NRC FORM 658
(9-1999)

U.S. NUCLEAR REGULATORY COMMISSION

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DATE OF MEETING
02/17/2000

The attached document(s), which was/were handed out in this meeting, is/are to be placed in the public domain as soon as possible. The minutes of the meeting will be issued in the near future. Following are administrative details regarding this meeting:

Docket Number(s)	**05000368**
Plant/Facility Name	**Arkansas Nuclear One, Unit-2**
TAC Number(s) (if available)	**MA1951**
Reference Meeting Notice	**02/02/2000**
Purpose of Meeting (copy from meeting notice)	**Entergy Operations, Inc. requested this meeting to present results from their last steam generator inspection and their operational assessment for future operations.**

NAME OF PERSON WHO ISSUED MEETING NOTICE	TITLE
Tom W. Alexion	**Project Manager**

OFFICE
Office of Nuclear Reactor Regulation

DIVISION
Division of Licensing Project Management

BRANCH
Project Directorate IV & Decommissioning, Section 1

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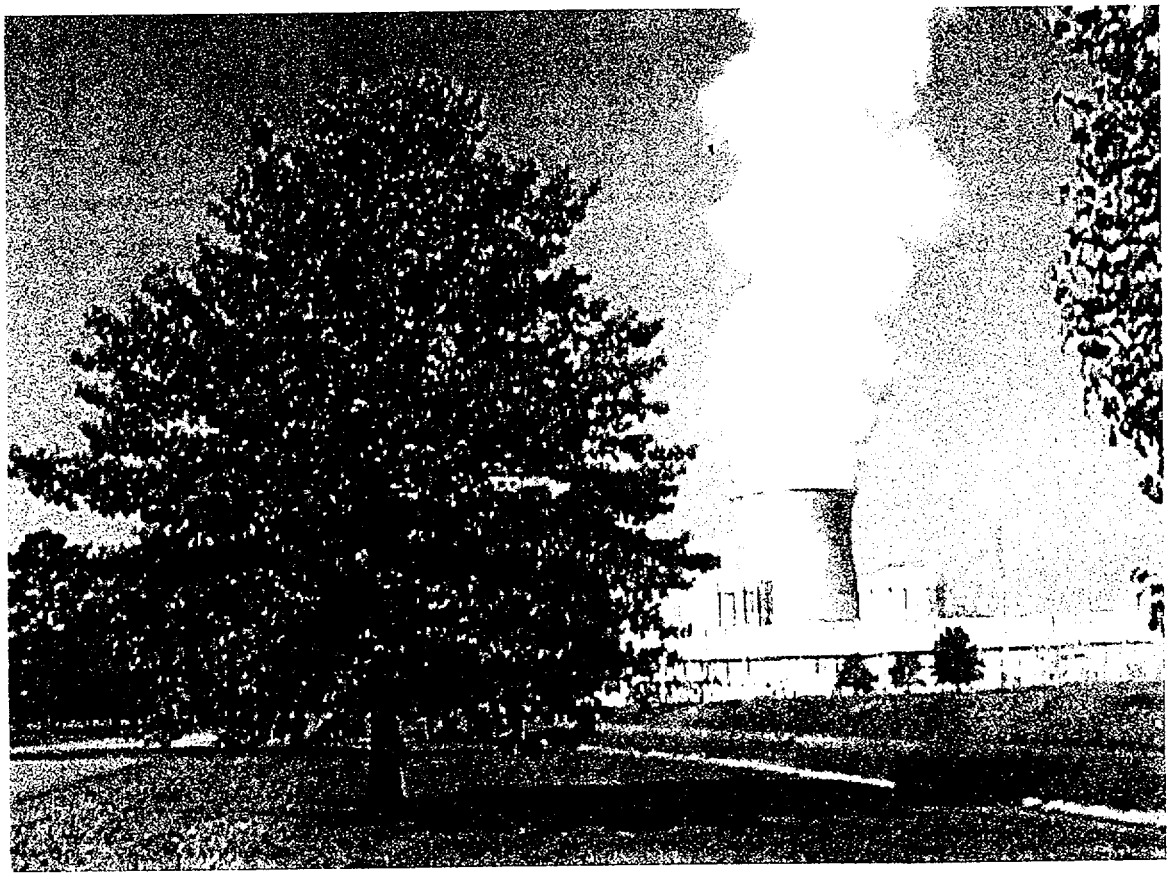
ARKANSAS NUCLEAR ONE
UNIT TWO

NRC Presentation on the Operational Assessment for the Remainder of Cycle 14

February 17th, 2000



ANO2 OPERATIONAL ASSESSMENT

- 2P99 Results
  - Inspection and Repair
  - In-Situ Testing
- Evaluation of R72L72
- Deterministic Operational Assessment

ANO2 OPERATIONAL ASSESSMENT

- Introduction
  - Previous operational assessment still valid based on 2P99 results
  - TTS examination confirmed original assumptions are still correct
  - Steam generator replacement outage September 2000 (2R14)
  - Operation until 2R14 is acceptable

ANO2 OPERATIONAL ASSESSMENT

- 2P99 Scope
  - 100 % bobbin from TEH to 07 Hot
  - 503 tube sample of TTS with MRPC
  - Rotated all bobbin indications
  - Used independent production and resolution analysts
    - Did not use resolution on lower eggcrate indications
  - Repaired all indications identified (210 tubes)

ANO2 OPERATIONAL ASSESSMENT

- 2P99 Results

	Indications	
	SGA	SGB
Eggcrate Axial	49	184
TTS Circ's	9	NA
Freespan Axial	5	0
Sludgepile Axial	2	0

ANO2 OPERATIONAL ASSESSMENT

- 3ΔP Value
  - Primary side design pressure (2250)
  - Secondary side design pressure (900)
  - Differential = 1350
  - 3ΔP = 3*1350 = 4050 (operating temperature)
  - Temperature correction (7.3%)

    = 4050/.927 = 4369 psi (room temperature)

ANO2 OPERATIONAL ASSESSMENT

- 2P99 In-Situ Test Results
  - Tested a total of 6 indications
    - All six met MSLB pressure with zero leakage
    - All six met 1.43 MSLB
    - Five met 4650 psi (3ΔP plus additional margin)
  - 1 flaw (R72L72) only taken to 4147 psi due to leakage in excess of pump capacity
    - Further analysis required to determine tube integrity

ANO2 OPERATIONAL ASSESSMENT

- Operational Assessment Strategy
  - Due to limited time frame - parallel paths
    - Deterministic
      - Evaluation of R72L72
    - Probabilistic/Risk Assessment

ANO2 OPERATIONAL ASSESSMENT

- 2P99 Condition Monitoring
  - Review of Tube R72L72 by Westinghouse
  - Leakage
    - Based on In-situ Testing - Zero Leakage @ MSLB
    - Based on Probabilistic Analysis - <0.01 gpm

Assessment of Burst Pressure for ANO-2 SG B, R72C72

NRC/Entergy Meeting
February 17, 2000

Prepared By:
T. A. Pitterle
R. F. Keating
Westinghouse Electric Company LLC

Assessment of Burst Pressure for ANO-2 R72C72

Objectives

- Assess post in situ test condition of R72C72 relative to complete or incomplete burst
  - Compare RPC response of R72C72 with responses for EDM notches, incomplete and complete bursts
- Estimate true burst pressure increase above R72C72 in situ pressure
  - Comparison of calculated pressures for burst and for ligament tearing
  - Comparisons of measured burst pressures for tests found to have incomplete and complete bursts

Burst Pressure Requirements

- $3\Delta P_{NO}$ freespan burst margin requirement
  - 4050 psi requirement at operating conditions based upon primary to secondary pressure differential of 1350 psi
- $3\Delta P_{NO} = 4369$ psi room temperature burst margin requirement
  - Based upon flow stress adjustment to room temperature
  - In situ test requirement

Definition of a Burst

R72C72 In Situ Test Results and RPC Response

In Situ Test Results

- 4147 psi maximum test pressure attained as limited by leakage capacity of test equipment
- Leak rate of 1.16 gpm at 4147 psi
  - Increased to > 4 gpm test system limit at next attempt to increase pressure
- Initial leakage at 3737 psi and leakage of 0.02 gpm measured at 3774 psi

Post In Situ RPC Response

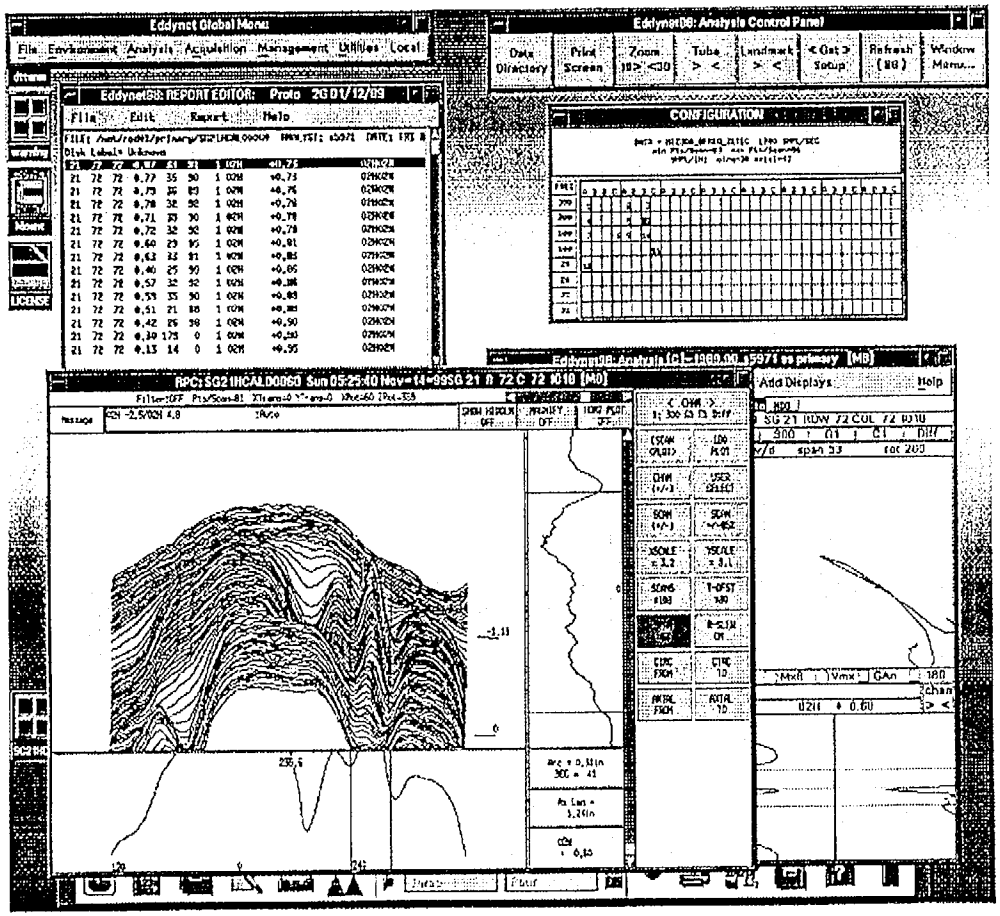
- Post in situ response characterized by uniform axial width, angular response wider than pre in situ, 'dips' in direction of probe rotation
- Response typical of crack opening compared to pre in situ, but without features of a burst indication

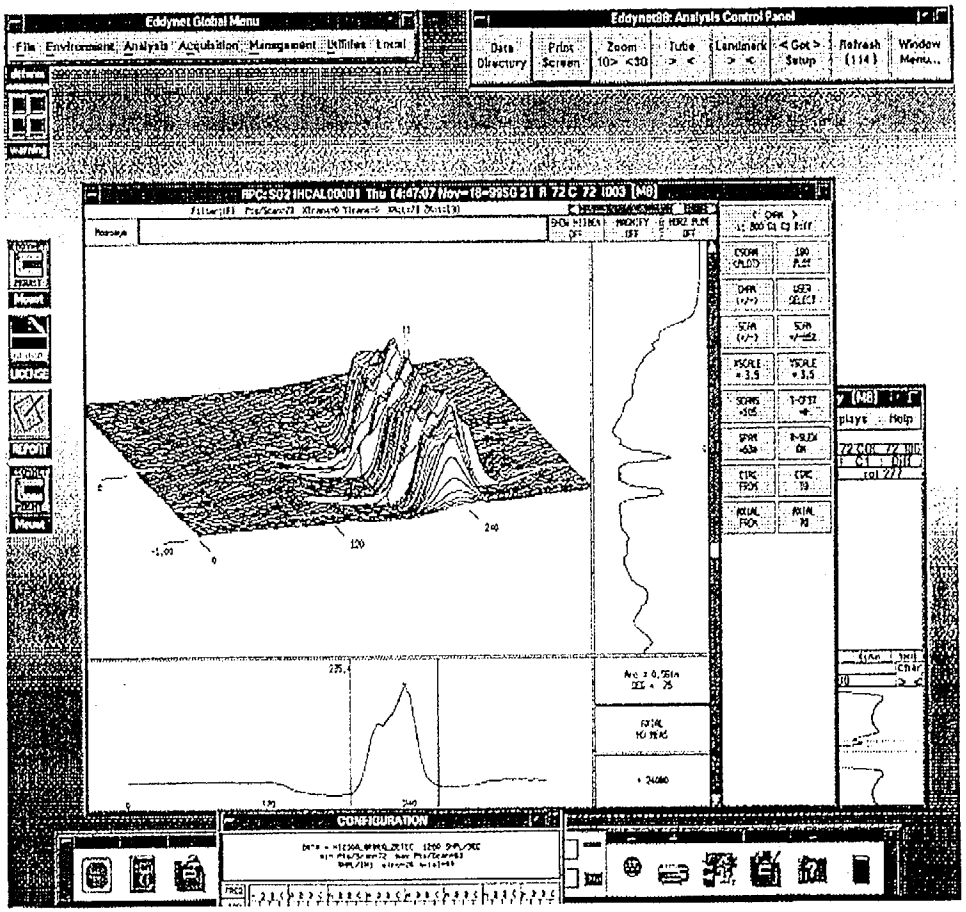
115 Pancake Coil Sizing

- Pre in situ (2 analyses): 1.24" to 1.42", 93% max. depth, 73% to 80% avg. depth, 0.72" to 0.9" deep segment with about 85% avg. depth
- Post in situ (1 analysis): 1.49" long, throughwall, about 95% avg. depth
  - Crack potentially opened over pre in situ detectable length

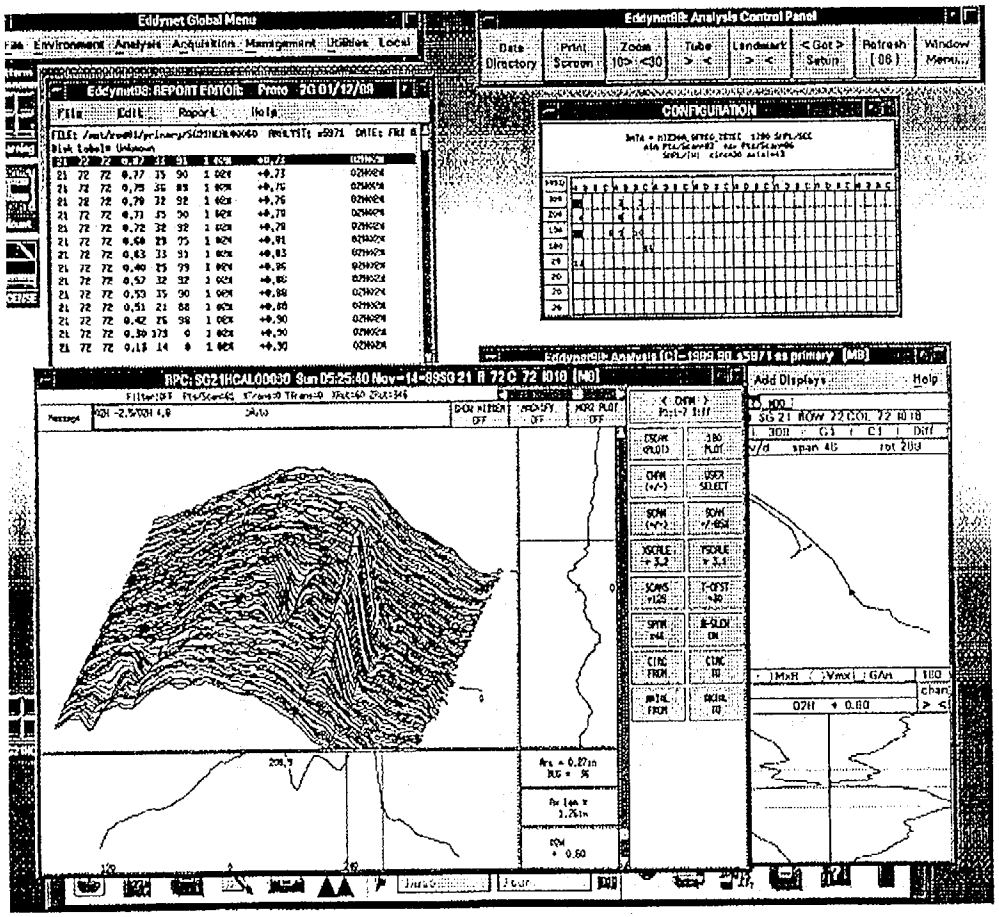
In Situ Test Results for SG B, R72C72 at 2P99 Outage	
Test Pressure (psi)	**Test Results**
1568	No leakage for 2 minute hold time. Simulates normal operating pressure differential.
2232	No leakage for a 2-minute hold time.
2882	No leakage for a 2 minute hold time. Simulates MSLB pressure differential.
3737	Leakage detected
3774	Leakage = 0.02 gpm measured over 5 minute interval.
3971	Step increases in leakage with associated test pressure drop.
3573	Leakage = 0.56 gpm
4132	Leakage = 0.92 gpm
4147	Leakage = 1.16 gpm. Maximum test pressure obtained as corrected for test equipment pressure drop due to leakage flow and for instrument error.

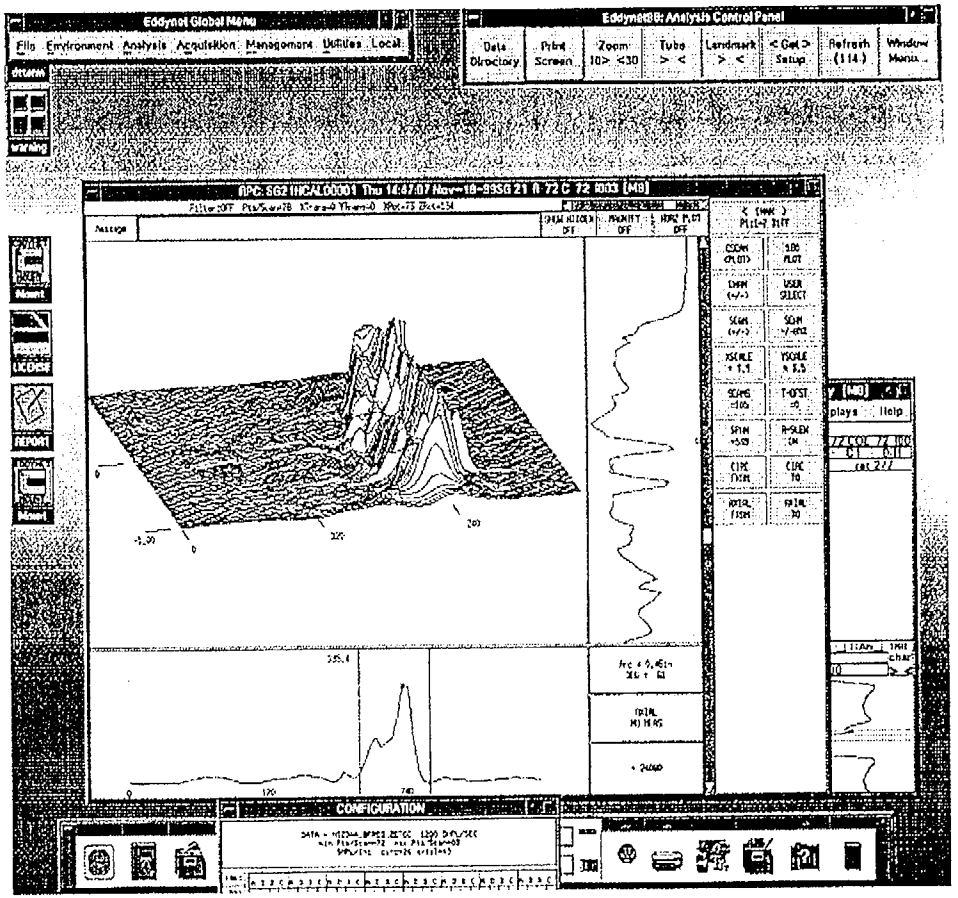
ANO-2 R72C72 Pre and Post In Situ 115 Pancake Coil 300 kHz Response



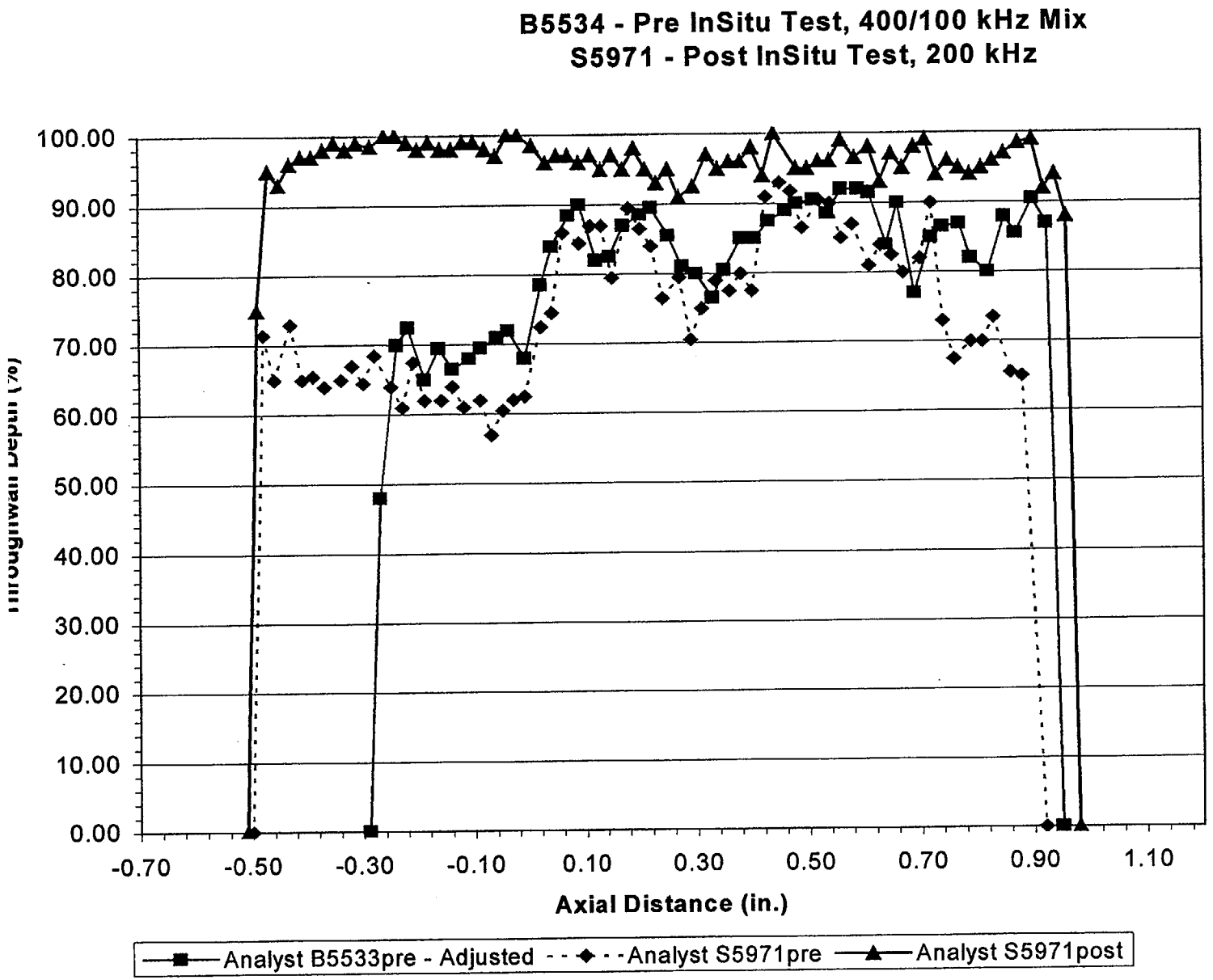


ANO-2 R72C72 Pre and Post In Situ 115 Pancake Coil 300/100 kHz Mix Response





ANO-2 R72C72 Pre and Post In Situ Depth Profiles



	Adjusted Pre B5534	Pre S5971	Post S5971
Length	1.24	1.42	1.49
Max. Volts	0.99	0.92	21.64
Max. Depth (%)	92.0	93.0	100.0
Avg. Depth (%)	79.9	73.1	95.0

Comparisons of R72C72 RPC Responses With EDM Notches and Burst Specimens

Comparison of R72C72 with TW EDM Notch RPC Responses

- TW EDM notch response shows slight 'dips" in direction of rotation, uniform angular response of about 51°
- R72C72 response shows larger 'dips" and uniform angular response of about 61° (increase from about 36° before in situ)

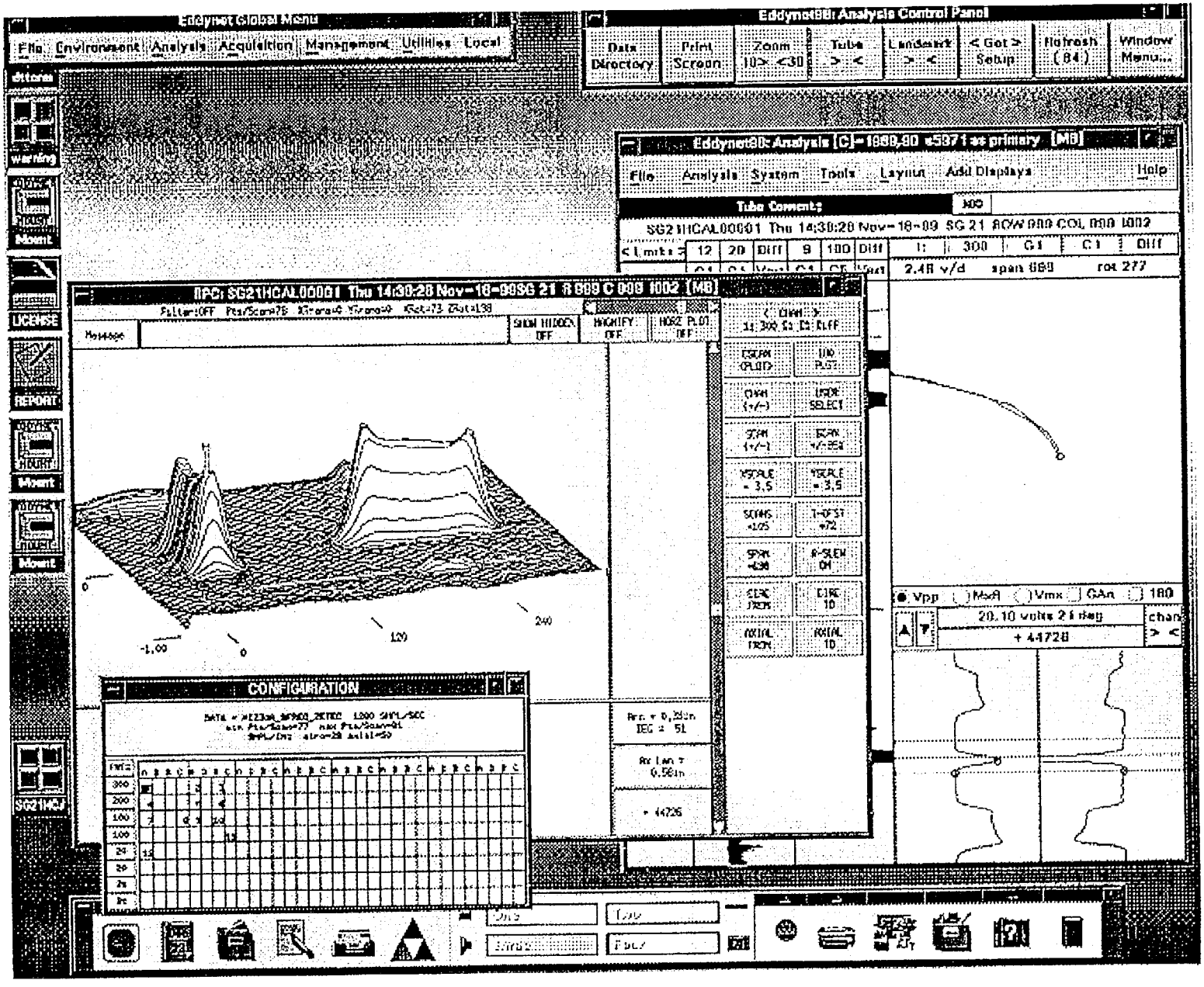
RPC Response of ANO-2 1996 R16C60 Post In Situ

- Complete burst obvious from RPC response - wide opening, flat response across gap, 'dips' at ends of crack (closely spaced crack faces)

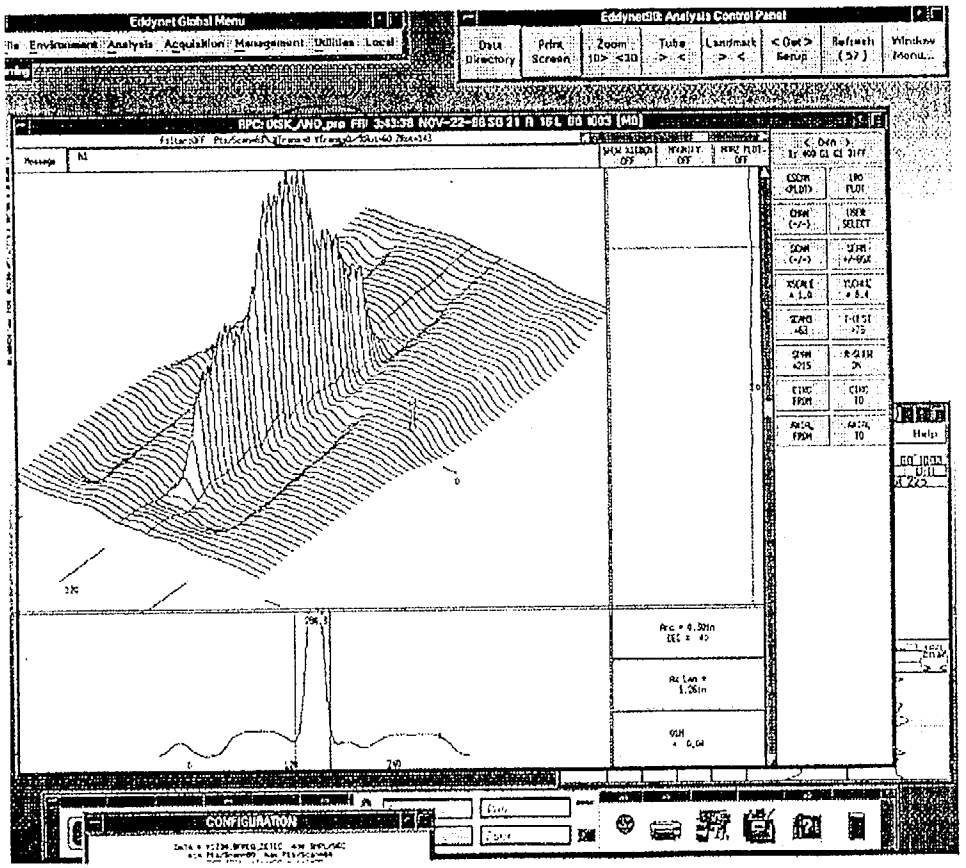
RPC Responses of Incomplete and Complete Bursts

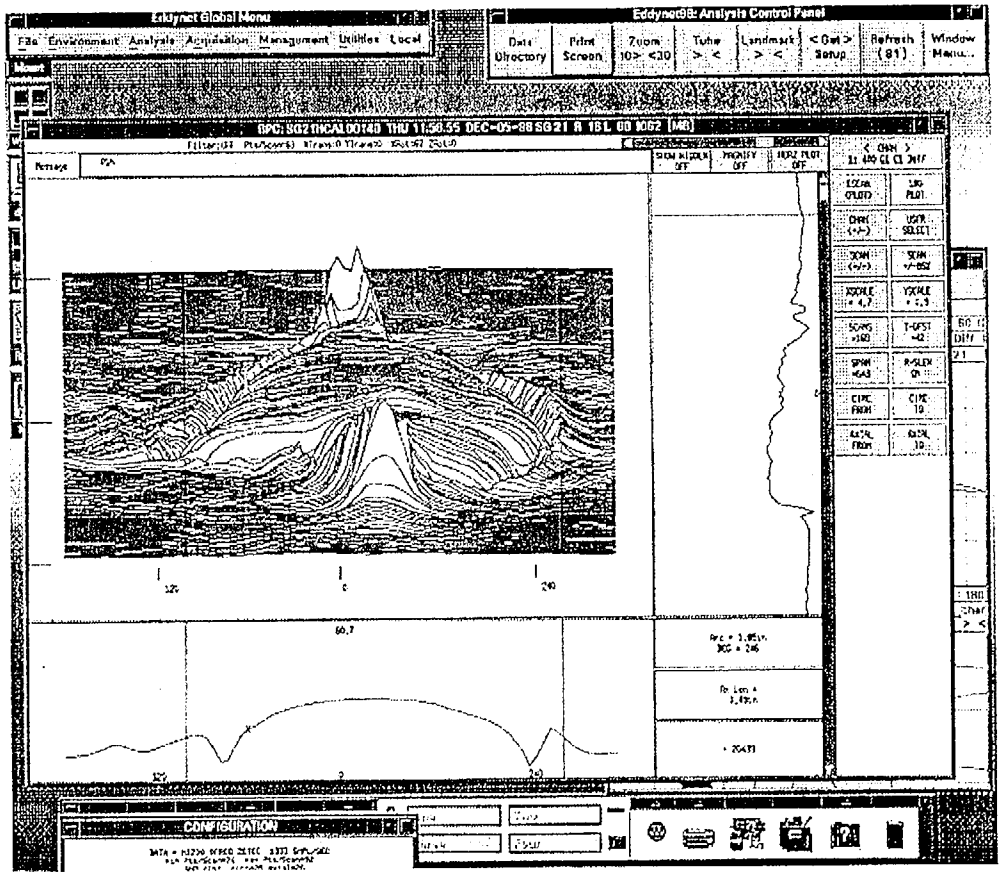
- Specimens taped to force coil on uniform ID to obtain responses typical of axially non-uniform EDM notches of varying width
  - 115 pancake coil responses show increased separation at center of crack, flat response across gap, 'dips' at ends of crack
- Specimens without tape to ride surface of opened crack flanks
  - 115 pancake coil responses very similar to that for R16C60
- RPC responses of incomplete bursts same as complete bursts except for extent of crack opening

Throughwall Slot 115 Pancake Coil 300 kHz Response

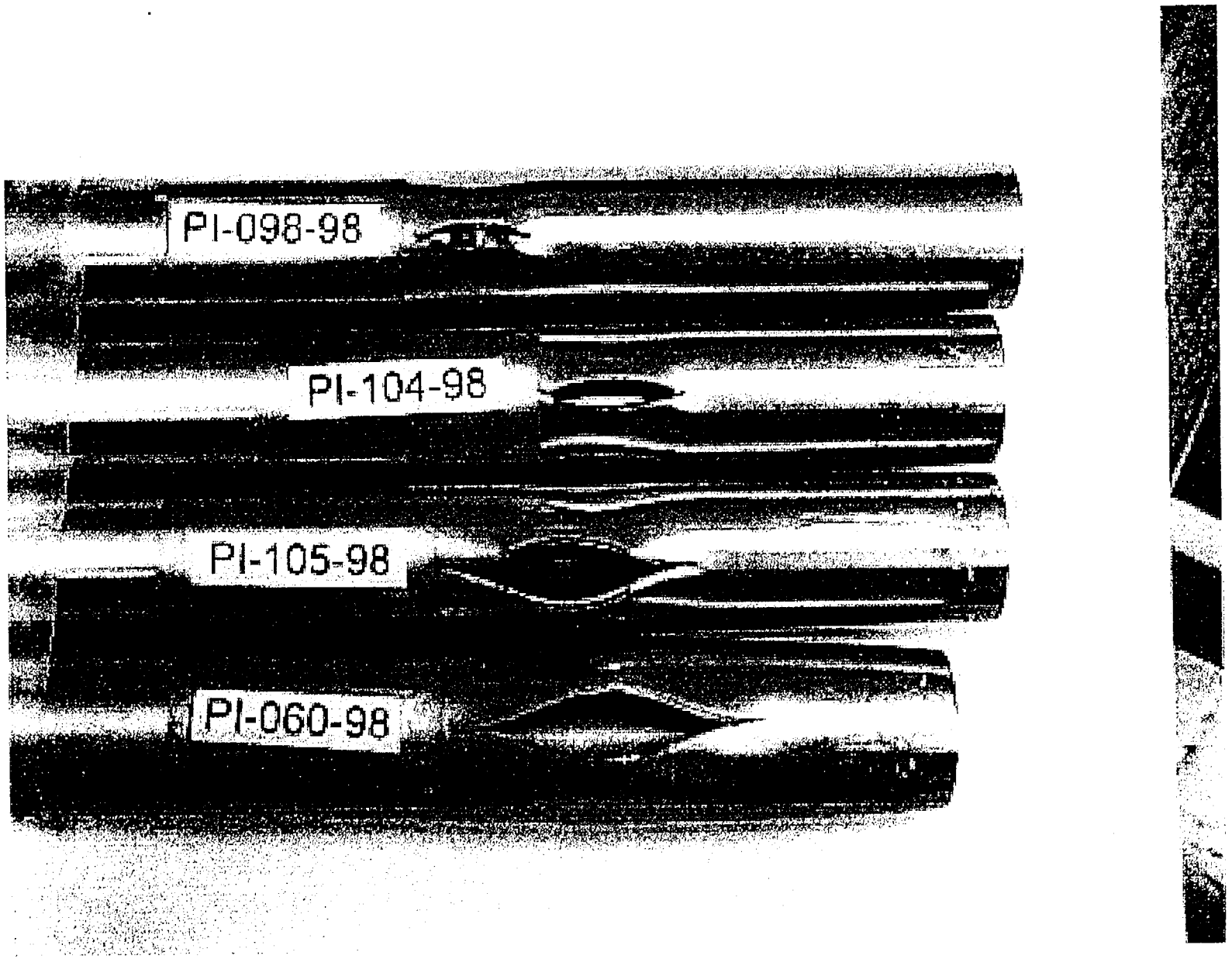


ANO-2 R16C60 1996 Pre and Post In Situ 115 Pancake Coil 400 kHz Response

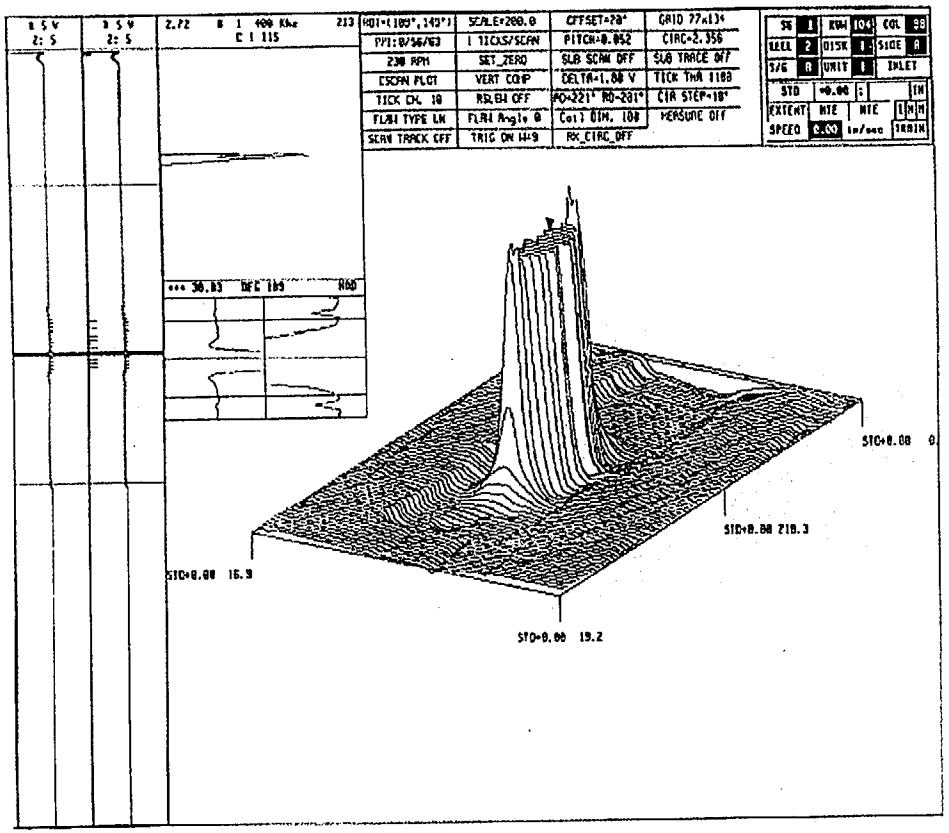


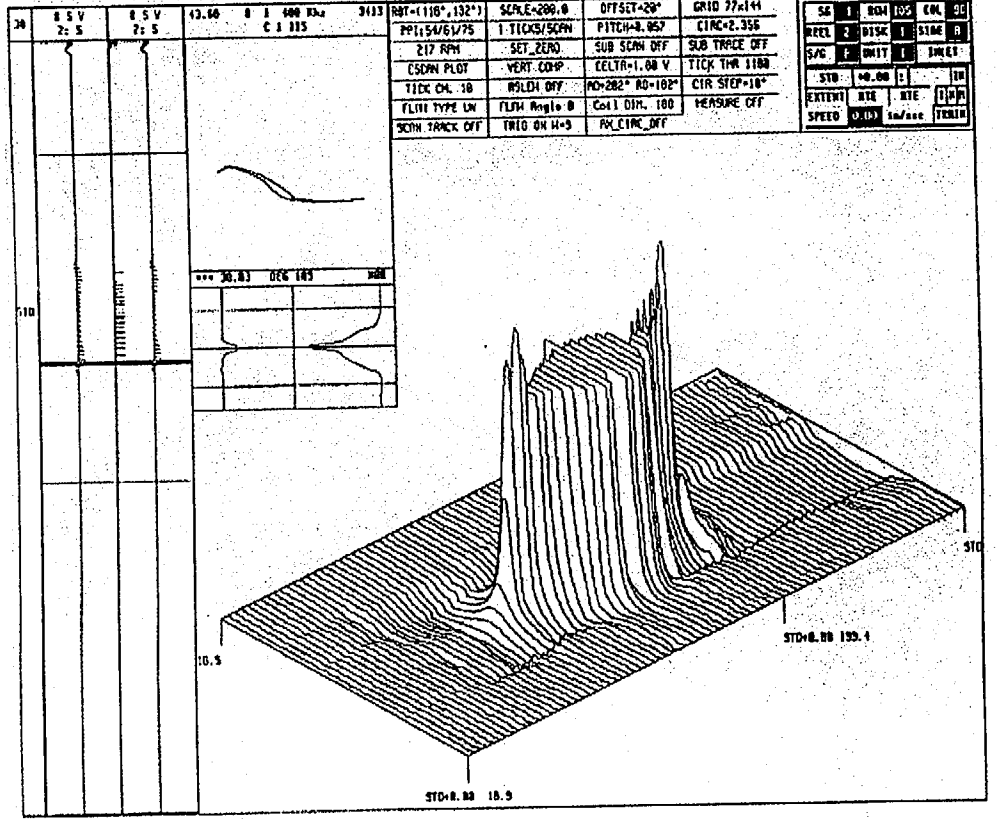


Post Burst Test Photo of Four Burst Openings with Varying Length and Width

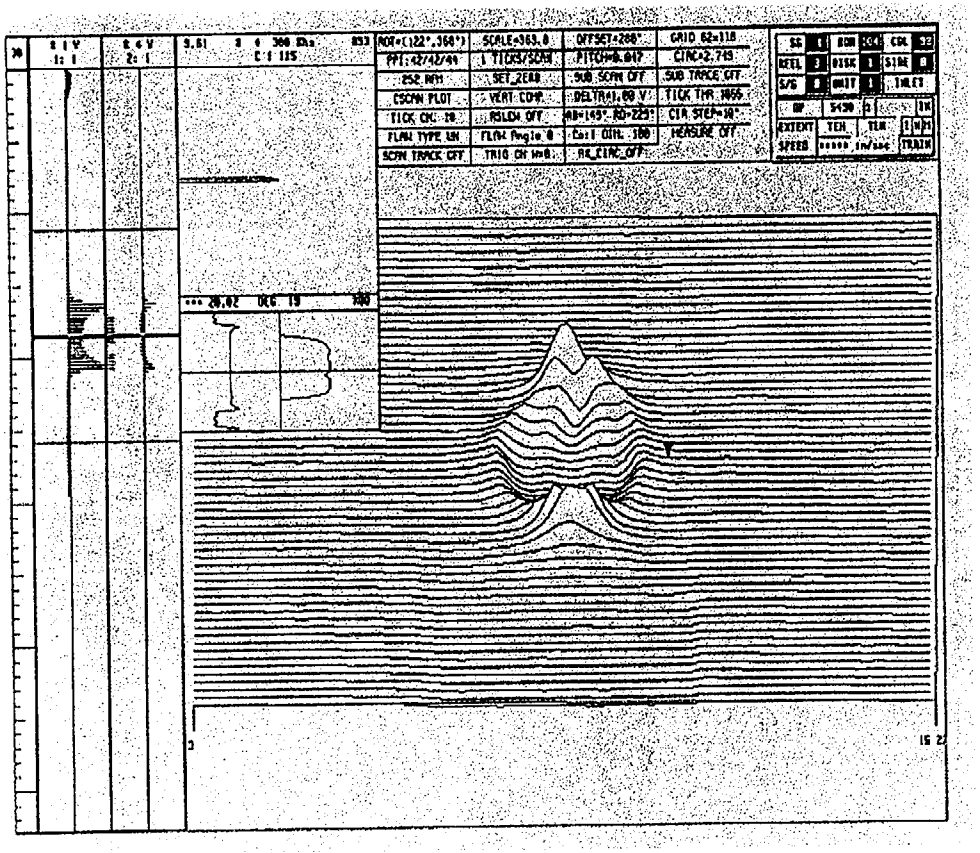


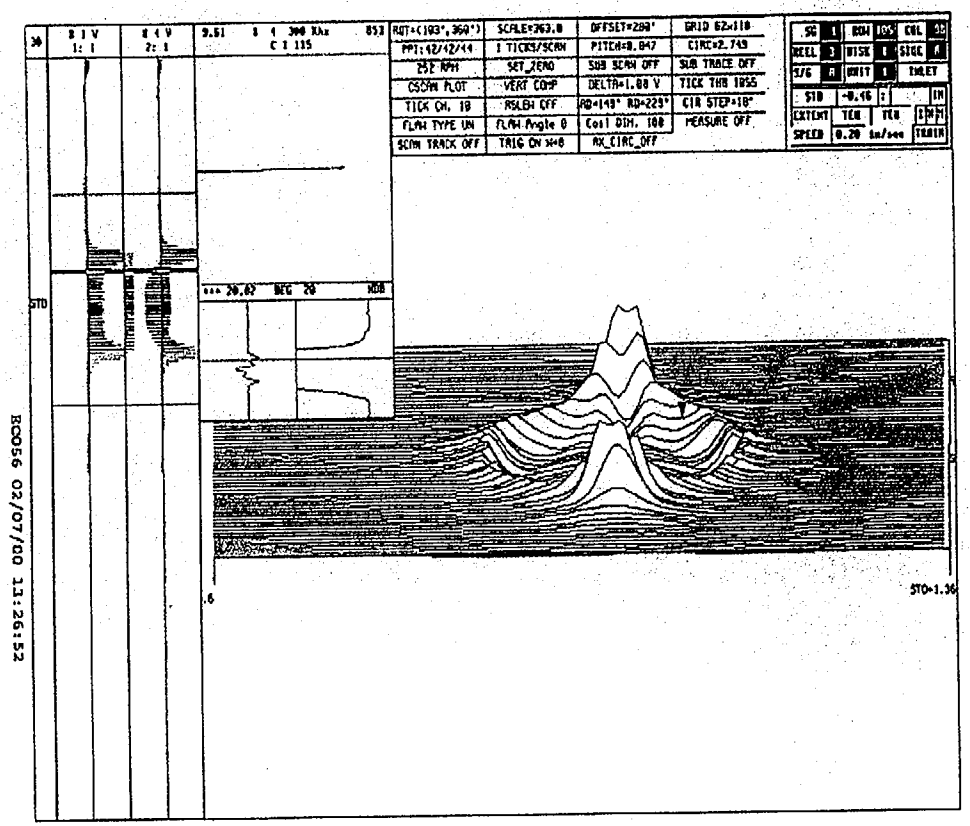
Specimens PI-104-98 and PI-105-98 Post Burst Test 115 Pancake Coil Response (Taped Opening)





Specimens PI-104-98 and PI-105-98 Post Burst Test
115 Pancake Coil 300 kHz Response





Conclusions on Post Test Condition of R72C72

In situ test pressure of 4147 psi for R72C72 does not represent a burst and the true burst pressure would exceed the test pressure

- Crack opening much less than expected for a burst

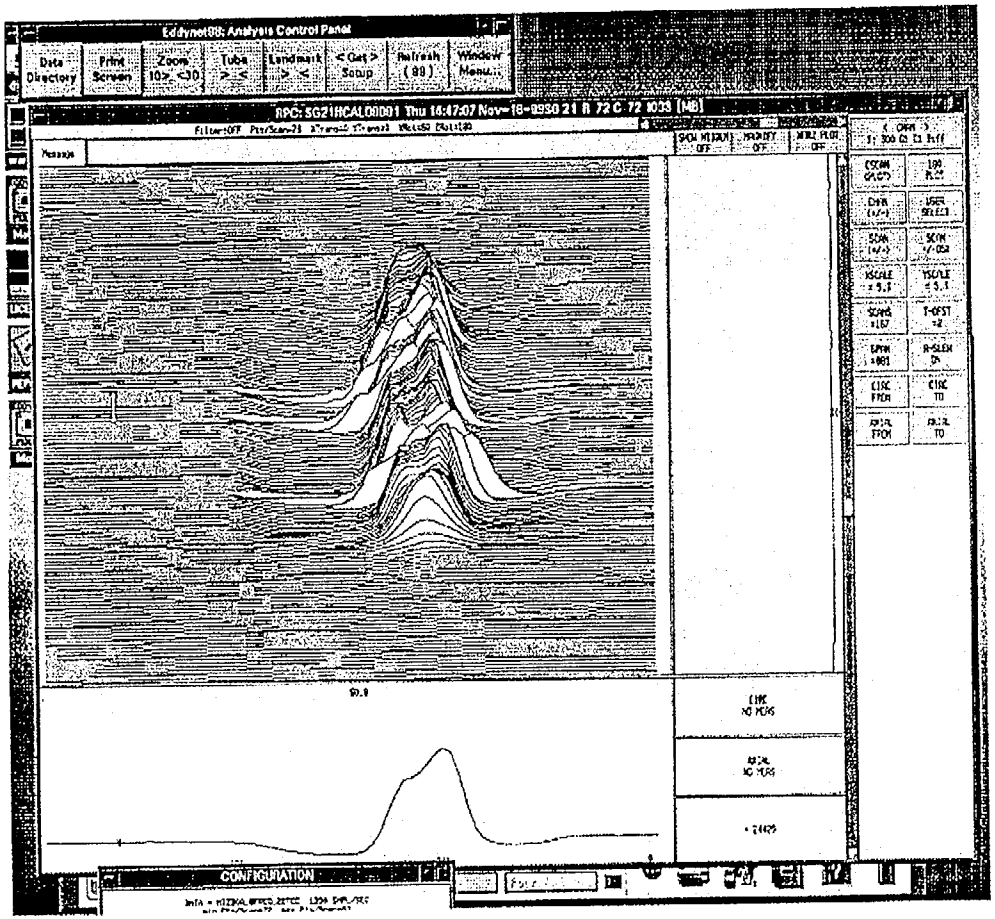
RPC response for a burst characterized by:

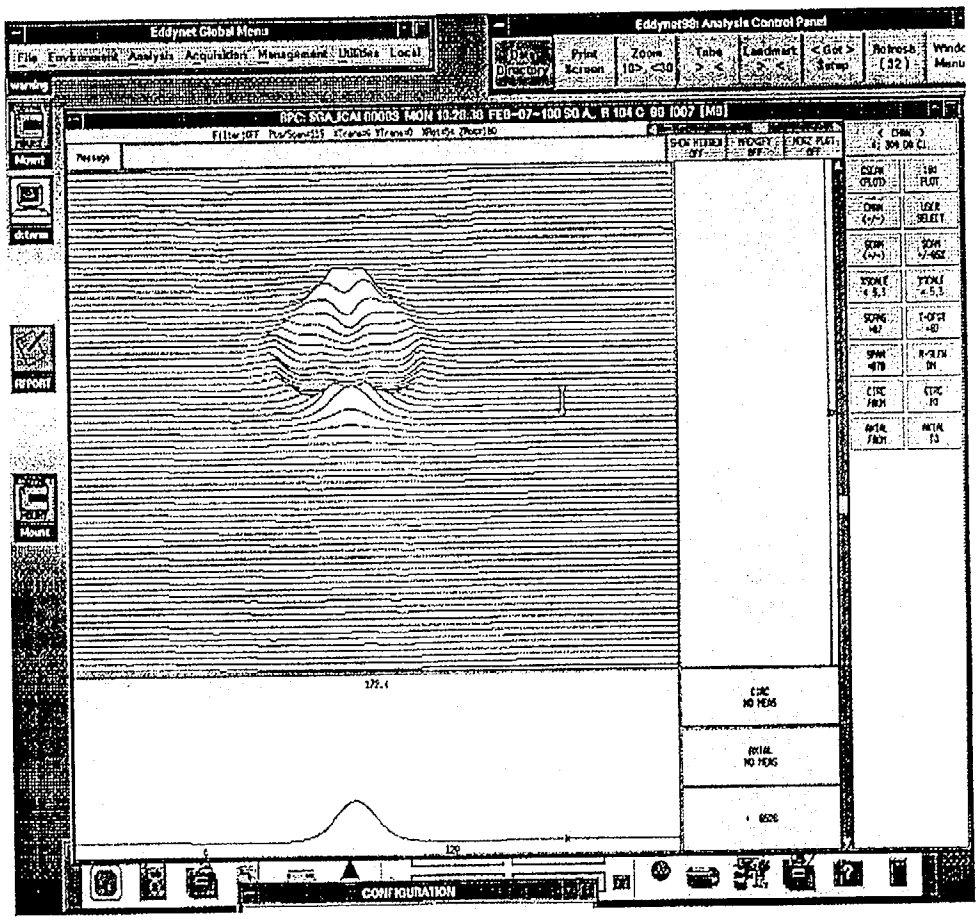
- Flat voltage response over widest part of the opening
- Dips in the response at the ends of the opening (closer crack faces)
  - Only burst characteristic seen for R72C72 response
- Varying angular response from end to end of the opening
- Largest angular response at center of the fish mouth burst opening

Post in situ condition for R72C72

- Equivalent to tearing of remaining wall thickness ligament to permit significant leakage but without crack extension required for a burst
  - Common test result in performing burst tests without a bladder
- Typical of condition predicted by ligament tearing models as contrasted to models for predicting burst pressure

Comparison of R72C72 and Specimen PI-104-98 Pancake Coil Responses with EDDYNET95 and Same Scale Settings





Time History Review of R72C72 In Situ Test

Pressurization rates constant for first 5 step increases up to about 4025 psi

- Indicates no likely deformation of crack faces

Next 2 steps to 4147 psi show slightly smaller pressurization rates than previous rates

- Implies some deformation of flanks of crack with tearing of ligaments to increase the leak rate
- Leak rate increased to 1 gpm at next to last step and exceeded system capacity of about 4 gpm after last step

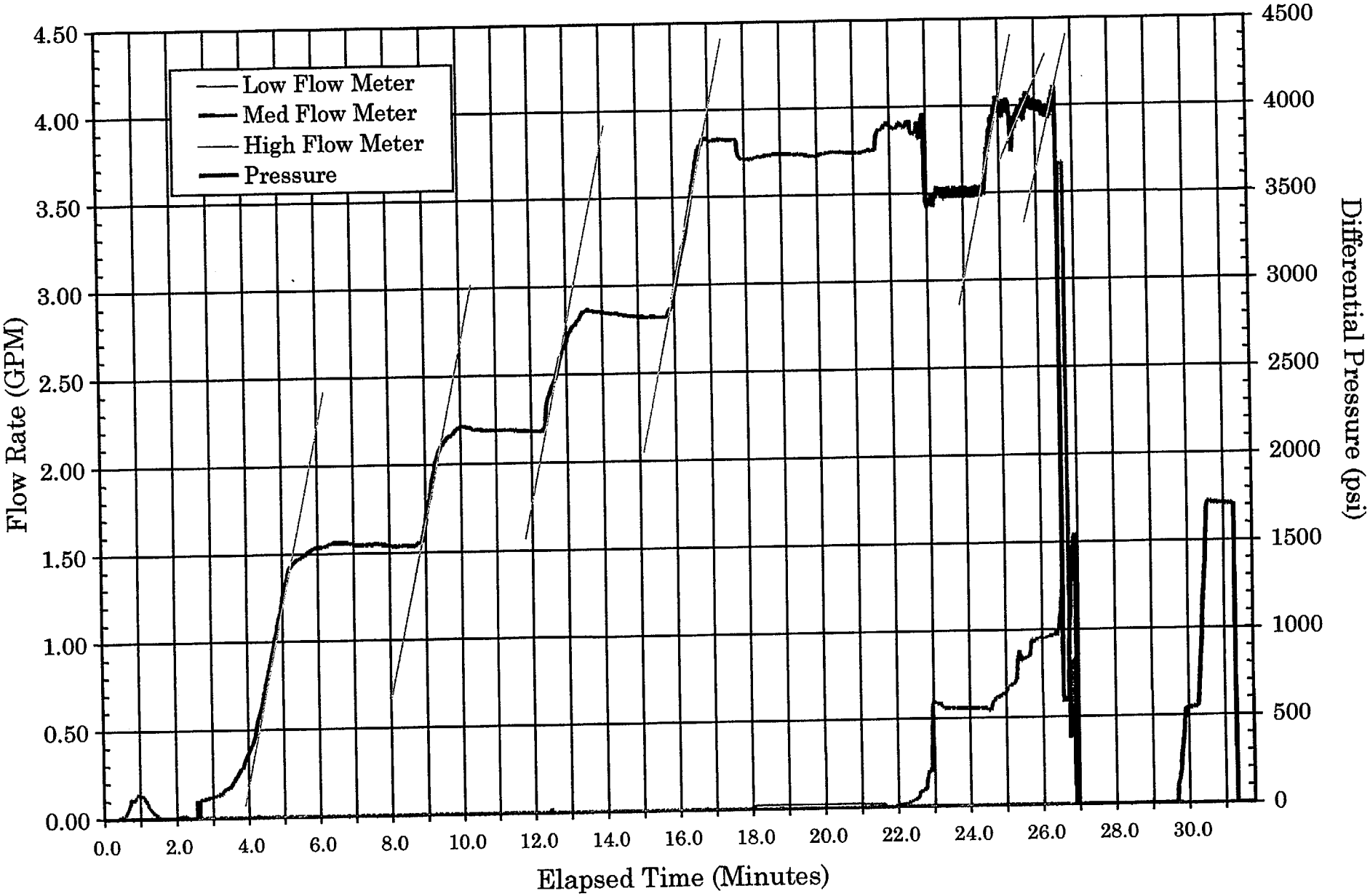
Time values of test history adjusted to uniformly increasing pressure as a function of time

- Pressure time history remained linear until final surge in leak rate

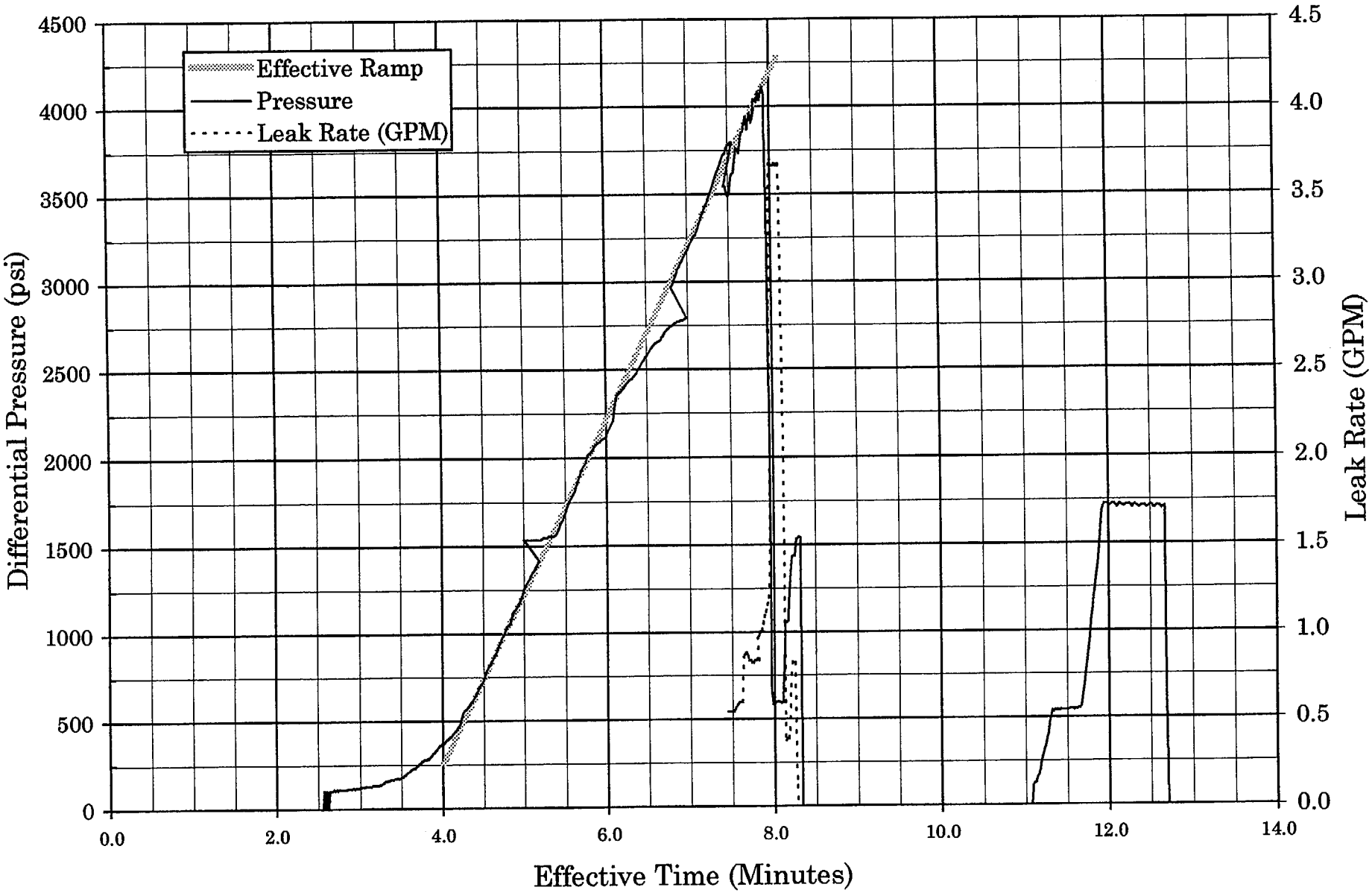
Conclusions

- Time history supports test termination at point of ligament tearing similar to conclusion from review of RPC data
- True burst pressure cannot be estimated from time history data

ANO2 R72C72 In Situ Leak Test
Leak Rate & Pressure Time History



ANO2 R72C72 In Situ Leak Test
Effective Pressure Time History



Increase in Burst Pressure Above Onset of Leakage

Evaluation based upon ligament tearing and burst pressure models

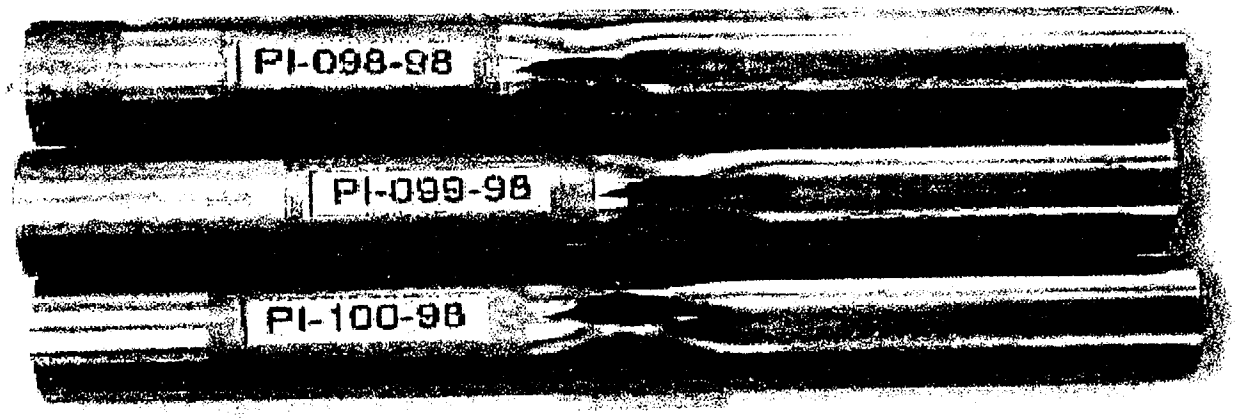
- Objective to predict pressure difference required between ligament tearing and burst
- Westinghouse burst model and ANL ligament tearing model applied to NDE profile
  - Flow stress for R72C72 not known and 80 ksi assumed similar to prior ANO pulled tubes with similar row material properties as row 72
- Predicted burst pressure of 4311 psi and ligament tearing pressure of 3752 for a pressure difference of 559 psi for correction to R72C72 in situ test pressure
  - Pressure difference of 519 psi for second NDE profile

Evaluation based on pressure differences between complete and incomplete burst tests

- 80% deep EDM notches - three 0.7" long and three 0.5" long with closely controlled notch tolerances
- Differences of 400 to 600 psi between 0.7" specimen #104 with incomplete burst and specimens #105 and #106 with complete burst
  - Supports analytical prediction of about 500 psi for pressure difference
  - RPC response shows specimen #104 crack more open than R72C72
- Shorter 0.5" specimens show larger pressure differences between incomplete and complete bursts

Photo of Burst Test Openings for Incomplete and Complete Bursts

EDM Notch - 0.50 Lg x 80% Deep

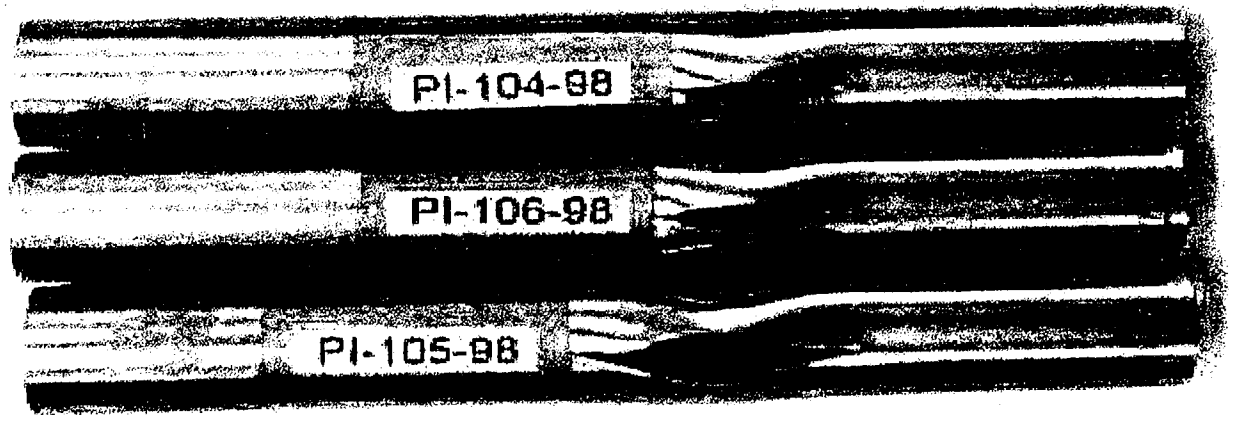


4200 psi

5400 psi

6200 psi

EDM Notch - 0.70 Lg x 80% Deep



3600 psi

4000 psi

4200 psi

Burst Pressure Differences Between Incomplete and Complete Bursts				
Specimen	**EDM Notch**	**Test Pressure (psi)**	**Burst Characterization**	**Comments**
PI-104-98	0.7" by 80% deep	3600	Incomplete Burst	Supports difference of 400 to 600 psi between incomplete and complete burst for flaw size comparable to that of the deeper part of R72C72
PI-105-98	0.7" by 80% deep	4200	Complete Burst	
PI-106-98	0.7" by 80% deep	4000	Complete Burst	
PI-98-98	0.5" by 80% deep	4200	Incomplete Burst	Indicates larger pressure differences between complete and incomplete burst for flaws shorter than R72C72
PI-99-98	0.5" by 80% deep	5400	Complete Burst	
PI-100-98	0.5" by 80% deep	6200	Complete Burst	

Overall Conclusions on Burst Pressure of R72C72

Estimated burst pressure for R72C72 of about 4650 psi exceeds room temperature $3\Delta P_{NO}$ burst margin requirement of 4369 psi

- In situ test pressure of 4147 psi increased by about 500 psi for limited crack opening resulting from test
- Correction of about 500 psi supported by difference between burst and ligament tearing models as well as difference between incomplete and complete burst test results

R72C72 post in situ test condition equivalent to that following tearing of wall thickness ligament, but without crack width and extension required for a burst

- Correction to a true burst can be estimated as calculated difference between burst and ligament tearing pressures

RPC responses can readily determine difference between limited crack opening of R72C72 and an incomplete or complete burst

- Differences between incomplete and complete burst are more difficult to determine by RPC since differences are only extent of crack opening

ANO2 OPERATIONAL ASSESSMENT

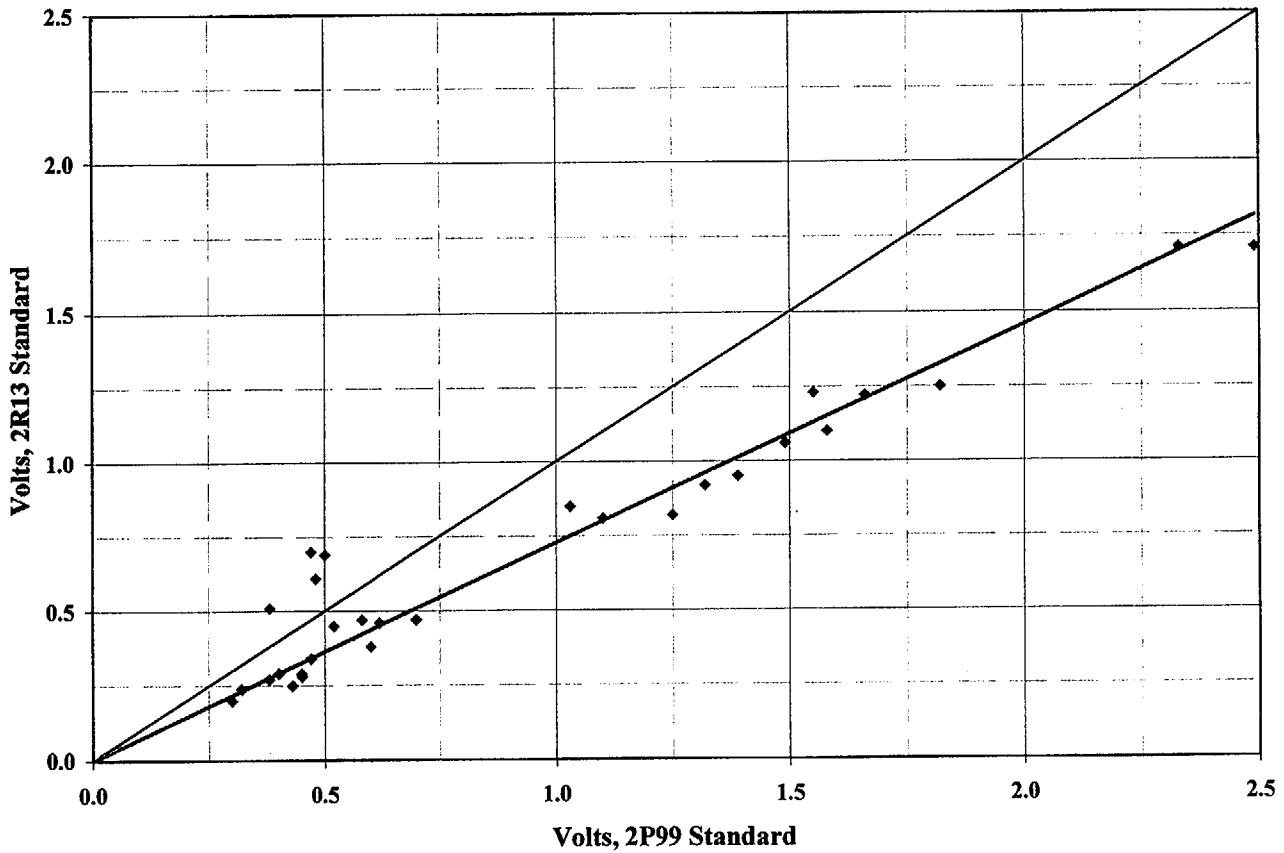
- Probability of Detection (POD)
  - Performed Site Specific Performance Demonstration (SSPD) Testing following 2R13
  - POD curves developed and used following 2R13 and 2P99

ANO2 OPERATIONAL ASSESSMENT

- Improvements to POD
  - Training of the analysts
  - Localized testing
  - New calibration standards

ANO2 OPERATIONAL ASSESSMENT

- Effect of the calibration standard



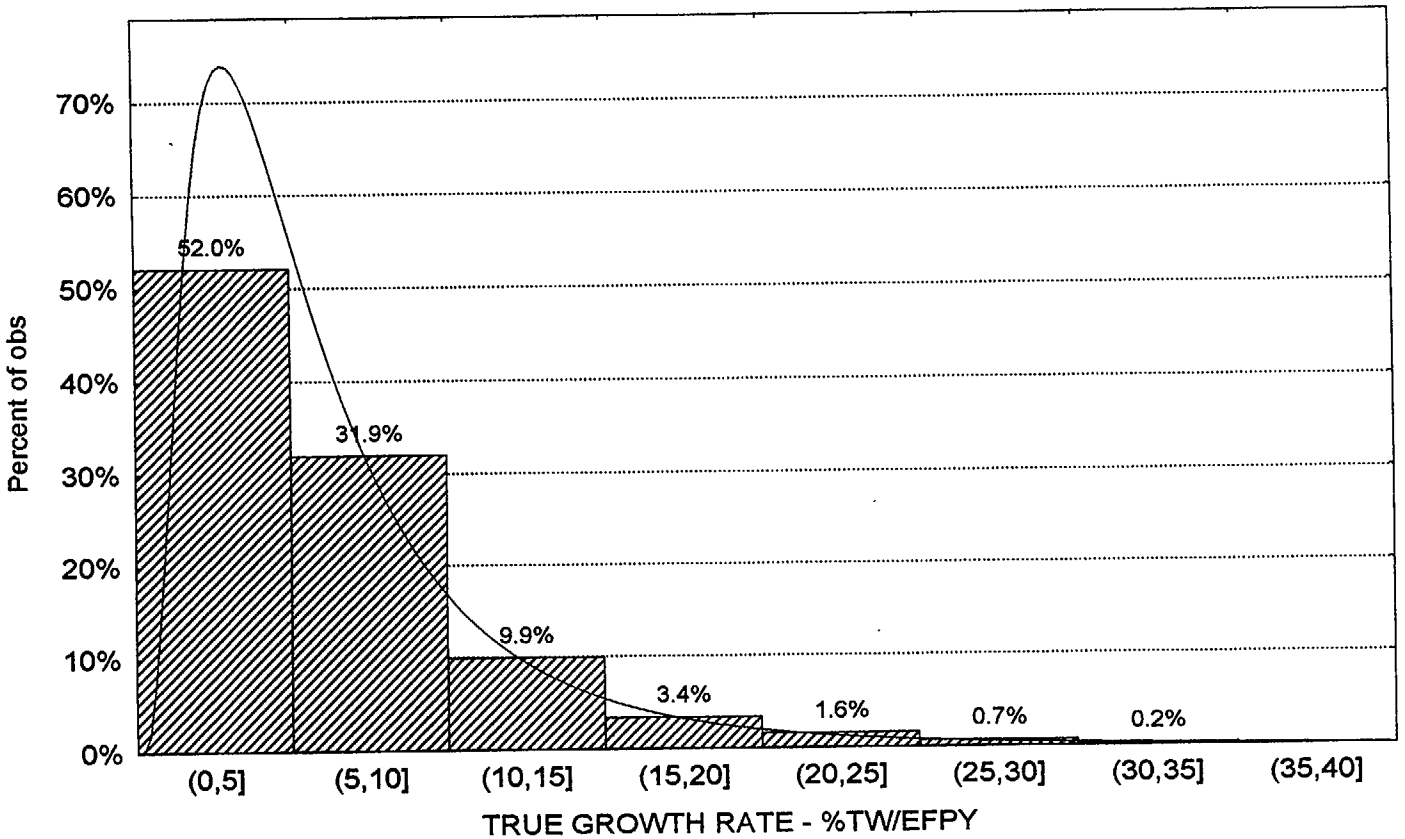
ANO2 OPERATIONAL ASSESSMENT

- Growth Rate
  - First performed during 1996-1997 era
  - Repeated study using 1998-1999 data
  - Results are consistent with those used in the past and other CE Plants

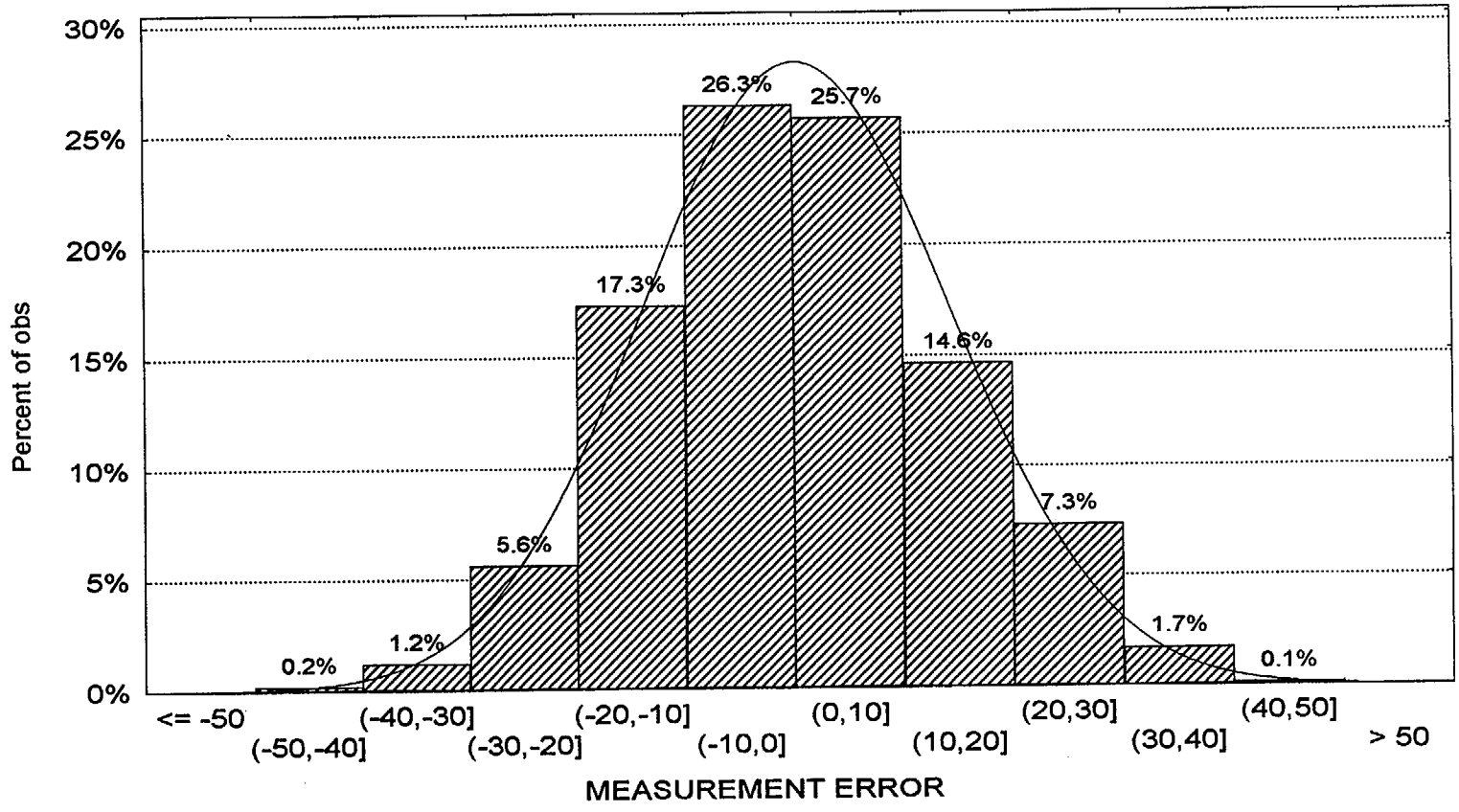
ANO2 OPERATIONAL ASSESSMENT

- Observed growth rates consist of:
  - Measurement errors
  - Underlying true growth rates
- Probabilistic extraction process required for realistic assessment

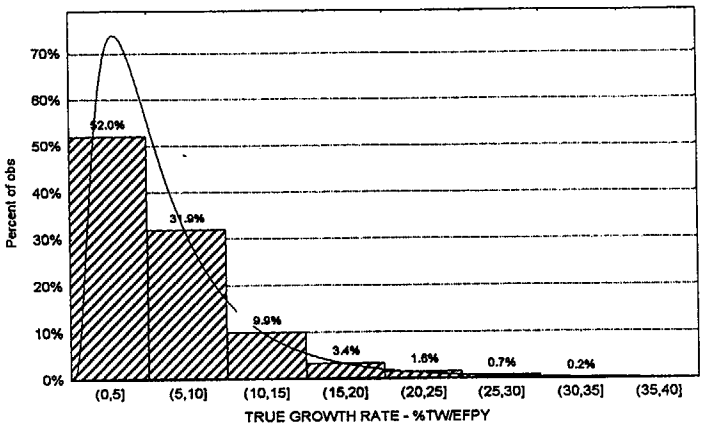
ANO2 OPERATIONAL ASSESSMENT

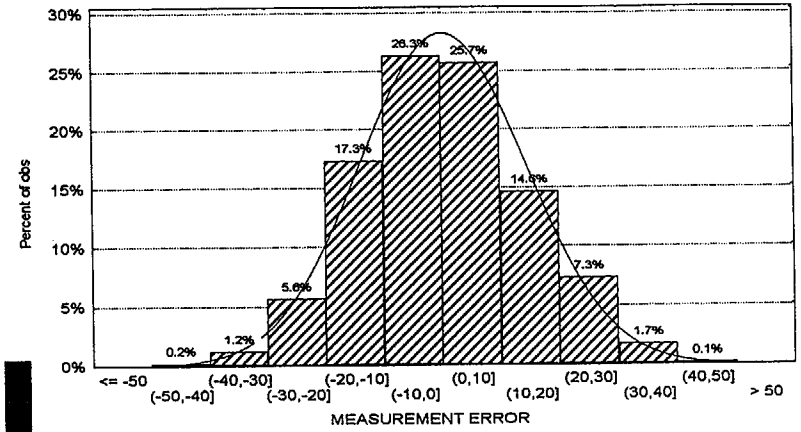


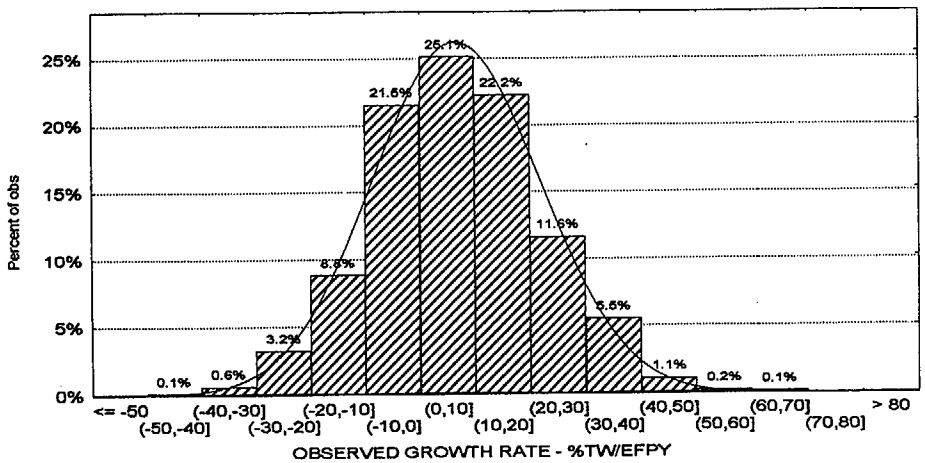
ANO2 OPERATIONAL ASSESSMENT



ANO2 OPERATIONAL ASSESSMENT

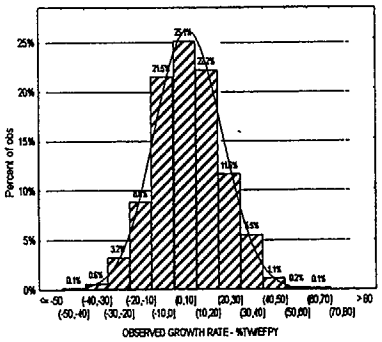






ANO2 OPERATIONAL ASSESSMENT

NONLINEAR OPTIMIZATION



SAMPLE FROM OBSERVED DISTRIBUTION

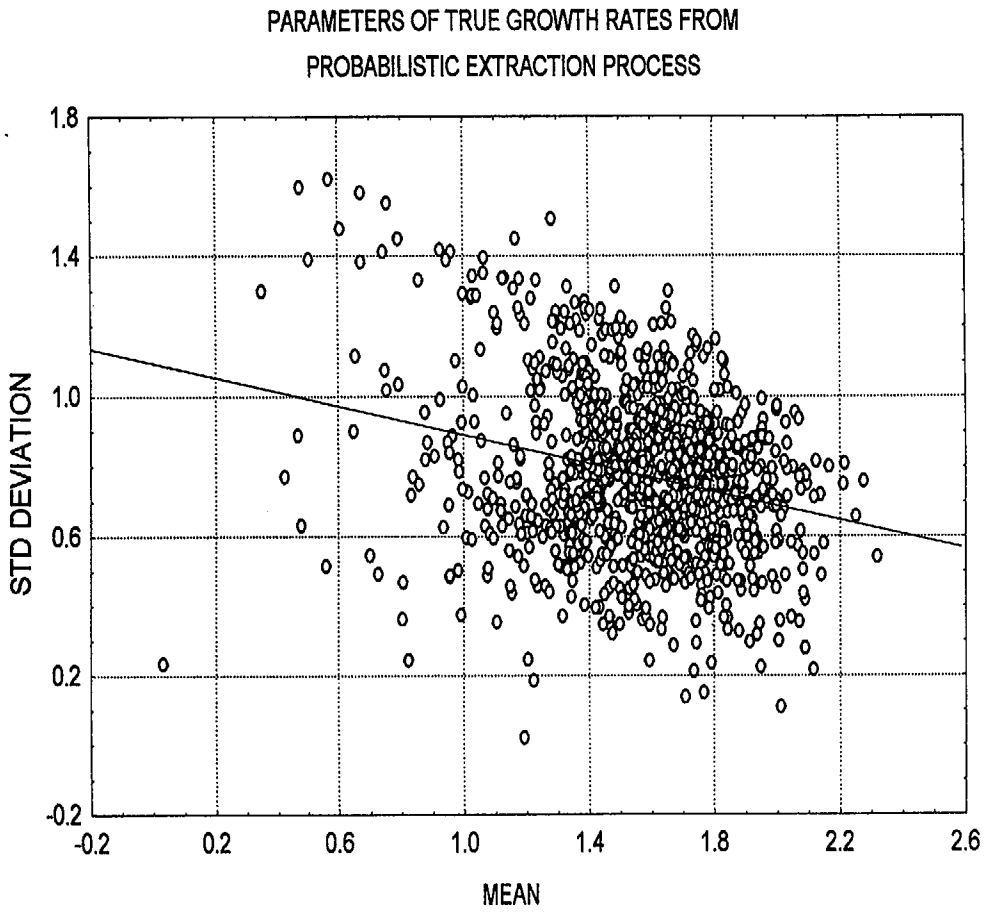
ESTIMATE PARAMETERS FOR:
1 ERROR DISTRIBUTION
2 TRUE GROWTH RATE

SAVE PARAMETER SET:
XBAR,
SIGMA

REPEAT PROCESS

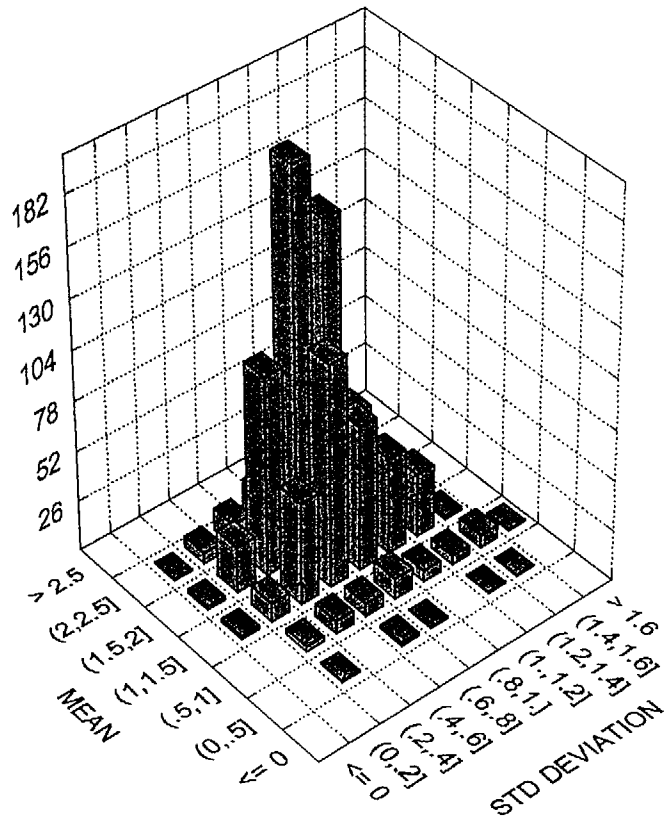
OUTPUT:
GROWTH RATE PARAMETER SETS FOR SIMULATON PROCESS

ANO2 OPERATIONAL ASSESSMENT

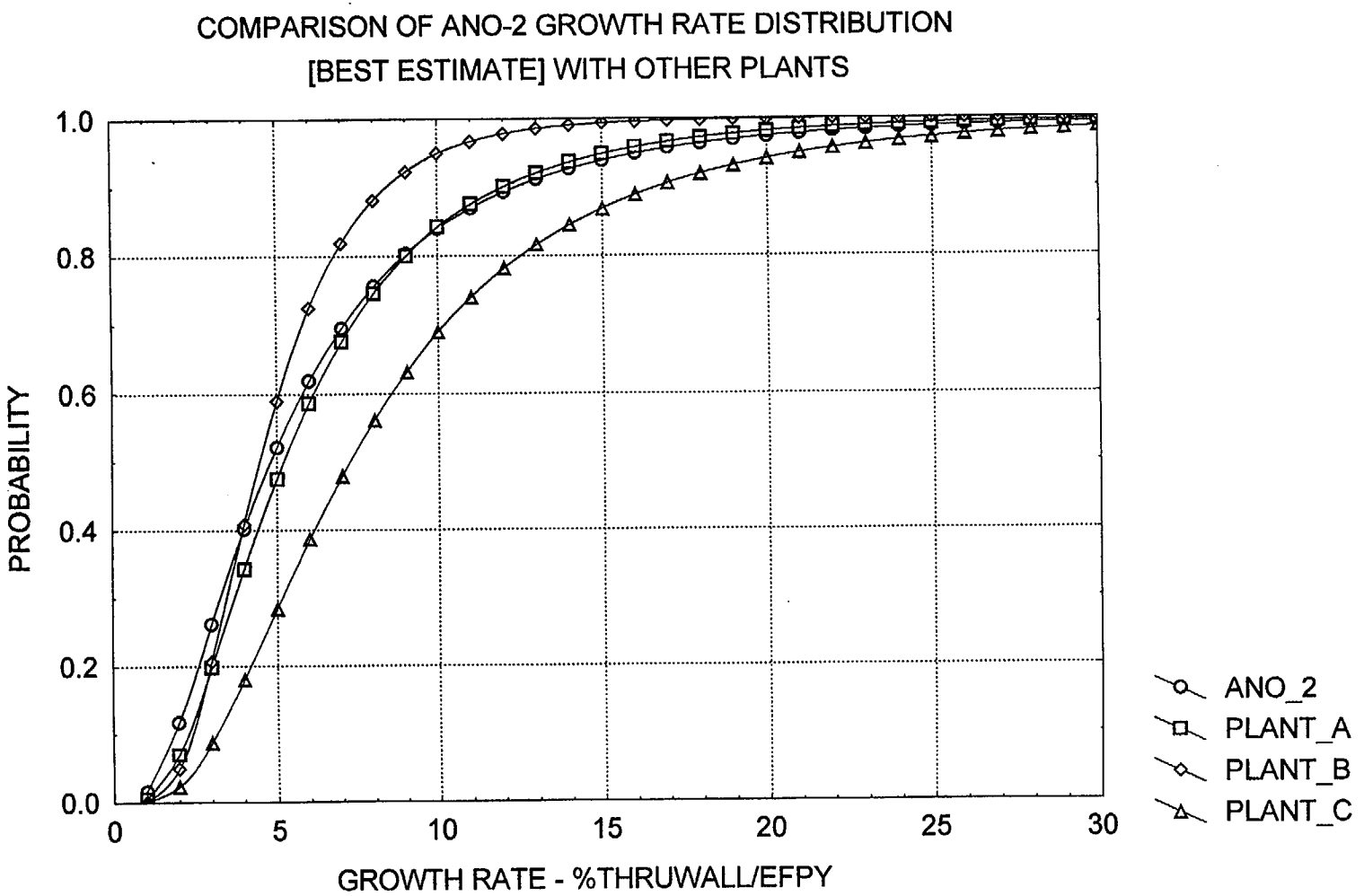


ANO2 OPERATIONAL ASSESSMENT

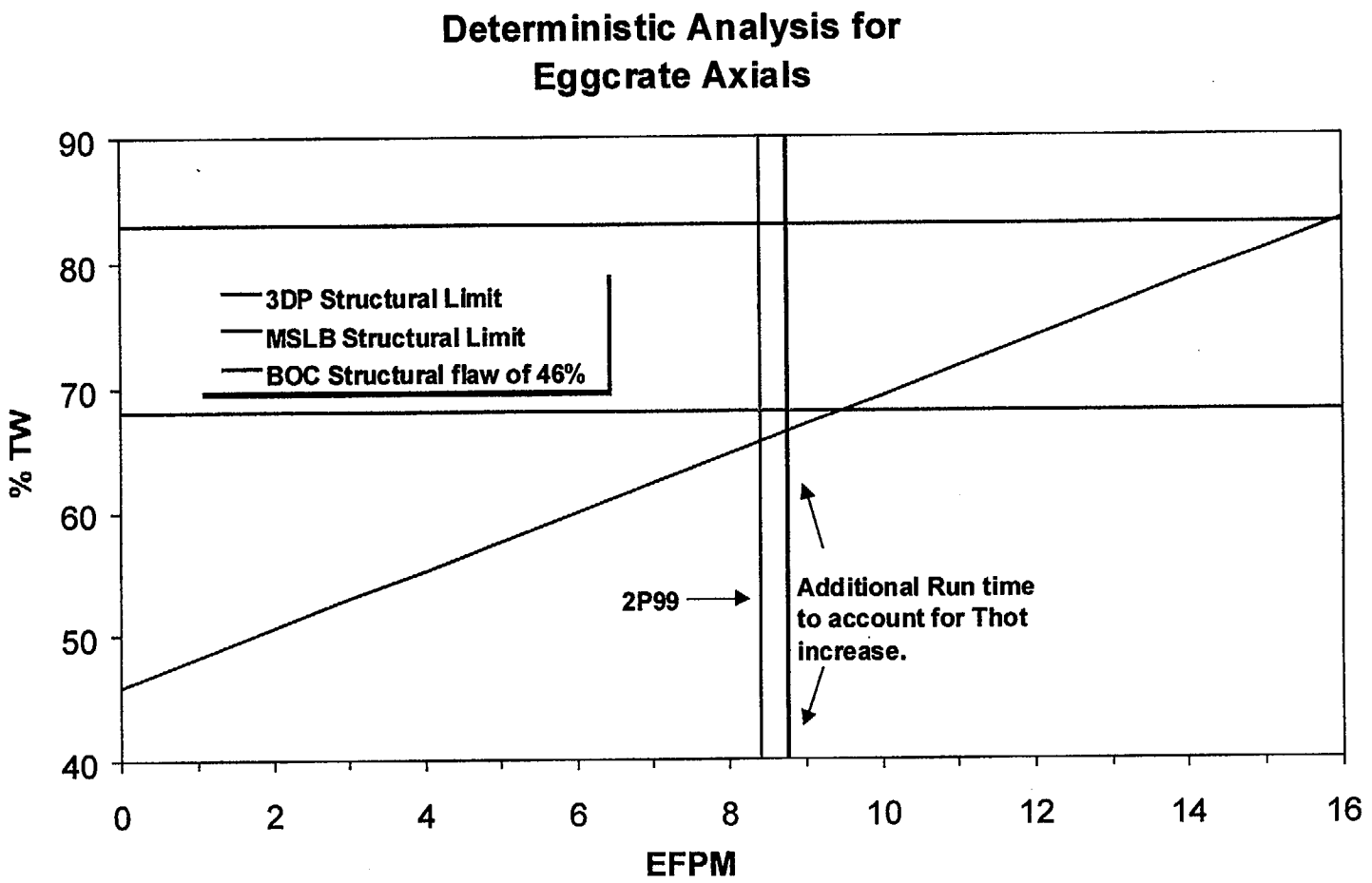
DISTRIBUTION OF TRUE GROW RATE PARAMETERS



ANO2 OPERATIONAL ASSESSMENT



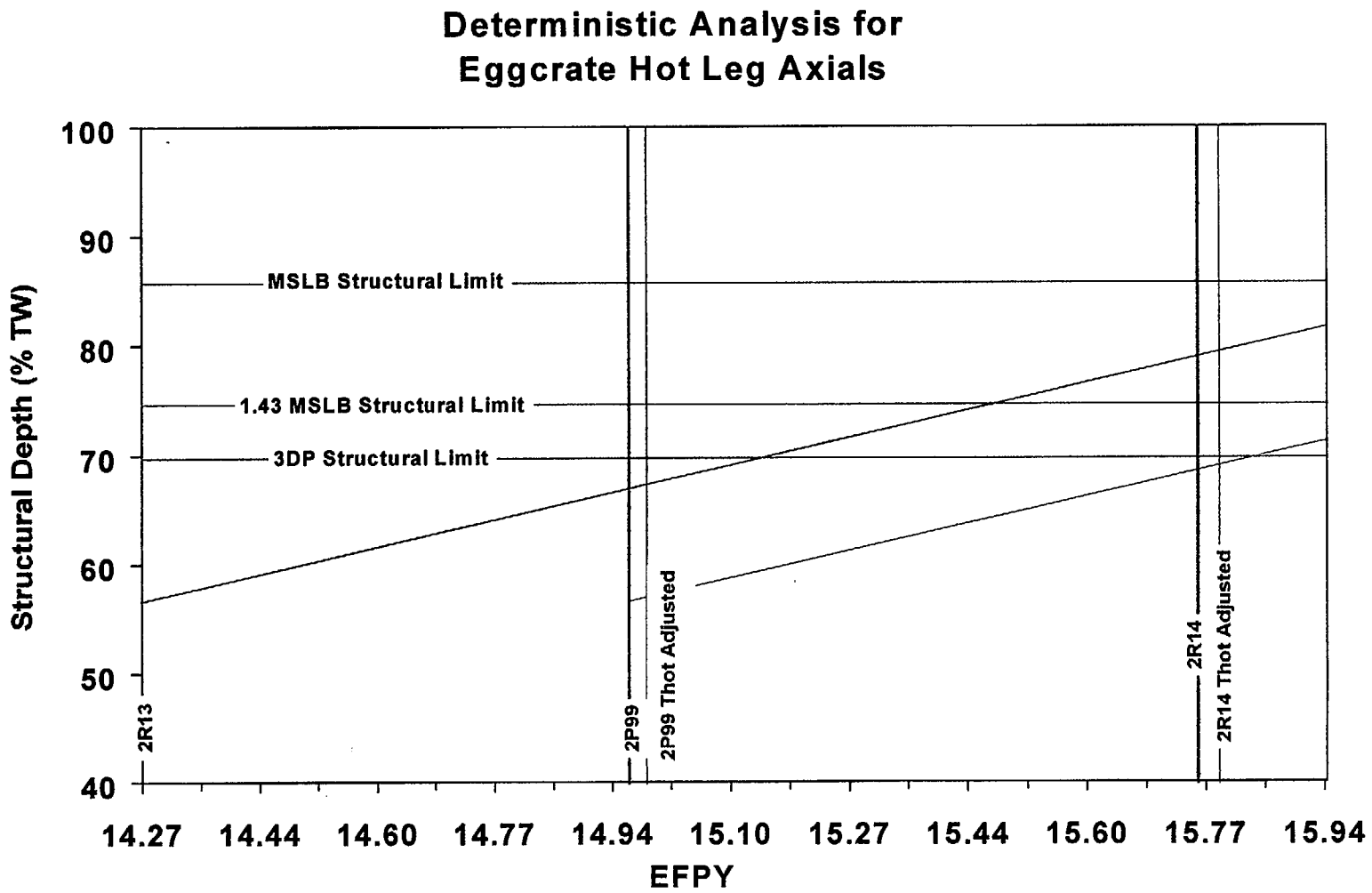
Deterministic for Eggcrate Axial Cracks - Previous Analysis



ANO2 Operational Assessment

PARAMETER	SGTI Guidelines
POD Value	**95%**
Structural Depth Equivalent	56.6%
Growth Rate	**95% Struct. Depth**
Growth Equivalent	15%
Length Value	**90% (2P99 data)**
Length Equivalent	0.98
Burst Correlation	**90% Value**
Material Properties	125,900
Material Equivalent	**90%**

DETERMINISTIC EVALUATION HL EGGCRATE AXIAL



ANO2 Operational Assessment

Summary