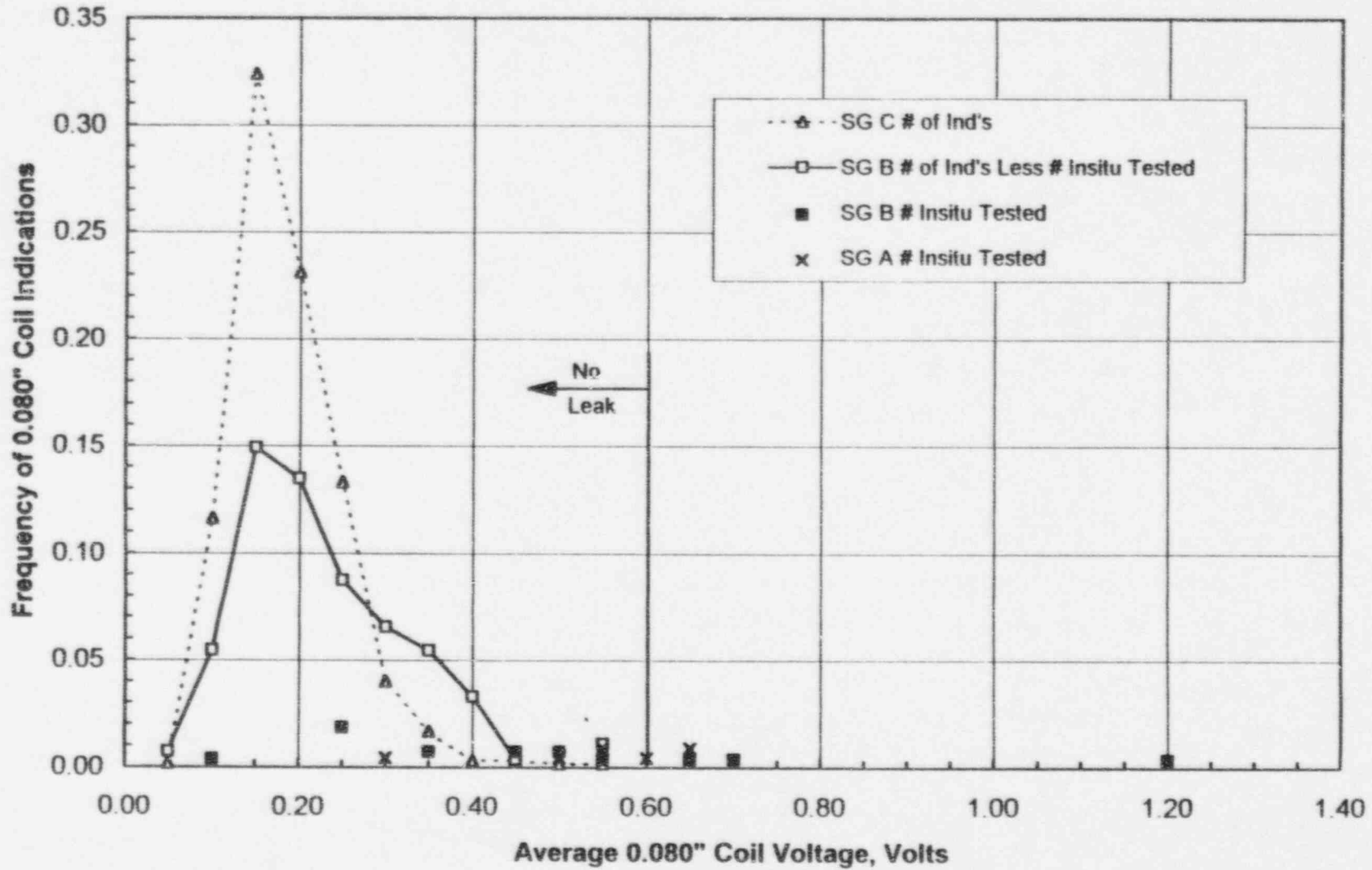
- 7 of the Largest Indications in SG A and 16 of the Largest Indications in SG B were Insitu Leak Tested to 3100 psi
- Total Circumferential Indication Leakage from Limiting SG is 2.15 gpm (SG B)
- 17 of the 23 Indications were Present in Look-back to 2/95
- Period of Time from 2/95 to 10/96 is 496.5 Days > 500°F
- All the Indications which Leaked were Present in 2/95
- Significantly Improved Inspection Techniques in 10/96

Therefore Site Allowable Leak Rates for Braidwood 1 Steam Generator Tubes are Met

Figure 1 Hydro Test Tool

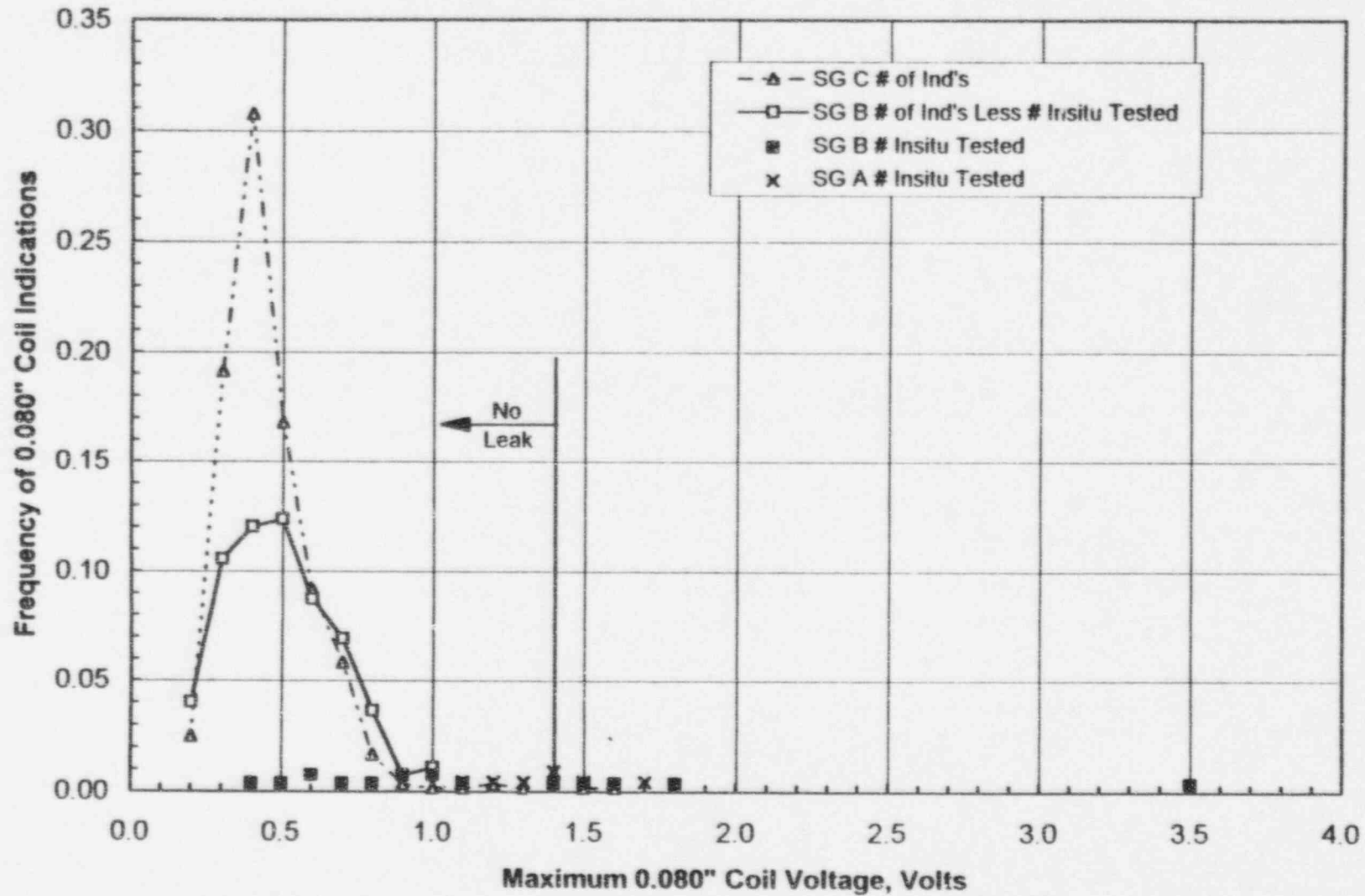


Frequency Distribution for Average 0.080" Coil Voltage



Conclusion: Insitu Pressure Tested Indications in SGs A and B Bound Largest Indications at Braidwood 1

Frequency Distribution for Maximum 0.080" Coil Voltage



Conclusion: Insitu Pressure Tested Indications in SGs A and B Bound Largest Indications at Braidwood 1

Braidwood 1 Structural Assessment

- Maximum and Average Voltage are used to Assess Structural Integrity
- 5 of the Largest Indications in SG A and 5 in SG B Insitu Pressure Tested to 5000psi, 3xNOdP 4035psi
- SG's A & B Have the Largest Indications, Bound SG's C & D
- Tube Selection Based upon Arc Length, +Point and 0.080" RPC Avg. Voltages
 - Arc Lengths Range from 164 to 316 Degrees
 - +Point Avg. Voltages Range from 0.35 to 2.25 Volts
 - 0.080" RPC Avg . Voltages Range from 0.29 to 1.2 Volts
- Tubes Met Structural Integrity Requirements

Braidwood 1 Leakage Assessment

- 7 Indications in SG A and 16 in SG B Leak Tested at 3100 psi, MSLB Pressure is 2560 psi
- Tube Selection Based Upon +Point and 0.080" RPC Vert. Max. Voltages and Max. Depth (Phase Angle)
 - +Point Vert. Max. Voltages Range from 0.65 to 7.07 Volts
 - 0.080" Vert. Max. Voltages Range from 0.39 to 3.5 Volts
 - +Point Max Depths Range from 8% to 88%
- Total Leakage in Limiting Steam Generator 2.15 gpm < Site Allowable Leak Limit (26.8 gpm) when Combined with Predicted TSP ODS/CC Leakage (6.99 gpm) and Leakage from Unfaulted SG's

Braidwood Unit 1 Insitu Test Result

ROW	COL	.080 MAX	Test Leak Rate (gpm)	Pressure (psi)	MSLB Leak Rate (gpm)
SG B					
21	76	3.5	0.1	3200	0.046
22	73	1.49	0.5	1300	2.1
22	73	1.49	1	2300	1
SG A					
27	60	1.14	0.006	5100	0
27	55	1.7	0.001	3200	0
23	41	1.43	0.001	3100	0

No Indications Below 0.080" Max. Voltage Leakage Threshold of 1.29 volts Leaked at MSLB Conditions

Total Leak Rate from Limiting SG = 2.15 gpm at MSLB Conditions

Braidwood 1 Tube R22C73 MSLB Leak Rate Confirmation

- ABB Insitu Test System Could not Attain MSLB Pressures due to High Leak Rates During Insitu Testing
- Westinghouse High Capacity Pump Mated with ABB Insitu Test System
- System Developed to Provide Confirmation of Calculated Leak Rates for Tube R22C73 at MSLB Conditions
- Due to Significant Pressure Drop in Test System (3000 - 4000 psi) System Flow Capacity is Reduced
- Qualification Testing of System to Verify the Pressure at the Flaw

Braidwood 1 Tube R22C73 MSLB Leak Rate Confirmation

- Leak Rate for Tube R22C73 Using the Hybrid System was 1 gpm at a Flaw Pressure of 2300 psi
- Corrected to MSLB Conditions the Leak Rate is 1 gpm

Conclusion:

- This Result Confirms the Magnitude of the Leak Rate (1 -2 gpm) Determined by Calculational Methods for R22C73 at MSLB Conditions

Locked Tube Inspection

- A Wet Plug was Identified in Visual Inspection of SG A
 - The Plug was in a Tube Expanded for TSP ODS/CC IPC
 - The Plug was Removed
 - No Water in Tube
- Inspection Scope:
 - From Tube End to 7th Support Plate Inspected with 610 Bobbin
 - TTS Inspected with Three Coil +Point Probe
 - 4 Locked TSP Expansions (8, 9, 10, & 11) Inspected with Gimbaled +Point Probe
- Primary, Secondary and Resolution Analysis with Independent Review of 2 Level III's
- No Indications Detected
- Conclusion: Plug Did Not Leak

Braidwood 1 Plan

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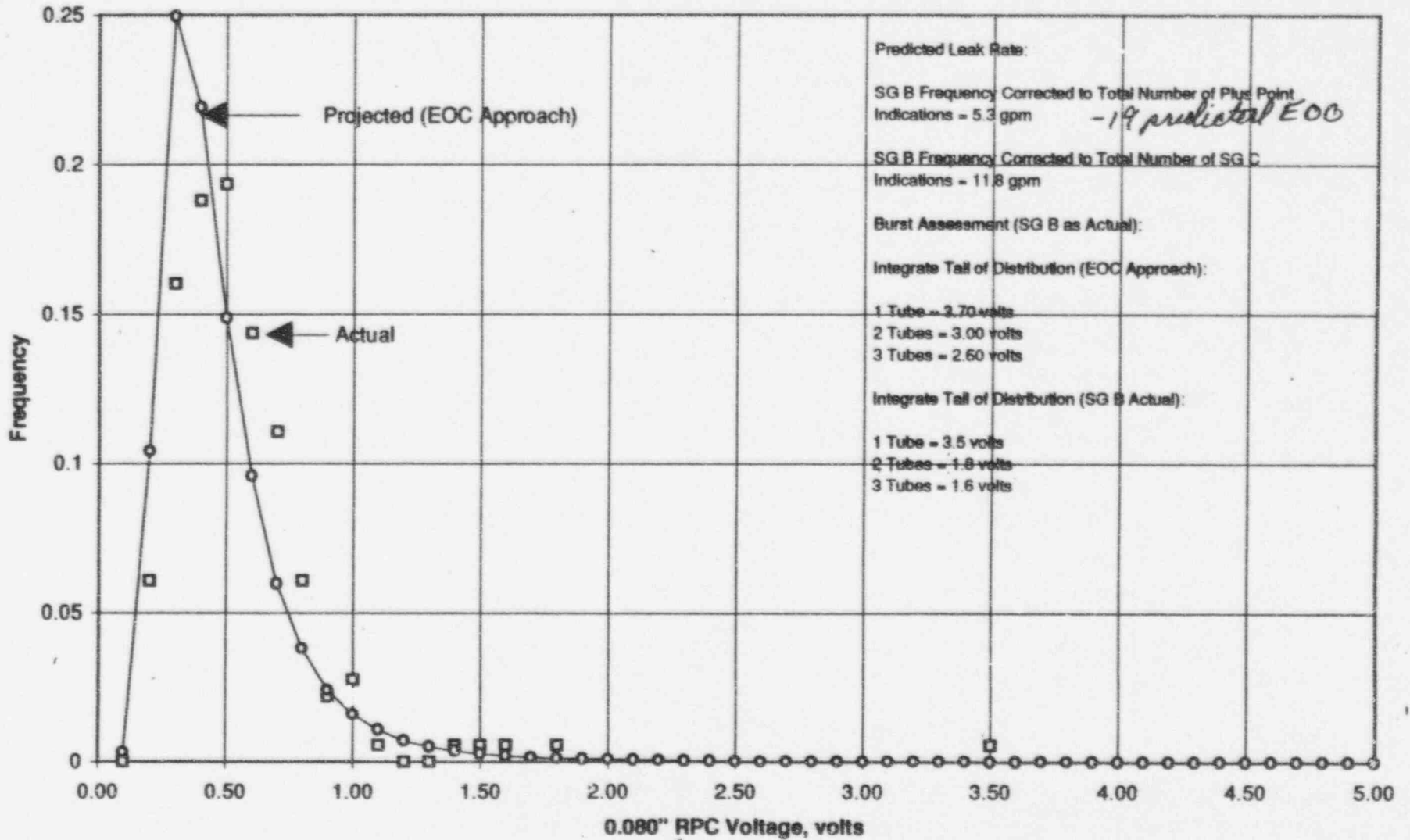
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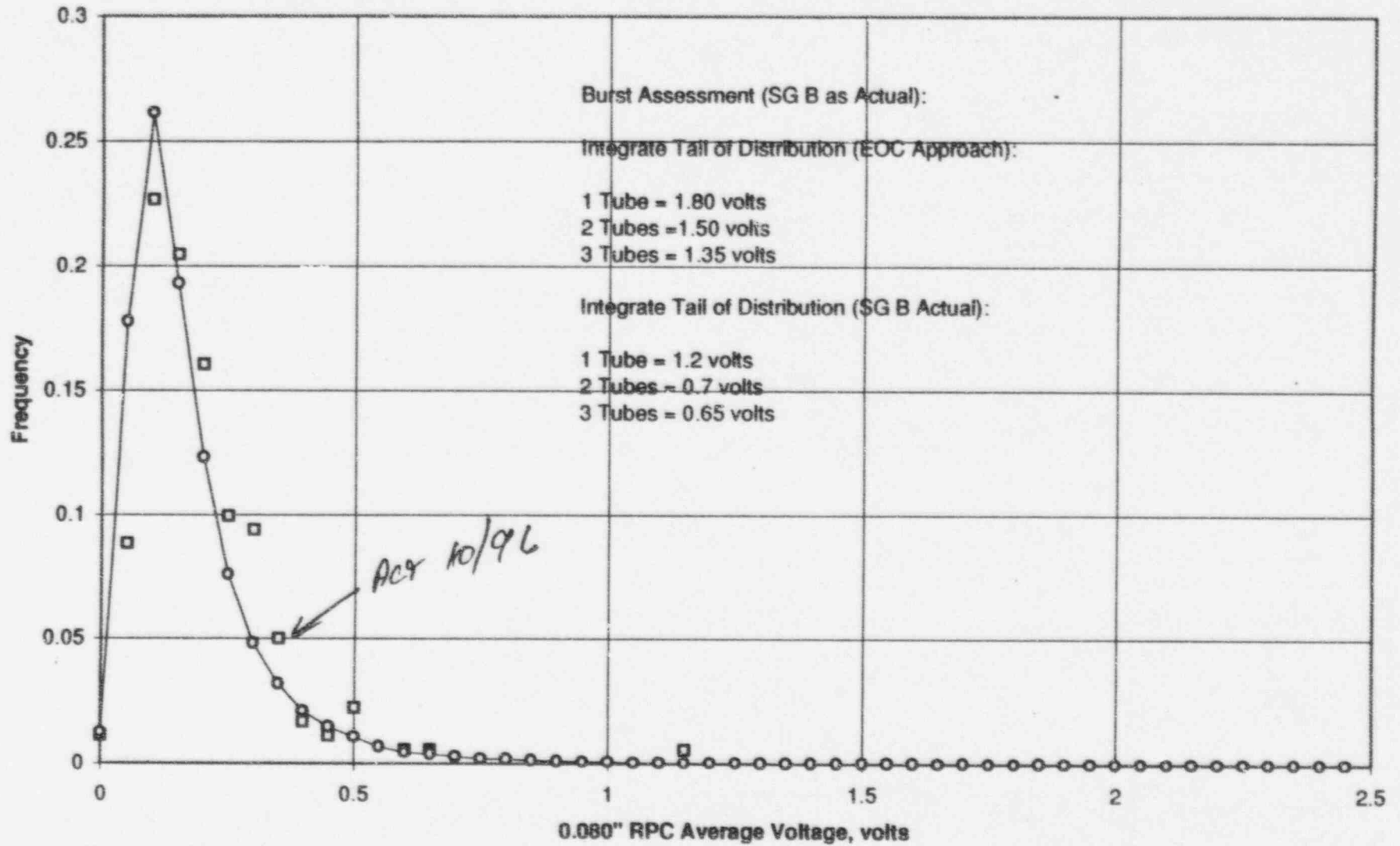
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Braidwood 1 SG B Frequency vs. Projected Frequency (EOC Approach)



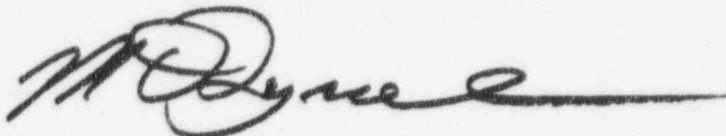
Braidwood 1 SG B Frequency vs. Projected Frequency (EOC Approach) Avg Volts



the metallurgical examination of the four SG tubes pulled from one of the Braidwood, Unit 1, SGs, to be factored into ComEd's submittal on November 27, 1996.

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