

**CAROLINA POWER & LIGHT COMPANY**

**H.B.Robinson Nuclear Project**

**Unit 2**

**REACTOR CONTAINMENT BUILDING INTEGRATED  
LEAKAGE RATE TEST REPORT**

**April 10, 1992**

**GENERAL PHYSICS CORPORATION**

**GP-R-213850**

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## I. INTRODUCTION

The Reactor Building Integrated Leakage Rate "Type A" Test is performed to demonstrate that leakage through the primary reactor containment systems and components penetrating primary reactor containment do not exceed the allowable leakage rates specified in the Plant Technical Specifications.

The purpose of this report is to provide information pertinent to the activities related to the preparation, test performance, and reporting of the H.B. Robinson Nuclear Project Unit 2 Integrated Leakage Rate Test (ILRT).

Highlights of activities and events which occurred prior to and during the ILRT are presented in Section II, Test Synopsis.

Section III, Test Data Summary, contains data and results necessary to demonstrate containment atmosphere stabilization, acceptable leakage rate, and successful verification test. In addition, plots provided in Appendices B and C supply a visual history of containment atmospheric conditions beginning with the 24 hour ILRT test period and ending with the verification test.

Information in Section IV, Analysis and Interpretation, supplies the technical details associated with the ILRT computer program and its associated hardware as well as the instrumentation used during the ILRT.

Section V, References, lists the documents used for the conduct of the ILRT.

The successful periodic Type A and verification test were performed according to the requirements of the H.B. Robinson Nuclear Project Unit 2 Technical Specifications and 10CFR50, Appendix J. The test method used was the Absolute Method, as described in ANSI/ANS 56.8-1987, "Containment System Leakage Testing Requirements".

Leakage rates were calculated using the Mass Point Analysis technique as described in ANSI/ANS 56.8-1987. Total Time Analysis equations from ANSI N45.4-1972, "Leakage-Rate Testing of Containment Structures for Nuclear Reactors" were run concurrently for informational purposes. The test results are reported in accordance with the requirements of 10CFR50, Appendix J, Section V.B.3.

## II. TEST SYNOPSIS

Prior to containment pressurization on 0440, April 7, 1992, site personnel were engaged in prerequisite activities for the conduct of the ILRT and SIT. The ILRT/SIT were conducted at the beginning of the refueling outage. The following discussion highlights some of the activities that were essential to the successful and timely completion of the ILRT. These items are presented in chronological order.

### A. Pre-pressurization Activities

These activities included ILRT procedure review and finalization, ILRT computer program checkout and linkup to the Fluke 2285B Data Acquisition System, ILRT instrumentation installation and operability checks, and containment subvolume weighting factor and sensor failure analysis calculation. A containment temperature survey was also performed and analyzed.

The ILRT test procedure was reviewed against the requirements of the Plant Technical Specifications; 10CFR50, Appendix J; and ANSI/ANS 56.8-1987.

The ILRT instrumentation was calibrated prior to the ILRT as recommended by ANSI N45.4-1972, Sections 6.2 and 6.3. Final ILRT instrumentation operability checks and in-situ checks, as specified in ANSI/ANS 56.8-1987, Section 4.2.3.1, were performed to ensure that all instrumentation was operating correctly. Calibration records for the ILRT instrumentation system components are retained at the plant.

## B. Test Summary Time-Line

<u>Phase</u>	<u>Time Frame</u>	<u>Duration</u>
Pressurization	From: 0440 on 4/7/92 To: 1545 on 4/8/92	35.08 hours*
*Includes hold points at 14, 21, and 35 psig for SIT data taking.		
Stabilization	From: 1615 on 4/8/92 To: 2315 on 4/8/92	7 hours
ILRT Test	From: 2330 on 4/8/92 To: 2330 on 4/9/92	24 hours
Verification Test	From: 2345 on 4/9/92 To: 0345 on 4/10/92	4.00 hours

## C. Containment Pressurization

Containment pressurization started at 2230 on April 7, 1992 using seven 1500 scfm diesel-driven 100% oil-free air compressors. The pressurization rate was maintained at approximately 3.5-4.0 psi per hour. Pressurization was stopped at 14, 21, and 35 psig plateaus for SIT data collection. The pressurization rate was gradually reduced as the containment pressure approached 42 psig by reducing the number of operating compressors. All compressors were stopped when the containment pressure reached 42.4 psig at 1545 on April 8, 1992. This was within the procedural limits of 42.0 +1,-0 psig.

During pressurization a containment walkdown was performed to identify potential leakage. No measurable leakage was observed. Pressurization was conducted with the use of the Reactor Containment Fan Cooling Units. However, the fans were stopped at 0438 on 8 April 1992 at a pressure of approximately 30 psig and were not used during the ILRT or verification test. No temperature stratification was observed.

#### D. Containment Atmosphere Stabilization

The stabilization phase was started at 1615 on April 8, 1992. By 2015 on April 8, 1992, the temperature stabilization criteria of ANSI/ANS 56.8-1987 had been met. Additional time was allotted for containment mass stabilization. At 2315 on April 8, 1992, stabilization was completed.

#### E. ILRT Test Period

The ILRT was officially started 2330 on April 8, 1992 and was successfully completed at 2330 on April 9, 1992. The maximum allowable leakage rate ( $L_a$ ) for the containment is 0.1 % wt. per day with a test acceptance limit of 0.075 % wt. per day ( $0.75 L_a$ ). The Total Time and Mass Point Analyses were run concurrently on the General Physics ILRT Computer Program. The leakage rate results are as follows:

	Total Time Analysis <u>% wt./day</u>	Mass Point Analysis <u>% wt./day</u>
Calculated Leakage Rate	0.0564*	0.0593*
95 % Upper Confidence Leakage rate	0.0644*	0.0602*

\* Does not include penalties for nonstandard alignments and water level changes

## F. Verification Test

A successful verification test was conducted following the ILRT. At 2331 on April 9, 1992, a leakage rate of 5.14 scfm was imposed on the primary containment. The 5.14 scfm leakage imposed ( $L_o$ ) on the existing containment leakage was slightly less than  $L_a$  (0.1 % wt./day) at 0.0992 % wt. per day. The verification phase was completed at 0345 on April 10, 1992.

The verification test results are presented below:

	Total Time Analysis <u>% wt./day</u>	Mass Point Analysis <u>% wt./day</u>
Leakage Rate ( $L_{am}$ )	0.0564	0.0593
Imposed Leak ( $L_o$ )	0.0992	0.0992
Lower Limit: $L_o + L_{am} - 0.25 L_a$	0.1306	0.1335
Composite Leakage ( $L_c$ )	0.1472	0.1563
Upper Limit: $L_o + L_{am} + 0.25 L_a$	0.1806	0.1835



III. TEST DATA SUMMARY

## A. Plant Information

Owner	Carolina Power & Light Company
Plant	H.B.Robinson Nuclear Project Unit 2
Location	Hartsville, South Carolina
Containment Type	Post-tensioned concrete with a steel liner
NSSS Supplier, Type	Westinghouse, 3 loop PWR
Date Test Completed	April 10, 1992

## B. Technical Data

Containment Net Free Volume	1,950,000 cubic feet
Design Pressure	42.0 psig
Design Temperature	263 ° F
Calculated Peak Accident Pressure	42.0 psig
Calculated Peak Accident Temperature	263 ° F

## C. Test Results - Type A

Test Method	Absolute
Test Pressure	42.0 psig

## Integrated Leakage Rate Total Time Analysis Test Results (Presented for information only):

Calculated Leakage Rate, $L_{am}$	0.0564 % wt./day
95 % Upper Confidence Limit Leakage Rate	0.0644 % wt./day

## Integrated Leakage Rate Mass Point Analysis Test Results

Calculated Leakage Rate, $L_{am}$	0.0593 % wt./day
95 % Upper Confidence Limit Leakage Rate	0.0602 % wt./day
Maximum Allowable Leakage Rate, $L_a$	0.1 % wt./day
ILRT Acceptance Criteria, $0.75 L_a$	0.075 % wt./day
Verification Test Imposed Leakage Rate, $L_o$	5.14 scfm or 0.0992 % wt./day

## Verification Test Total Time Analysis Results and Limits (Presented for information only)

Upper Limit ( $L_o + L_{am} + 0.25 L_a$ )	0.1806 % wt./day
Calculated Composite Leakage Rate, $L_c$	0.1472 % wt./day
Lower Limit ( $L_o + L_{am} - 0.25 L_a$ )	0.1306 % wt./day

## Verification Test Mass Point Analysis Results and Limits

Upper Limit ( $L_o + L_{am} + 0.25 L_a$ )	0.1835 % wt./day
Calculated Composite Leakage Rate, $L_c$	0.1563 % wt./day
Lower Limit ( $L_o + L_{am} - 0.25 L_a$ )	0.1335 % wt./day

## Report Printouts

The report printouts of the ILRT and verification test calculations for the Total Time and Mass Point Analyses are provided in Appendices B and C. Stabilization data is provided in Appendix A.

## D. Test Results - Type B and C Tests

The local leakage rate (Type B and C) test program at H. B. Robinson consists of the following:

1. Isolation valves in ten penetrations are tested in accordance with the requirements of 10 CFR 50, Appendix J.
2. The Personnel Airlock is tested in accordance with the requirements of 10 CFR 50, Appendix J.
3. Electrical penetrations, mechanical penetrations, the Personnel Airlock Door seals, the Equipment Hatch seals, and isolation valves in six penetrations are continuously pressurized and leakage monitored by the Penetration Pressurization System (PPS).
4. Isolation valves in the two Containment Air Sample penetrations are normally open during reactor operations and are not continuously pressurized by PPS. These valves are cycled quarterly and while closed, the interspaces are pressurized by PPS and the total PPS leakage rate is recorded.

The acceptance criteria for item 1. above is  $0.3L_a$  (1.57 scfm). The combined acceptance criteria for items 2., 3., and 4. above is  $0.3L_a$ . Thus the total acceptance criteria for Type B and C tests is  $0.6L_a$  (3.14 scfm).

Isolation valves in twenty-nine other penetrations are served by the Isolation Valve Seal Water (IVSW) System. This system is a qualified seal water system as defined in 10 CFR 50, Appendix J. The leakage results from these valves are not included in the 0.6L<sub>a</sub> Type B and C acceptance criteria. Each of the four IVSW headers has a separate acceptance criteria as identified in the H. B. Robinson Updated Final Safety Analysis Report and Technical Specifications.

A summary of local leakage rate test results since the ILRT in 1987 are included in Appendix F.

E. Integrated Leakage Rate Measurement System

1. Absolute Pressure

Quantity	2
Manufacturer	Paroscientific
Type	DigiQuartz Pressure Transducer
Range	0 - 100 psia
Accuracy	0.01 psia
Sensitivity	0.001 psia
Repeatability	0.001 psia
Resolution	0.0001 psia

## 2. Drybulb Temperature

Quantity	24
Manufacturer	Rosemount
Type	78 Series 100 ohm platinum resistance temperature detectors (RTD)
Range, calibrated	0 - 150 ° F
Accuracy	+/- 0.5 ° F
Sensitivity	0.001 ° F

## 3. Dewpoint Temperature

Quantity	5
Manufacturer	Foxboro
Type	Dewcel Model 2781 18 CGQ
Range, calibrated	0 - 200 ° F
Accuracy	+/- 2 ° F
Sensitivity	0.01 ° F

## 4. Verification Flow

Quantity	2
Manufacturer	Wallace & Tiernan
Type	Model 5210 Rotameter
Range	0.5 - 6 scfm
Accuracy	+/- 1% full scale

## 5. Readout Device

Quantity	1
Manufacturer	Fluke
Type	Model 2285B
Repeatability	

Drybulb Temp	0.054 ° F
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Dewpoint Temp	0.054 ° F
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## Resolution

Drybulb Temp	0.014 ° F
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Dewpoint Temp	0.014 ° F
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The Instrumentation Selection Guide (ISG) value from ANSI/ANS 56.8-1987 based on a 24 hour test and the above ILRT instrumentation configuration is 0.003 % wt./day. (Refer to Appendix D for calculations) The sensor locations and volume fractions as installed for the ILRT are shown in Appendix G.

## G. Information Retained at Plant

The following information is available for review at the H.B.Robinson Nuclear Project site:

1. Access control procedure used to control access to the containment during testing,
2. A listing of all containment penetrations, including the total number, size, and function.
3. A listing of normal operating instrumentation used for the leakage test.

4. A system lineup (at time of test), showing required valve positions and status of piping systems.
5. A continuous, sequential log of events from the initial survey of containment to restoration of tested systems.
6. Documentation of instrumentation calibrations and standards, including a sensor failure analysis.
7. Data to verify temperature stabilization criteria as established by test procedure (Appendix A).
8. The working copy of the test procedure that includes signature sign-offs of procedural steps.
9. The procedure and data that verifies completion of penetration and valve testing, including as-found leak rates, corrective action, and final leak rates.
10. Computer printouts of ILRT data and automated data acquisition printouts along with a summary description of the computer program.
11. The Quality Assurance audit plan or checklist that was used to monitor the ILRT with proper signoffs.
12. A listing of test exceptions including changes in the containment system boundaries.
13. Description of sensor malfunctions, repairs, and methods used to redistribute volume weighting fractions to operating instrumentation.
14. A review of confidence limits of test results with accompanying computer printouts.
15. Description of the method of leakage rate verification.
16. ILRT data plots obtained during the test.
17. The P&IDs of pertinent systems.

IV. ANALYSIS AND INTERPRETATION

The upper 95% confidence limit (UCL) Total Time and Mass Point leakage rates calculated during the ILRT were less than the test acceptance criteria of 0.75 L<sub>a</sub> (0.075 % wt./day). Additions to the calculated leakage rates must be made to account for penetration paths not exposed to the ILRT pressure and for changes in the net free containment volume due to changes in containment water levels. These additions are discussed below.

## A. Type C Penalties

Penetration paths not exposed to the ILRT pressure and the corresponding minimum pathway leakage rates are as follows:

<u>Pen. No.</u>	<u>System</u>	<u>Leakage Rate (sccm)</u>
P67	Containment Manometer Line	0.0
P70	Containment Pressure Sensing	0.0

LLRT results, based on the above. There was no applicable local leakage rate Type C penalty addition.

## B. Volume Change Corrections

The following volumes were monitored for liquid level changes which would affect the containment net free volume:

<u>Volume Monitored</u>	<u>Level Change</u>	<u>Volume Change</u>
Pressurizer	-3%	+152 cu. ft.
Containment Sump	0	0



Based on the volumes monitored, the containment net free volume increased during the ILRT. Since this is conservative and is already reflected in the ILRT results, no additional correction is required.

C. As Found ILRT Results

The as found ILRT leakage rate including the required additions is as follows:

	<u>Total Time Analysis (% wt./day)</u>	<u>Mass Point Analysis (% wt./day)</u>
95 % UCL Leakage Rate	0.0644	0.0602
Type C Penalties	none	none
Volume Change	0.0000	0.0000
As Found 95 % UCL Leakage Rate	0.0644	0.0602

The as found Total Time and Mass Point 95 % UCL leakage rates are less than the test acceptance criteria value of  $0.75 L_a$  (0.075 % wt./day).

D. As Left ILRT Results

The ILRT was performed at the beginning of the outage prior to any repairs or modifications. Therefore, the as left ILRT result is identical to the as found ILRT result.

V. REFERENCES

- A. H. B. Robinson Nuclear Project Engineering Surveillance Test Procedure, EST-085, Containment Integrated Leak Rate Test.
- B. H. B. Robinson Nuclear Project Engineering Surveillance Test Procedure, EST-095, Integrated Leak Rate Test Instrumentation Pre-Test Calibration Procedure.
- C. H. B. Robinson Nuclear Project Unit 2 Technical Specifications.
- D. H. B. Robinson Nuclear Project Unit 2 Updated Final Safety Analysis Report.
- E. Code of Federal Regulations, Title 10, Part 50, Appendix J, Primary Reactor Containment Leakage Testing for Water Cooled Power Reactors.
- F. ANSI N45.4-1972, Leakage-Rate Testing of Containment Structures for Nuclear Reactors.
- G. ANSI/ANS 56.8-1987, Containment System Leakage Testing Requirements.

VI APPENDICES

APPENDIX A  
STABILIZATION PHASE DATA

STABILIZATION MODE  
OPTIONS

TIME : 2315  
MODE SUMMARY

- 1 - MANUAL DATA ENTRY
- 2 - PARAMETER GRAPHS
- 3 - SENSOR PLOTS
- 4 - SENSOR DIFFERENTIALS
- 5 - ANSI STABILIZATION CRITERIA
- 6 - BN-TOP-1 STAB.CRITERIA
- 7 - ANSI CRITERIA PRINTOUT
- 8 - BN-TOP-1 CRITERIA PRINTOUT
- 9 - REPRINT CURRENT DATA POINT
- P - PASS WORD MENU
- Q - FLASH OFF

# OF DATA POINTS = 29  
MODE DURATION (IN HRS) = 7.00  
TOT TIME MEASURED LEAK = 0.0521  
TOT TIME CALCULATED LEAK = 0.0938  
TOT TIME 95% UCL = 0.2226  
MASS FT LEAK = 0.0675  
MASS FT 95% UCL = 0.0771

ANSI TEMPERATURE STABILIZATION CRITERIA MET  
BN-TOP TEMPERATURE STABILIZATION CRITERIA MET

POINT SUMMARY: CURRENT VALUE/DIFFERENCE FROM PREVIOUS POINT

AVG TEMP:	74.225/ -0.004	AVG PRESS:	56.918/ -0.000
MASS:	561124.00/ +1.313	AVG DEW PRESS:	0.2003/-0.0001
		TOTAL PRESS:	57.119/ -0.000

20.063

UNIT 2

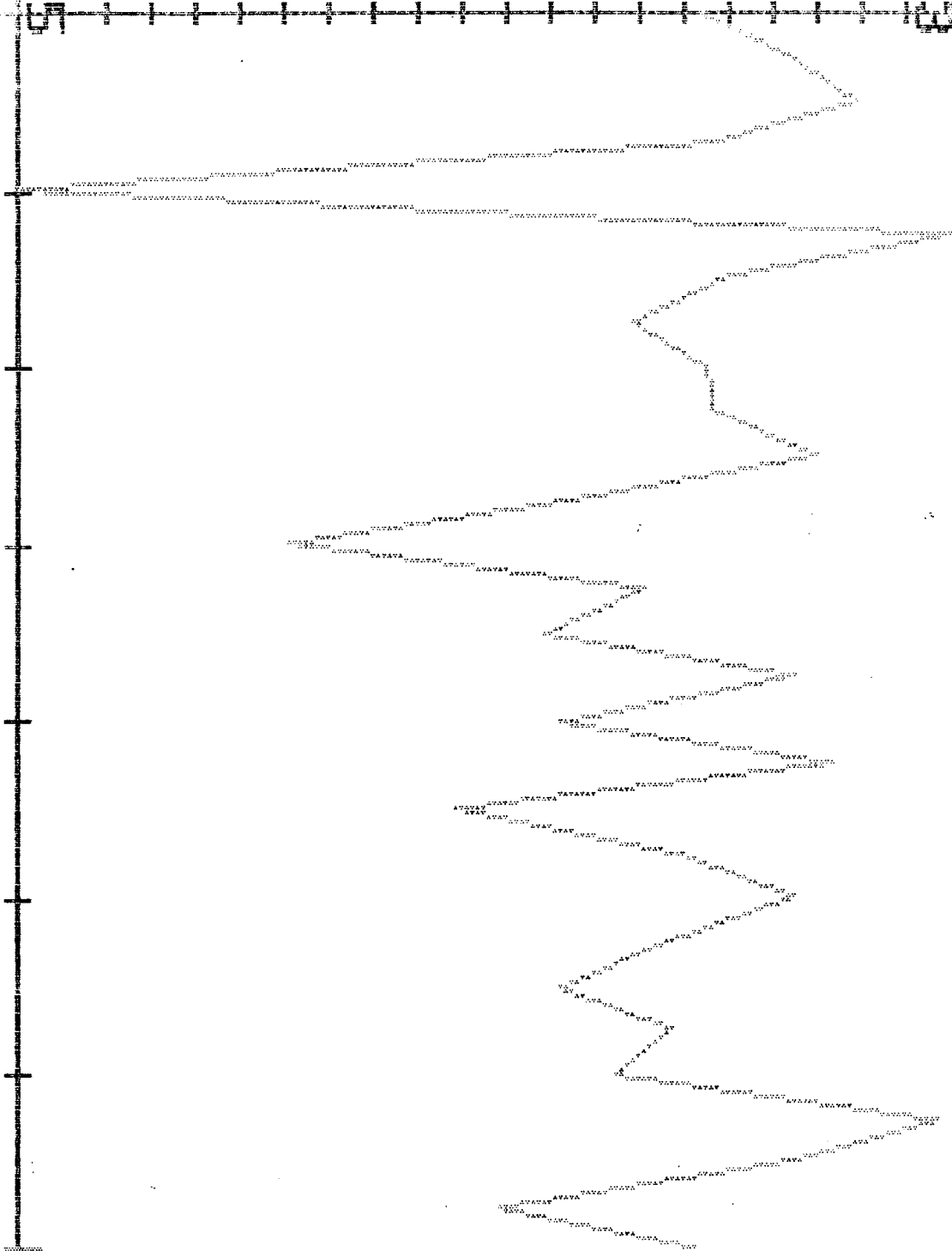
DIFFERENTIAL PRESSURE

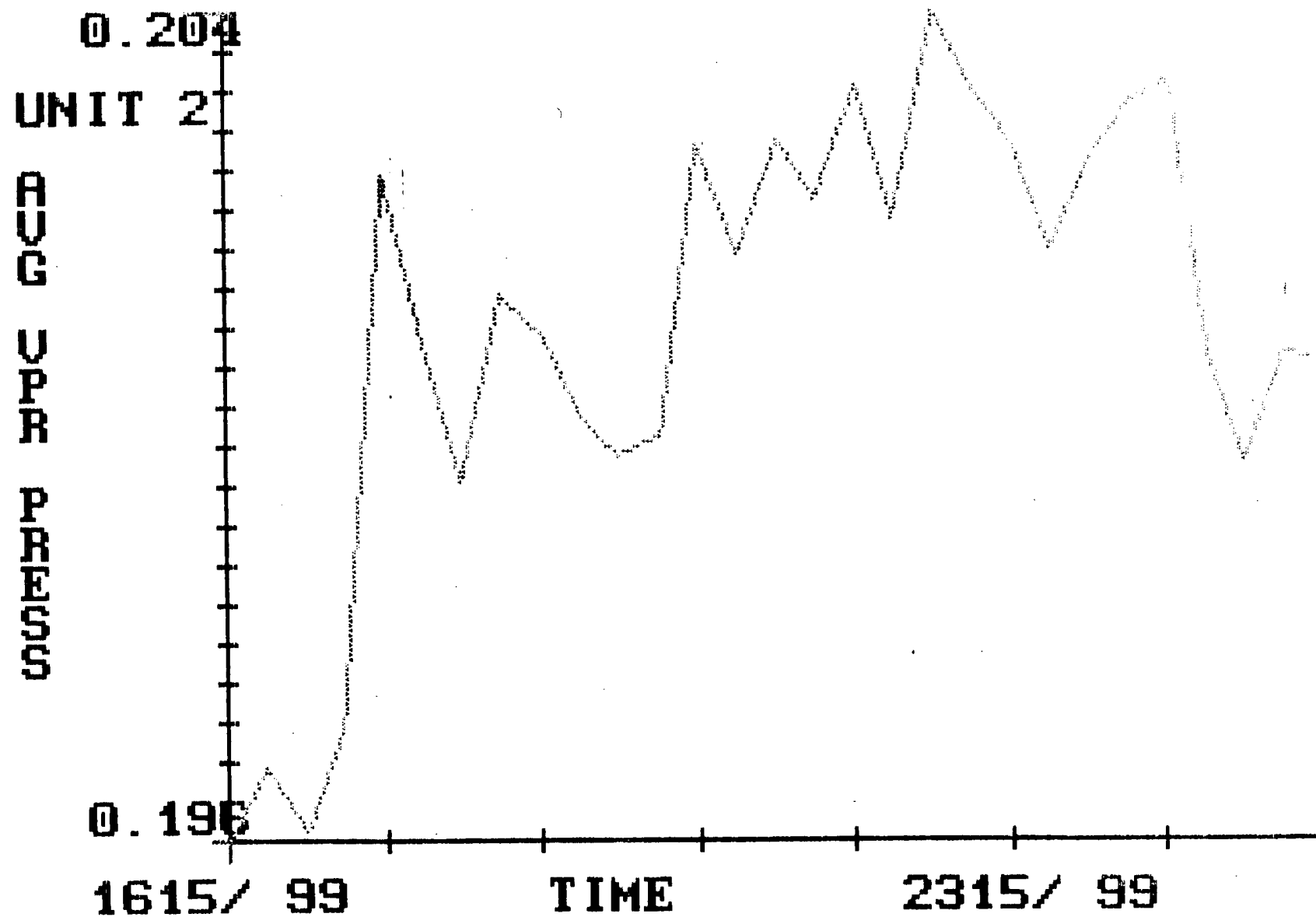
-55.375

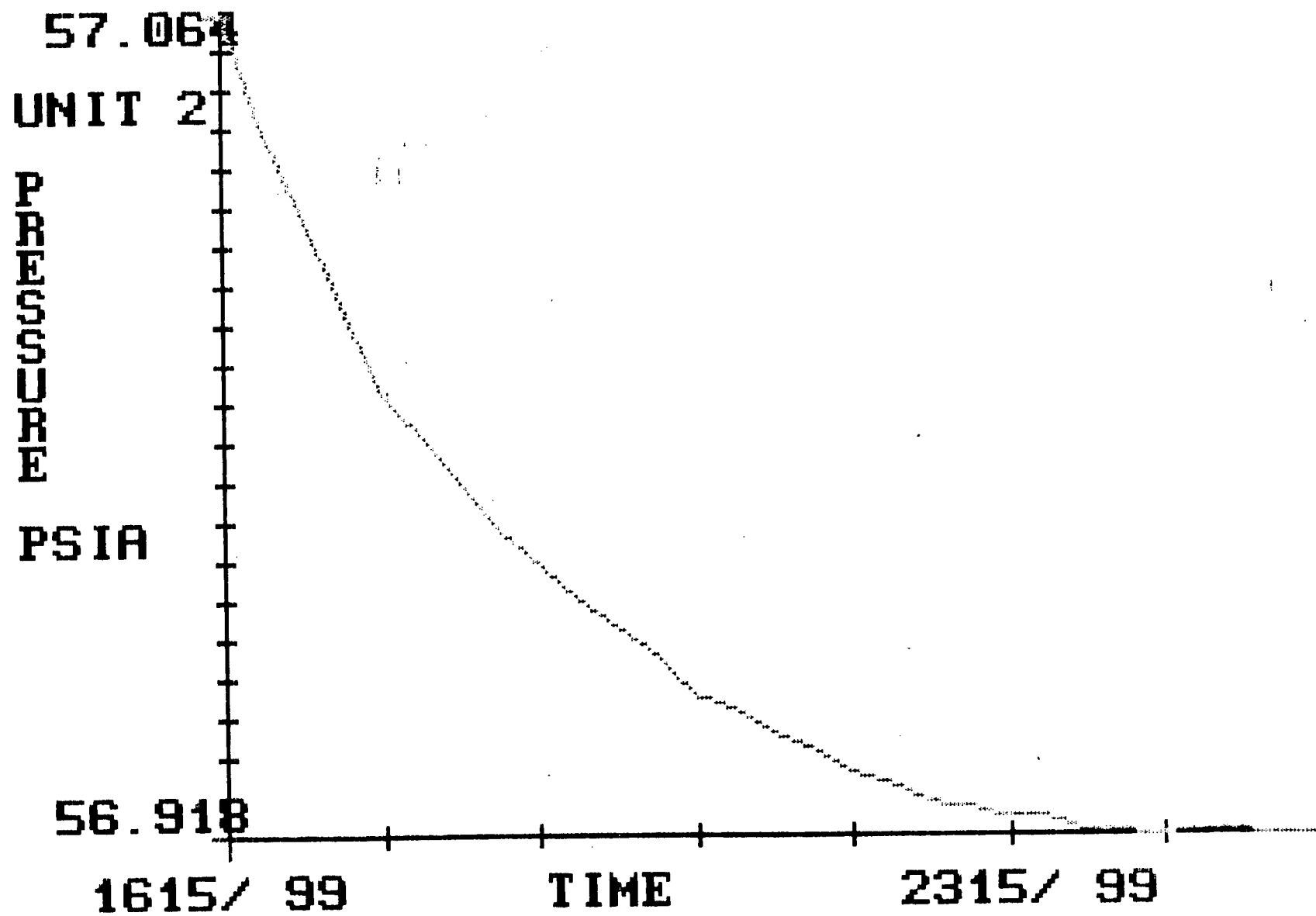
1615/ 99

TIME

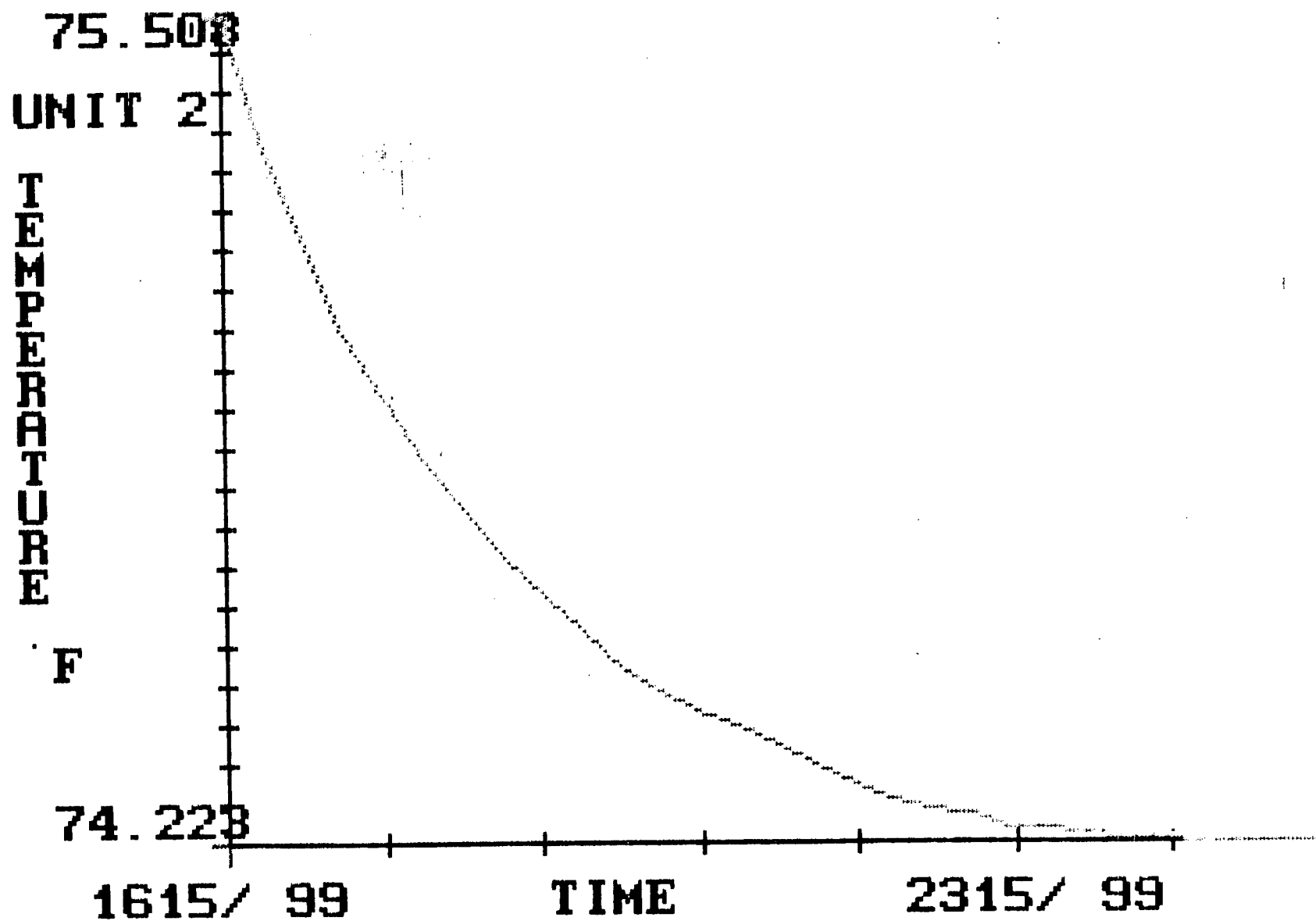
2315/ 99











# STABILIZATION ANSI56.8

TIME	TEMP	56.8 1 HR F/HR	56.8 4 HR F/HR	4-1 HR
7.00	74.225	0.009	0.052	0.043
6.75	74.228	0.007	0.060	0.053
6.50	74.223	0.016	0.070	0.053
6.25	74.227	0.022	0.084	0.062
6.00	74.233	0.018	0.095	0.077
5.75	74.235	0.034	0.110	0.077
5.50	74.240	0.038	0.128	0.090
5.25	74.249	0.046	0.144	0.099
5.00	74.251	0.071	0.168	0.097
4.75	74.269	0.082	0.188	0.106
4.50	74.278	0.101	0.220	0.119
4.25	74.294	0.115	0.255	0.140
4.00	74.323	0.110	0.296	0.186
3.75	74.351	0.116	0.000	-0.116
3.50	74.379	0.123	0.000	-0.123
3.25	74.410	0.153	0.000	-0.153
3.00	74.432	0.182	0.000	-0.182
2.75	74.467	0.210	0.000	-0.210
2.50	74.502	0.251	0.000	-0.251
2.25	74.563	0.264	0.000	-0.264
2.00	74.614	0.308	0.000	-0.308
1.75	74.677	0.344	0.000	-0.344
1.50	74.753	0.404	0.000	-0.404
1.25	74.826	0.488	0.000	-0.488
1.00	74.922	0.586	0.000	-0.586
0.75	75.021	0.000	0.000	0.000
0.50	75.157	0.000	0.000	0.000
0.25	75.314	0.000	0.000	0.000

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APPENDIX B  
ILRT TEST DATA AND PLOTS

TEST MODE

PLEASE SELECT THE OPTION

WISH TO USE:

TEST DATA 2330

- 1 - MANUAL DATA ENTRY
- 2 - PARAMETER GRAPHS
- 3 - SENSOR PLOTS
- 4 - TREND ANALYSIS
- 5 - REPRINT CURRENT DATA PT
- 6 - SENSOR DIFFERENTIALS

# OF DATA POINTS = 97  
MODE DURATION (IN HOURS) = 24.00  
TOT TIME MEASURED LEAK = 0.0572  
TOT TIME CALCULATED LEAK = 0.0564  
TOT TIME 95% UCL = 0.0644  
MASS POINT LEAK = 0.0593  
MASS POINT 95% UCL = 0.0602  
75% La = .075  
MASS = 560952.00

P - PASS WORD MENU

SELECTED OPTION=

POINT SUMMARY: CURRENT VALUE/DIFFERENCE FROM PREVIOUS POINT

AVG TEMP:	74.812 / +0.019	AVG PRESS:	56.963 / +0.002
MASS:	560952.00 / -4.813	AVG DEW PRESS:	0.1779 / -0.0002
		TOTAL PRESS:	57.141 / +0.001

0.1660

UNIT 2

MASS  
ANAL.

MT%/  
DAY

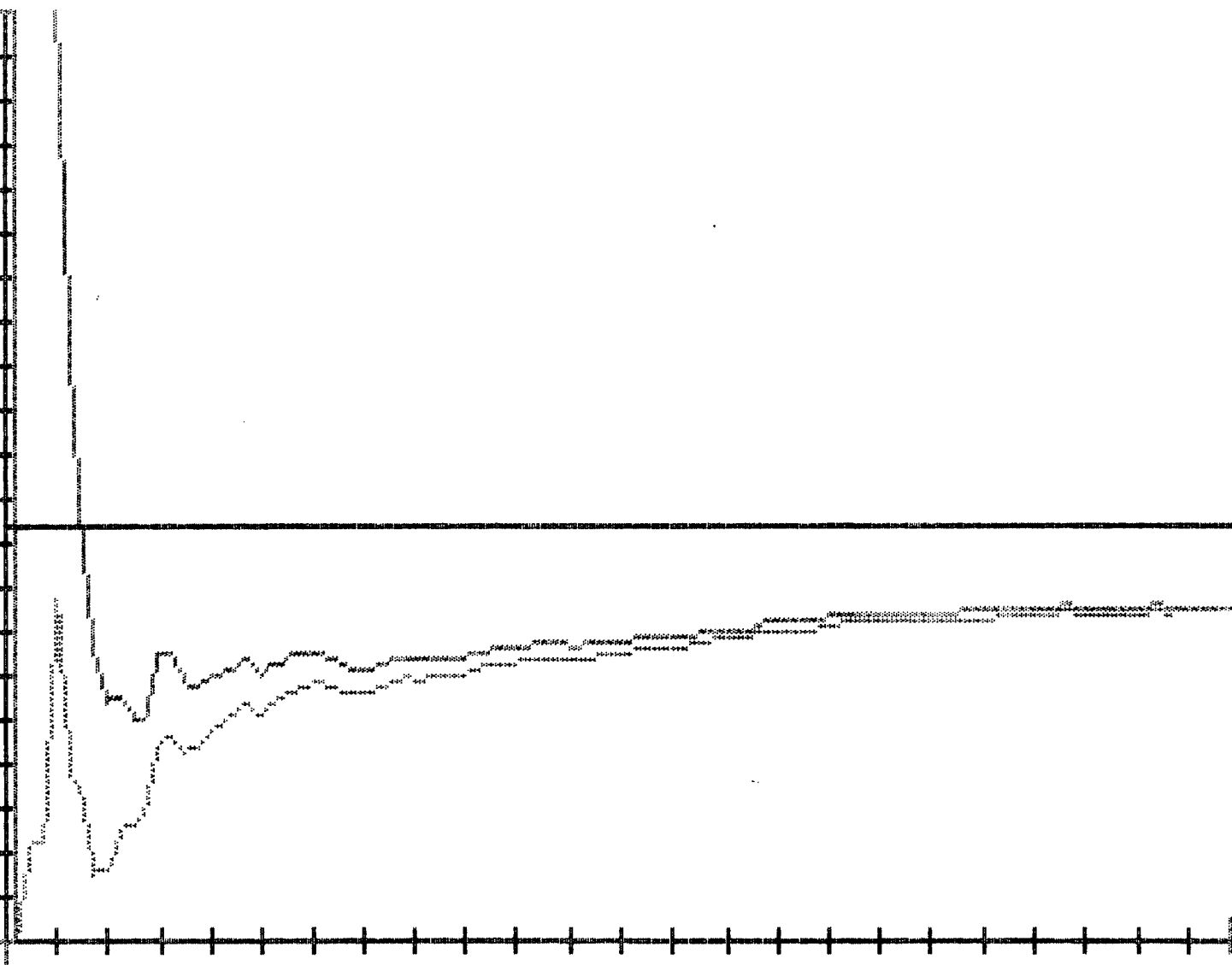
LEGEND  
= L

0.0000

2330/ 99

TIME

2330/ 100



0.2608

UNIT 2

TOT  
TIME

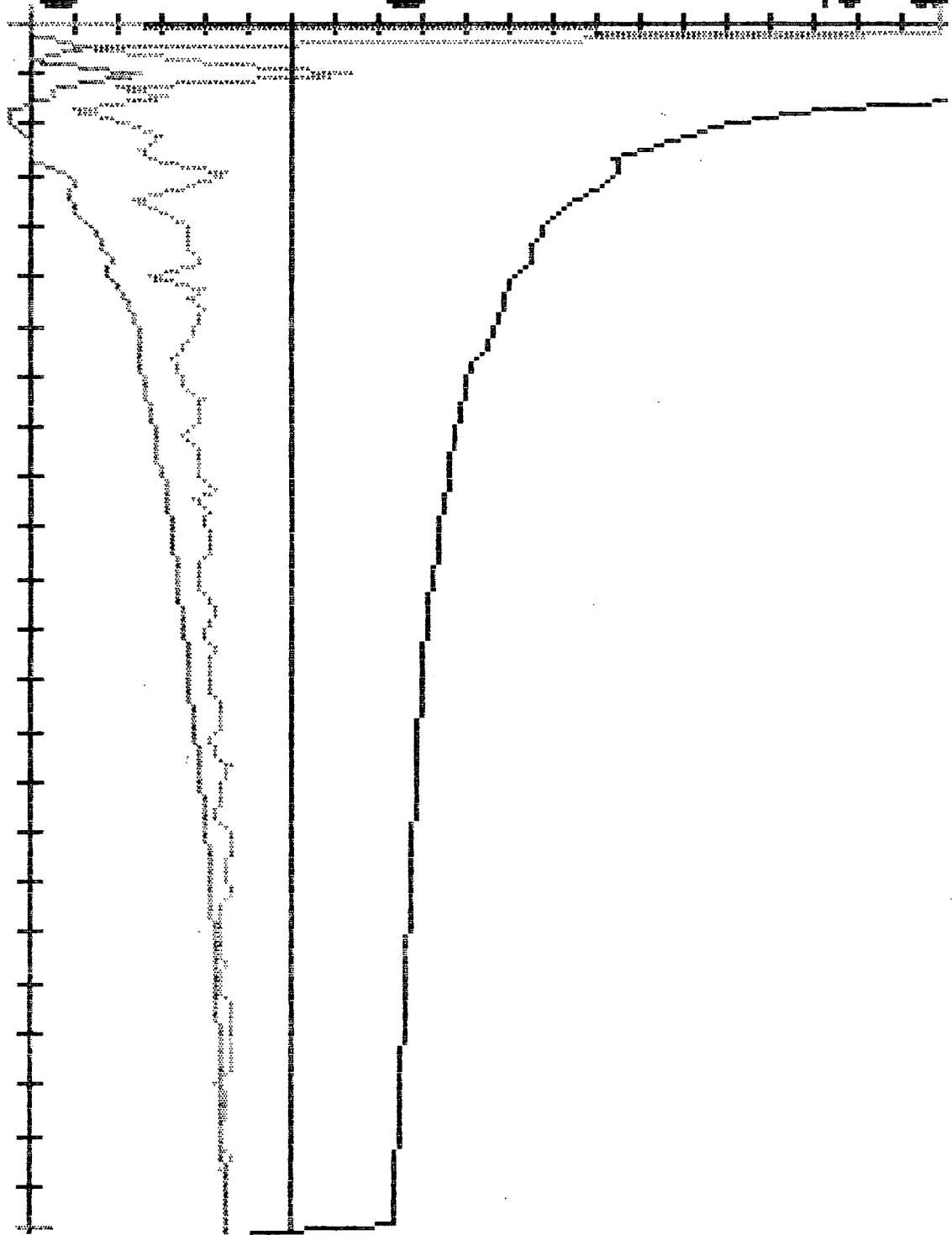
ANAL

WT%/  
DRY

LEGEND  
= L

0.0000

2330 / 99 TIME 2330 / 100



TEST MODE

Page 1

## AVERAGE DATA VALUES

DATE	TIME	RTD	DEW PT.	VAP PRESS	DRY PRESS	MASS
99	0.00	74.239	50.819	0.183	56.935	561273.25
99	0.25	74.251	50.864	0.184	56.935	561258.00
100	0.50	74.249	50.714	0.183	56.936	561271.38
100	0.75	74.252	50.737	0.183	56.936	561265.31
100	1.00	74.254	50.830	0.184	56.934	561251.63
100	1.25	74.258	50.574	0.182	56.936	561265.75
100	1.50	74.257	50.763	0.183	56.935	561259.25
100	1.75	74.262	50.495	0.181	56.937	561267.88
100	2.00	74.264	50.626	0.182	56.936	561259.88
100	2.25	74.274	50.587	0.182	56.937	561252.88
100	2.50	74.271	50.640	0.182	56.937	561254.94
100	2.75	74.280	50.591	0.182	56.937	561250.31
100	3.00	74.296	50.651	0.182	56.937	561233.75
100	3.25	74.294	50.715	0.183	56.937	561239.00
100	3.50	74.303	50.497	0.181	56.939	561248.75
100	3.75	74.316	50.534	0.182	56.940	561238.75
100	4.00	74.325	50.521	0.181	56.940	561231.88
100	4.25	74.330	50.554	0.182	56.940	561228.31
100	4.50	74.340	50.544	0.182	56.941	561224.81
100	4.75	74.343	50.586	0.182	56.941	561219.63
100	5.00	74.346	50.397	0.181	56.942	561232.19
100	5.25	74.361	50.549	0.182	56.942	561211.13
100	5.50	74.371	50.420	0.181	56.943	561214.50
100	5.75	74.377	50.508	0.181	56.943	561206.13
100	6.00	74.385	50.477	0.181	56.944	561204.44
100	6.25	74.388	50.513	0.181	56.944	561204.44
100	6.50	74.403	50.357	0.180	56.946	561206.50
100	6.75	74.402	50.396	0.181	56.946	561208.13
100	7.00	74.413	50.363	0.180	56.946	561203.50
100	7.25	74.422	50.400	0.181	56.947	561197.50
100	7.50	74.437	50.433	0.181	56.947	561185.56
100	7.75	74.439	50.401	0.181	56.947	561185.25
100	8.00	74.446	50.382	0.181	56.948	561181.38
100	8.25	74.452	50.262	0.180	56.949	561186.63
100	8.50	74.457	50.360	0.180	56.948	561176.75
100	8.75	74.457	50.393	0.181	56.948	561174.13
100	9.00	74.459	50.436	0.181	56.948	561169.50
100	9.25	74.469	50.439	0.181	56.948	561156.88
100	9.50	74.465	50.333	0.180	56.948	561167.44
100	9.75	74.475	50.374	0.180	56.948	561154.81

AVERAGE DATA VALUES						
DATE	TIME	RTD	DEW PT.	VAP PRESS	DRY PRESS	MASS
100	10.00	74.476	50.375	0.180	56.948	561155.56
100	10.25	74.480	50.353	0.180	56.948	561149.88
100	10.50	74.487	50.340	0.180	56.948	561144.38
100	10.75	74.491	50.222	0.179	56.949	561149.50
100	11.00	74.491	50.194	0.179	56.949	561148.69
100	11.25	74.497	50.143	0.179	56.950	561145.88
100	11.50	74.502	50.308	0.180	56.949	561132.75
100	11.75	74.513	50.231	0.179	56.949	561127.56
100	12.00	74.515	50.220	0.179	56.950	561127.56
100	12.25	74.515	50.168	0.179	56.949	561126.44
100	12.50	74.515	50.268	0.180	56.948	561114.50
100	12.75	74.516	50.212	0.179	56.949	561116.06
100	13.00	74.520	50.113	0.179	56.949	561116.31
100	13.25	74.516	50.062	0.178	56.948	561114.00
100	13.50	74.525	50.094	0.179	56.948	561101.31
100	13.75	74.527	50.201	0.179	56.947	561093.88
100	14.00	74.522	50.230	0.179	56.947	561090.44
100	14.25	74.517	50.197	0.179	56.947	561097.56
100	14.50	74.528	50.121	0.179	56.947	561089.13
100	14.75	74.536	50.299	0.180	56.946	561070.25
100	15.00	74.536	50.181	0.179	56.946	561073.63
100	15.25	74.533	50.088	0.179	56.947	561079.06
100	15.50	74.539	50.081	0.178	56.947	561075.44
100	15.75	74.541	50.033	0.178	56.947	561074.06
100	16.00	74.543	50.212	0.179	56.946	561062.56
100	16.25	74.556	50.152	0.179	56.946	561050.00
100	16.50	74.554	50.248	0.180	56.946	561048.88
100	16.75	74.559	50.123	0.179	56.947	561053.94
100	17.00	74.560	50.154	0.179	56.946	561048.19
100	17.25	74.576	50.048	0.178	56.947	561038.13
100	17.50	74.565	50.124	0.179	56.947	561048.44
100	17.75	74.577	50.019	0.178	56.947	561041.94
100	18.00	74.586	50.000	0.178	56.948	561041.50
100	18.25	74.583	50.057	0.178	56.948	561038.75
100	18.50	74.593	50.096	0.179	56.948	561034.88
100	18.75	74.604	50.116	0.179	56.948	561022.94
100	19.00	74.604	50.028	0.178	56.949	561027.63
100	19.25	74.610	50.021	0.178	56.950	561027.31
100	19.50	74.624	50.019	0.178	56.949	561010.13
100	19.75	74.628	50.107	0.179	56.949	561003.94



AVERAGE DATA VALUES						
DATE	TIME	RTD	DEW PT.	VAP PRESS	DRY PRESS	MASS
100	20.00	74.630	50.084	0.179	56.949	561001.69
100	20.25	74.641	50.048	0.178	56.950	560996.13
100	20.50	74.645	50.048	0.178	56.950	560995.25
100	20.75	74.647	50.184	0.179	56.949	560987.38
100	21.00	74.649	49.920	0.177	56.952	561007.56
100	21.25	74.663	50.050	0.178	56.952	560995.06
100	21.50	74.679	50.012	0.178	56.953	560985.38
100	21.75	74.694	49.914	0.177	56.954	560982.00
100	22.00	74.696	49.937	0.178	56.955	560987.31
100	22.25	74.703	50.016	0.178	56.955	560986.56
100	22.50	74.725	50.050	0.178	56.956	560968.44
100	22.75	74.732	49.989	0.178	56.957	560977.44
100	23.00	74.744	50.063	0.178	56.958	560966.91
100	23.25	74.765	49.972	0.178	56.960	560963.81
100	23.50	74.778	49.994	0.178	56.961	560964.75
100	23.75	74.793	50.028	0.178	56.962	560956.81
100	24.00	74.812	49.997	0.178	56.963	560952.00

TEST MODE

Page 1

## LEAKAGE RATE SUMMARY UNIT 2

		TOTAL TIME			MASS/POINT	
DATE	TIME	TTLM	LMCALC	SL	LAM	L95
99	0.00	0.0000	0.0000	0.0000	0.0000	0.0000
99	0.25	0.2608	0.0000	0.0000	0.0000	0.0000
100	0.50	0.0165	0.0165	0.0000	0.0171	1.2264
100	0.75	0.0452	-0.0003	1.0793	0.0180	0.2040
100	1.00	0.0924	0.0323	0.5879	0.0616	0.1660
100	1.25	0.0257	0.0093	0.3642	0.0306	0.1032
100	1.50	0.0397	0.0065	0.2857	0.0279	0.0765
100	1.75	0.0131	-0.0062	0.2252	0.0126	0.0517
100	2.00	0.0286	-0.0066	0.1992	0.0137	0.0432
100	2.25	0.0388	-0.0023	0.1877	0.0199	0.0440
100	2.50	0.0313	-0.0012	0.1743	0.0208	0.0402
100	2.75	0.0356	0.0013	0.1661	0.0242	0.0405
100	3.00	0.0564	0.0097	0.1687	0.0347	0.0520
100	3.25	0.0451	0.0132	0.1645	0.0371	0.0521
100	3.50	0.0299	0.0122	0.1553	0.0339	0.0472
100	3.75	0.0394	0.0138	0.1508	0.0346	0.0462
100	4.00	0.0442	0.0164	0.1483	0.0369	0.0474
100	4.25	0.0453	0.0188	0.1461	0.0389	0.0484
100	4.50	0.0461	0.0211	0.1442	0.0406	0.0492
100	4.75	0.0483	0.0235	0.1428	0.0426	0.0506
100	5.00	0.0351	0.0231	0.1384	0.0406	0.0480
100	5.25	0.0506	0.0256	0.1379	0.0429	0.0501
100	5.50	0.0457	0.0269	0.1362	0.0438	0.0504
100	5.75	0.0499	0.0287	0.1354	0.0452	0.0514
100	6.00	0.0491	0.0302	0.1343	0.0461	0.0518
100	6.25	0.0470	0.0313	0.1328	0.0465	0.0518
100	6.50	0.0439	0.0318	0.1309	0.0461	0.0511
100	6.75	0.0412	0.0318	0.1286	0.0452	0.0498
100	7.00	0.0426	0.0321	0.1268	0.0449	0.0493
100	7.25	0.0447	0.0326	0.1253	0.0451	0.0491
100	7.50	0.0500	0.0338	0.1248	0.0461	0.0500
100	7.75	0.0486	0.0346	0.1240	0.0469	0.0506
100	8.00	0.0491	0.0355	0.1233	0.0475	0.0511
100	8.25	0.0449	0.0358	0.1220	0.0472	0.0505
100	8.50	0.0486	0.0365	0.1212	0.0477	0.0508
100	8.75	0.0484	0.0371	0.1204	0.0480	0.0509
100	9.00	0.0493	0.0378	0.1198	0.0484	0.0512
100	9.25	0.0538	0.0389	0.1197	0.0493	0.0522
100	9.50	0.0476	0.0392	0.1188	0.0495	0.0522
100	9.75	0.0519	0.0400	0.1185	0.0499	0.0526

## LEAKAGE RATE SUMMARY UNIT 2

		TOTAL TIME			MASS/POINT	
DATE	TIME	TTLM	LMCALC	SL	LAM	L95
100	10.00	0.0503	0.0405	0.1179	0.0503	0.0529
100	10.25	0.0515	0.0412	0.1175	0.0508	0.0533
100	10.50	0.0525	0.0418	0.1171	0.0513	0.0537
100	10.75	0.0492	0.0421	0.1164	0.0513	0.0536
100	11.00	0.0484	0.0424	0.1157	0.0512	0.0534
100	11.25	0.0484	0.0426	0.1150	0.0510	0.0531
100	11.50	0.0523	0.0431	0.1146	0.0514	0.0534
100	11.75	0.0530	0.0437	0.1144	0.0518	0.0538
100	12.00	0.0519	0.0441	0.1140	0.0520	0.0539
100	12.25	0.0512	0.0445	0.1135	0.0523	0.0542
100	12.50	0.0543	0.0450	0.1133	0.0527	0.0545
100	12.75	0.0527	0.0454	0.1130	0.0529	0.0547
100	13.00	0.0516	0.0457	0.1126	0.0531	0.0548
100	13.25	0.0514	0.0460	0.1121	0.0530	0.0547
100	13.50	0.0545	0.0465	0.1119	0.0535	0.0551
100	13.75	0.0558	0.0470	0.1118	0.0540	0.0556
100	14.00	0.0558	0.0475	0.1117	0.0544	0.0560
100	14.25	0.0527	0.0478	0.1113	0.0544	0.0560
100	14.50	0.0543	0.0481	0.1111	0.0547	0.0562
100	14.75	0.0589	0.0488	0.1112	0.0553	0.0570
100	15.00	0.0569	0.0492	0.1111	0.0558	0.0574
100	15.25	0.0544	0.0495	0.1108	0.0559	0.0575
100	15.50	0.0546	0.0498	0.1106	0.0560	0.0576
100	15.75	0.0541	0.0501	0.1103	0.0561	0.0576
100	16.00	0.0563	0.0504	0.1101	0.0564	0.0579
100	16.25	0.0587	0.0509	0.1101	0.0570	0.0585
100	16.50	0.0581	0.0513	0.1101	0.0573	0.0588
100	16.75	0.0560	0.0516	0.1099	0.0574	0.0589
100	17.00	0.0566	0.0519	0.1097	0.0576	0.0590
100	17.25	0.0583	0.0523	0.1096	0.0579	0.0593
100	17.50	0.0549	0.0525	0.1093	0.0579	0.0593
100	17.75	0.0557	0.0527	0.1091	0.0579	0.0593
100	18.00	0.0551	0.0529	0.1088	0.0579	0.0592
100	18.25	0.0549	0.0530	0.1086	0.0580	0.0592
100	18.50	0.0551	0.0532	0.1083	0.0580	0.0592
100	18.75	0.0571	0.0534	0.1081	0.0582	0.0594
100	19.00	0.0553	0.0535	0.1079	0.0582	0.0594
100	19.25	0.0546	0.0536	0.1076	0.0582	0.0593
100	19.50	0.0577	0.0539	0.1075	0.0584	0.0595
100	19.75	0.0583	0.0542	0.1074	0.0585	0.0597

LEAKAGE RATE SUMMARY UNIT 2						
		TOTAL TIME			MASS/POINT	
DATE	TIME	TTLM	LMCALC	SL	LAM	L95
100	20.00	0.0581	0.0544	0.1073	0.0588	0.0598
100	20.25	0.0585	0.0547	0.1072	0.0589	0.0600
100	20.50	0.0580	0.0549	0.1070	0.0591	0.0602
100	20.75	0.0589	0.0551	0.1070	0.0593	0.0604
100	21.00	0.0541	0.0552	0.1066	0.0591	0.0602
100	21.25	0.0560	0.0553	0.1064	0.0591	0.0602
100	21.50	0.0572	0.0554	0.1062	0.0592	0.0602
100	21.75	0.0573	0.0556	0.1061	0.0593	0.0603
100	22.00	0.0556	0.0557	0.1058	0.0592	0.0602
100	22.25	0.0551	0.0557	0.1056	0.0592	0.0601
100	22.50	0.0579	0.0559	0.1054	0.0593	0.0603
100	22.75	0.0556	0.0559	0.1052	0.0592	0.0601
100	23.00	0.0570	0.0560	0.1050	0.0593	0.0602
100	23.25	0.0569	0.0562	0.1048	0.0593	0.0602
100	23.50	0.0561	0.0562	0.1046	0.0593	0.0602
100	23.75	0.0570	0.0563	0.1045	0.0593	0.0601
100	24.00	0.0572	0.0564	0.0644	0.0593	0.0602

## UNIT 2

THE HOUSE

21-06-88

**00000000**

四  
 三  
 二  
 一

2330/100

[illegible]

5.6127

UNIT 2

MASS

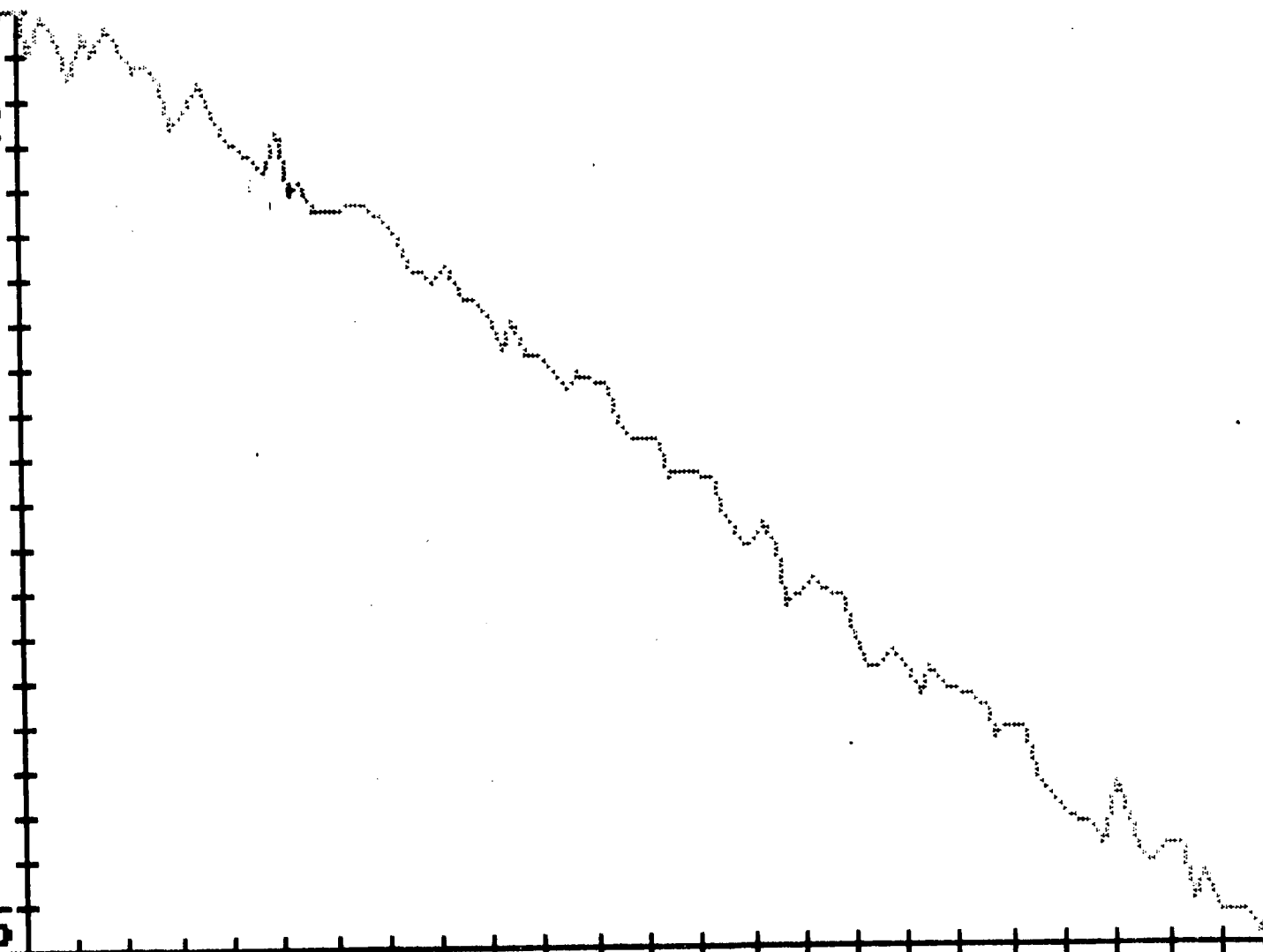
LBM  
 $\times 10^5$

5.6095

2330/ 99

TIME

2330/ 100



56.963

UNIT 2

PRESSURE

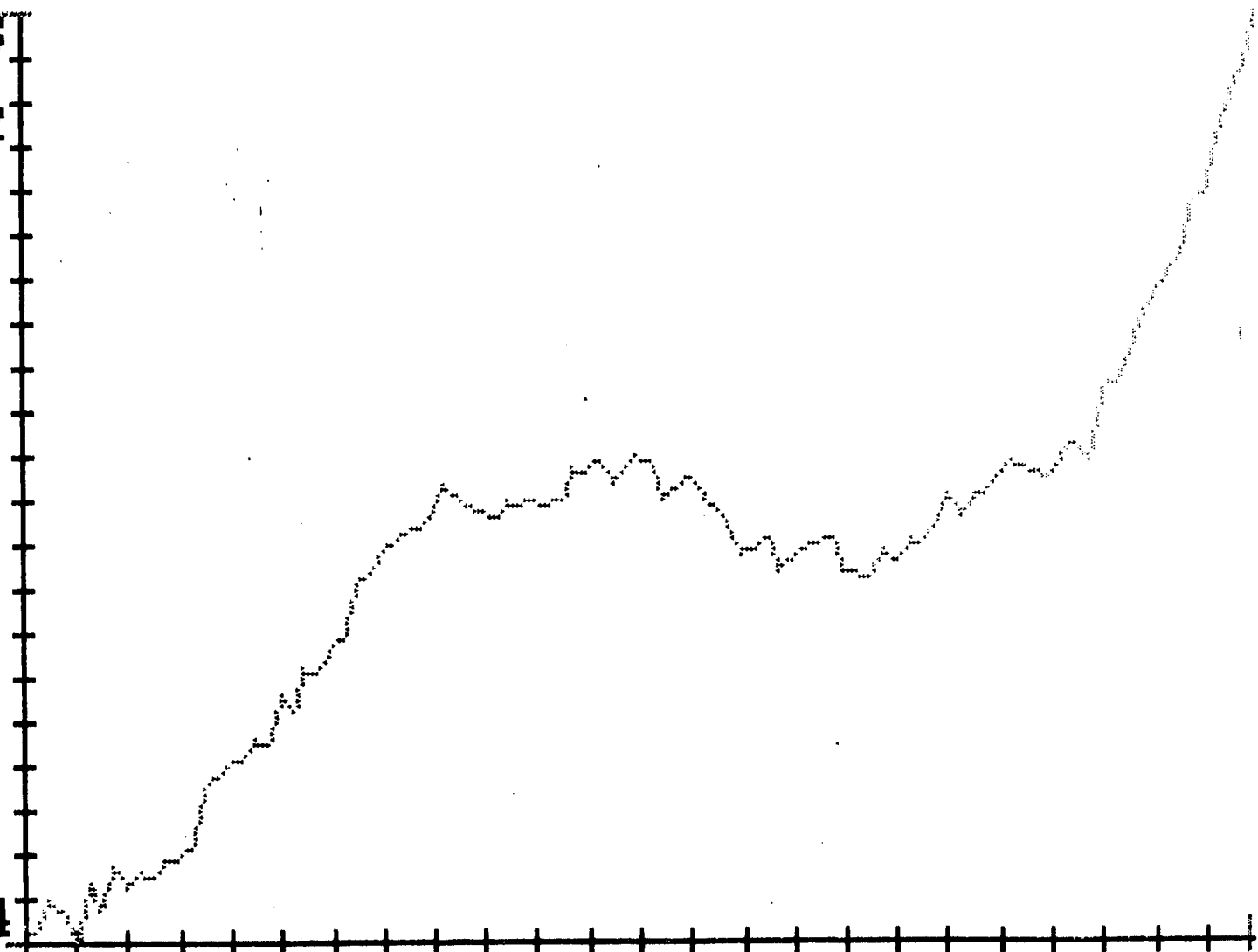
PSIA

56.934

2330/ 99

TIME

2330/ 100



74.812

UNIT 2

TEMPERATURE

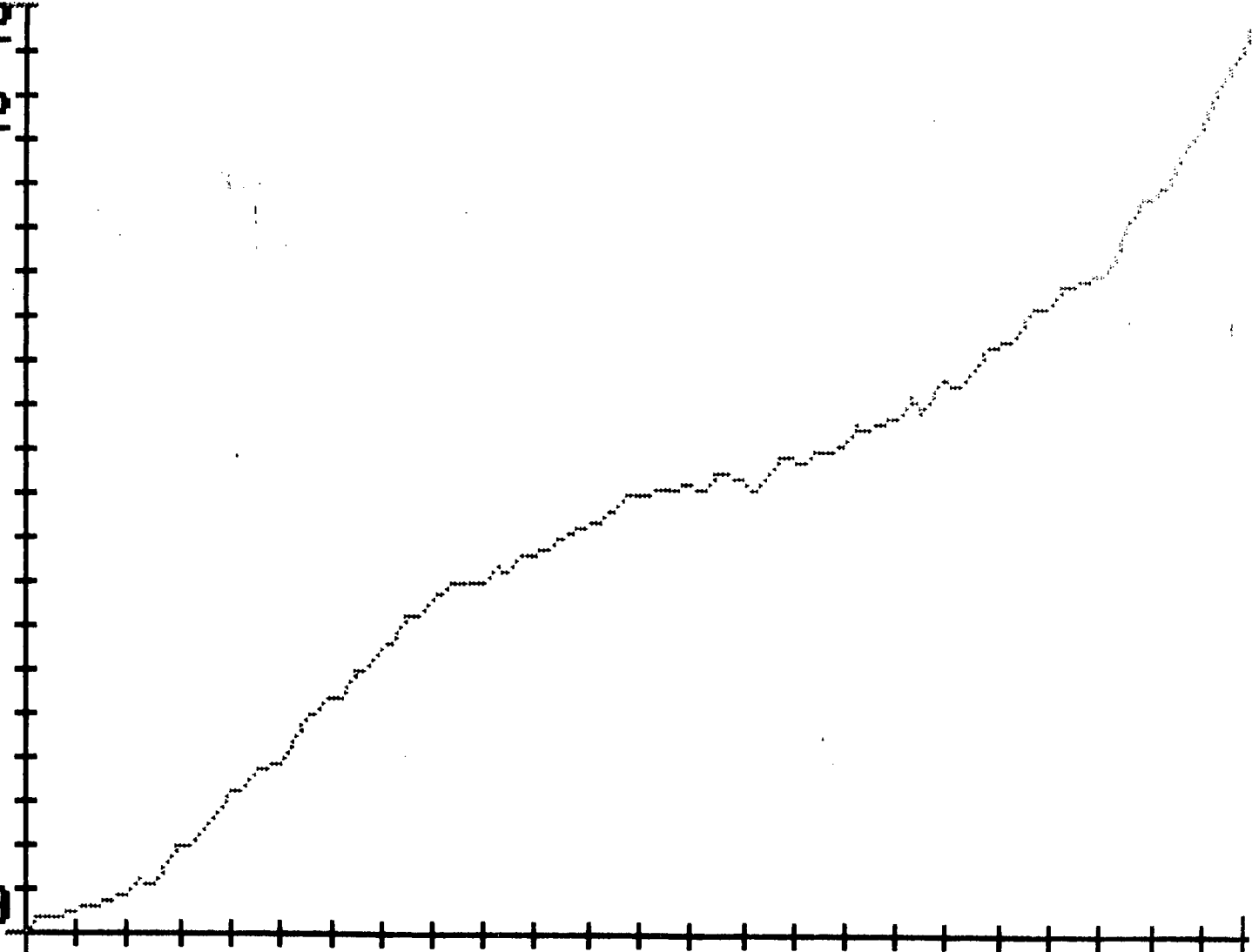
F

74.239

2330/ 99

TIME

2330/ 100





50.864

UNIT 2

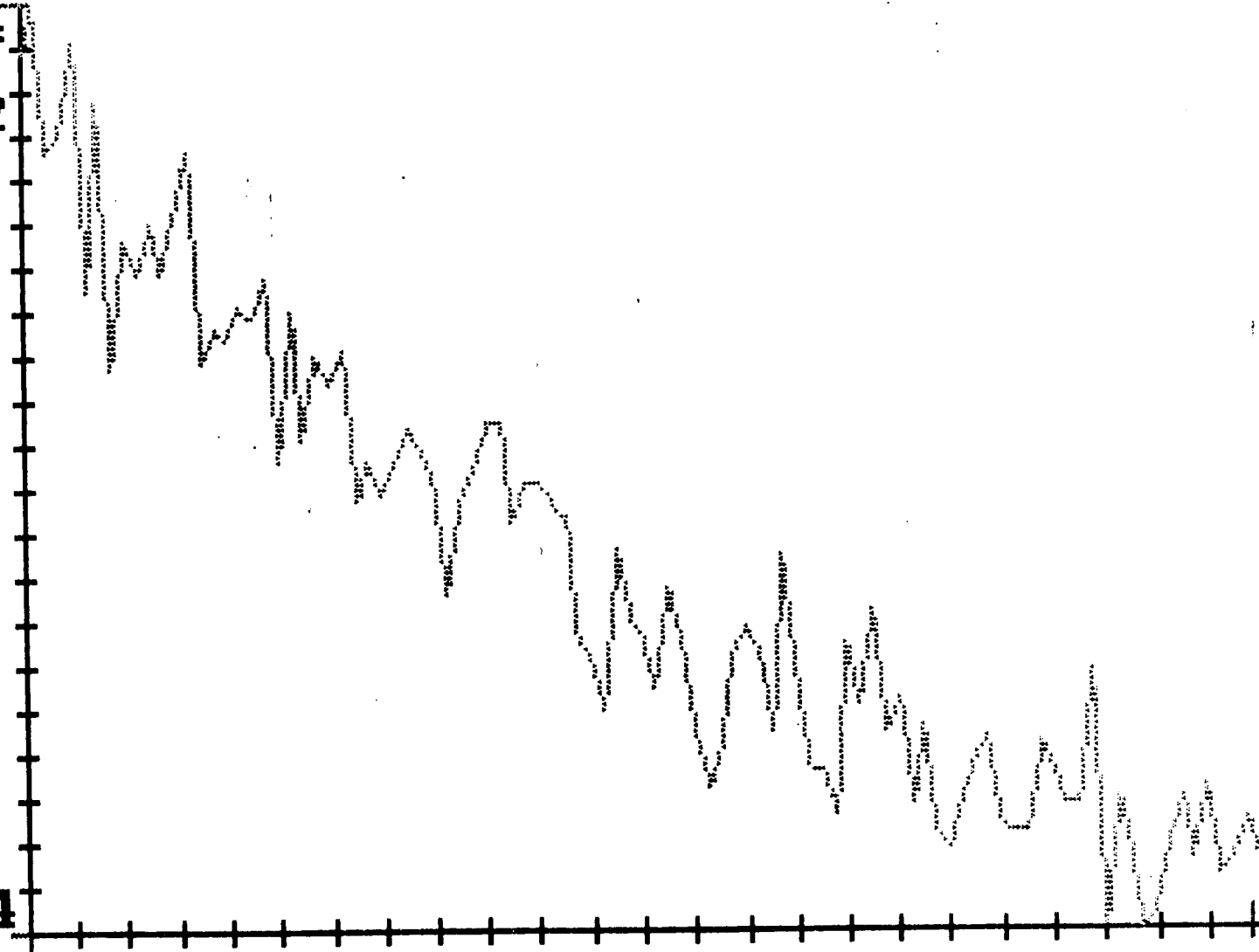
AC  
C  
D  
E  
E  
T  
P  
F

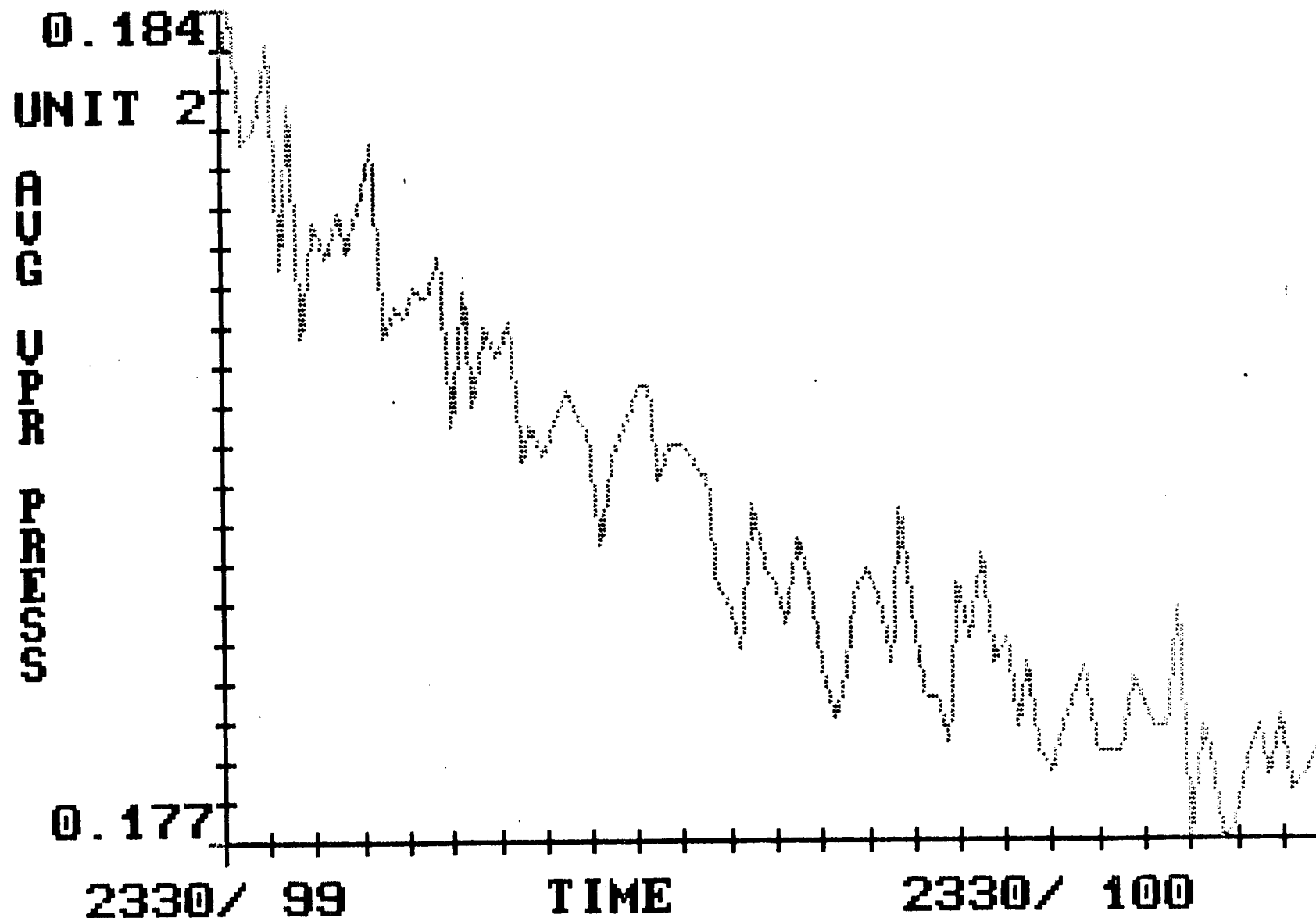
49.914

2330/ 99

TIME

2330/ 100





GP-R-213850

GENERAL PHYSICS CORPORATION

APPENDIX C  
VERIFICATION TEST DATA AND PLOTS

VERIFICATION MODE  
OPTIONS:

TIME= 0345  
TEST SUMMARY

- MANUAL DATA ENTRY
- PARAMETER GRAPHS
- 3 - SENSOR PLOTS
- 4 - TREND ANALYSIS
- 5 - REPRINT CURRENT DATA PT
- 6 - SENSOR DIFFERENTIALS

P - PASS WORD MENU

SELECTED OPTION =

# OF DATA POINTS = 17  
MODE DURATION (IN HOURS) = 4.00  
TOT TIME MEASURED LEAK = 0.1642  
TOT TIME CALCULATED LEAK = 0.1472  
MASS PT LEAK = 0.1563  
IMPOSED LEAK = 0.0992  
TOT TIME UPPER LIMIT = 0.1806  
TOT TIME LOWER LIMIT = 0.1306  
MASS PT UPPER LIMIT = 0.1835  
MASS PT LOWER LIMIT = 0.1335

TOT TIME VERIFICATION CRITERIA HAS BEEN MET

MASS PT VERIFICATION CRITERIA HAS BEEN MET

POINT SUMMARY: CURRENT VALUE/DIFFERENCE FROM PREVIOUS POINT

AVG TEMP: 75.052/ +0.013  
MASS: 560800.75/ -13.000

AVG PRESS: 56.974 / +0.000  
AVG DEW PRESS: 0.1775/ +0.0005  
TOTAL PRESS: 57.151 / +0.001

LEAKAGE RATE SUMMARY UNIT 2							
		TOTAL TIME				MASS/POINT	
DATE	TIME	TTLM	LMCALC	SL	LAM	L95	
100	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
101	0.25	0.3006	0.0000	0.0000	0.0000	0.0000	0.0000
101	0.50	0.2015	0.2015	0.0000	0.2011	0.6925	0.6925
101	0.75	0.1872	0.1731	0.5083	0.1788	0.2638	0.2638
101	1.00	0.2210	0.1896	0.4271	0.2026	0.2538	0.2538
101	1.25	0.1827	0.1754	0.3273	0.1839	0.2211	0.2211
101	1.50	0.2183	0.1876	0.3244	0.2012	0.2325	0.2325
101	1.75	0.1765	0.1758	0.2878	0.1850	0.2139	0.2139
101	2.00	0.1667	0.1649	0.2610	0.1714	0.1976	0.1976
101	2.25	0.1792	0.1628	0.2505	0.1703	0.1908	0.1908
101	2.50	0.1750	0.1603	0.2413	0.1684	0.1851	0.1851
101	2.75	0.1750	0.1589	0.2349	0.1675	0.1813	0.1813
101	3.00	0.1621	0.1542	0.2251	0.1620	0.1749	0.1749
101	3.25	0.1666	0.1522	0.2196	0.1603	0.1713	0.1713
101	3.50	0.1650	0.1504	0.2150	0.1588	0.1685	0.1685
101	3.75	0.1602	0.1480	0.2099	0.1566	0.1654	0.1654
101	4.00	0.1642	0.1472	0.2073	0.1563	0.1640	0.1640

VERF MODE

Page 1

AVERAGE MASS		
DATE	TIME (HOURS)	MASS (LBM)
100	0.00	560954.19
101	0.25	560936.63
101	0.50	560930.69
101	0.75	560921.44
101	1.00	560902.63
101	1.25	560900.81
101	1.50	560877.69
101	1.75	560882.06
101	2.00	560876.25
101	2.25	560859.94
101	2.50	560852.00
101	2.75	560841.75
101	3.00	560840.56
101	3.25	560827.63
101	3.50	560819.19
101	3.75	560813.75
101	4.00	560800.75

0.3846

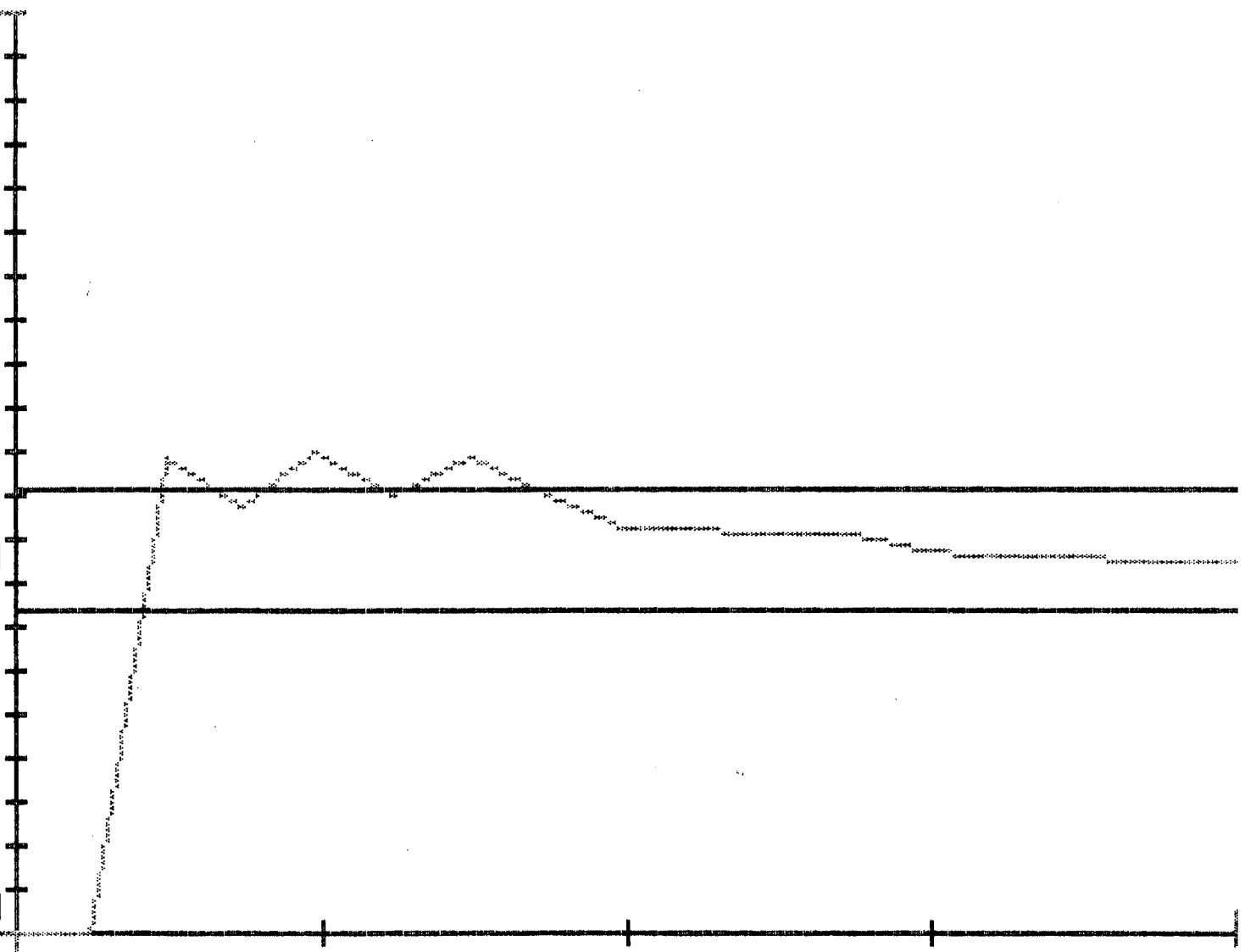
UNIT 2

MASS  
ANAL.

WT%/  
DAY

LEGEND  
= L

0.0000



2345/ 100

TIME

0345/ 101

5.6095

UNIT 2

MASS

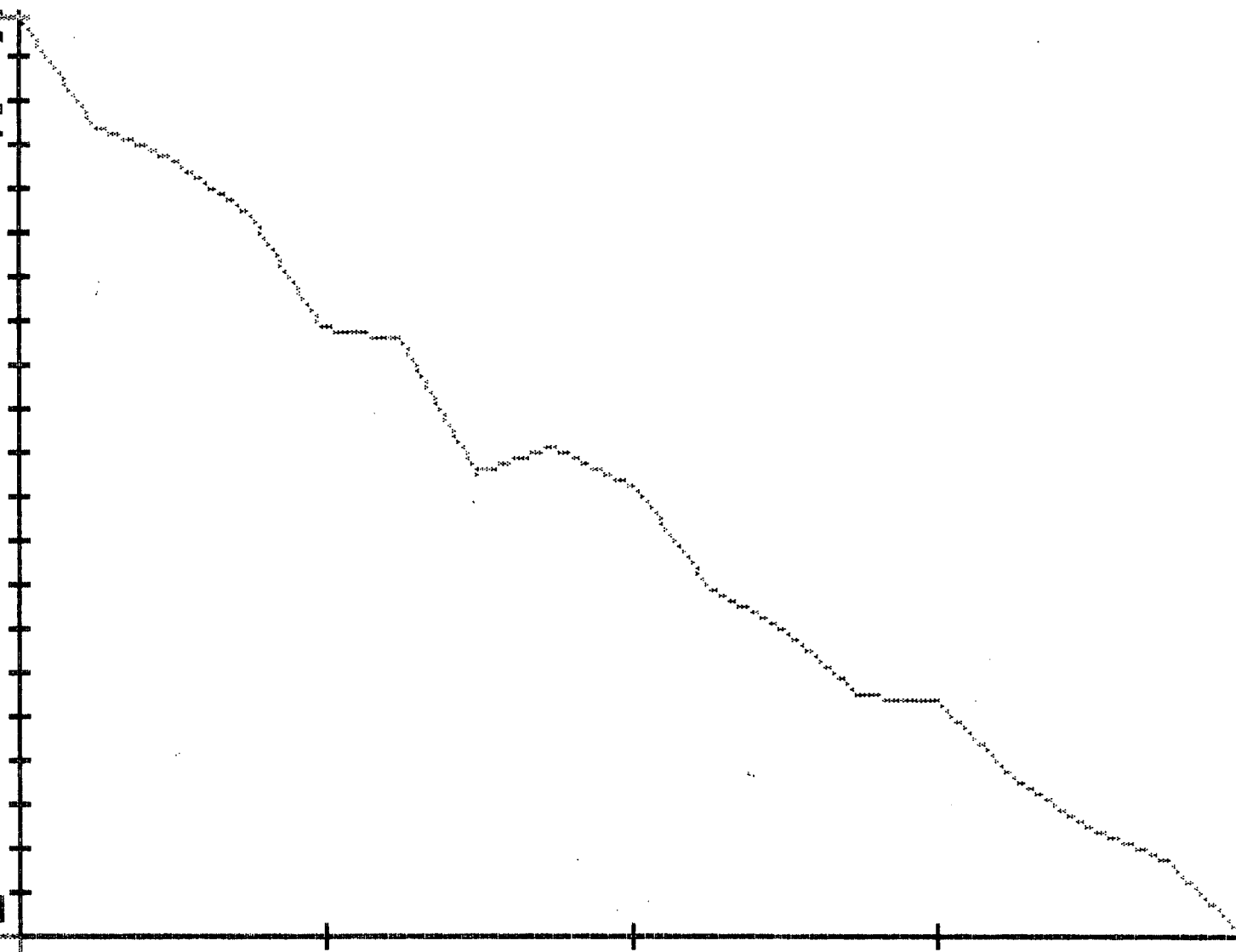
LBM  
 $\times 10^5$

5.6080

2345/ 100

TIME

0345/ 101





57.151

UNIT 2

PRESSURE

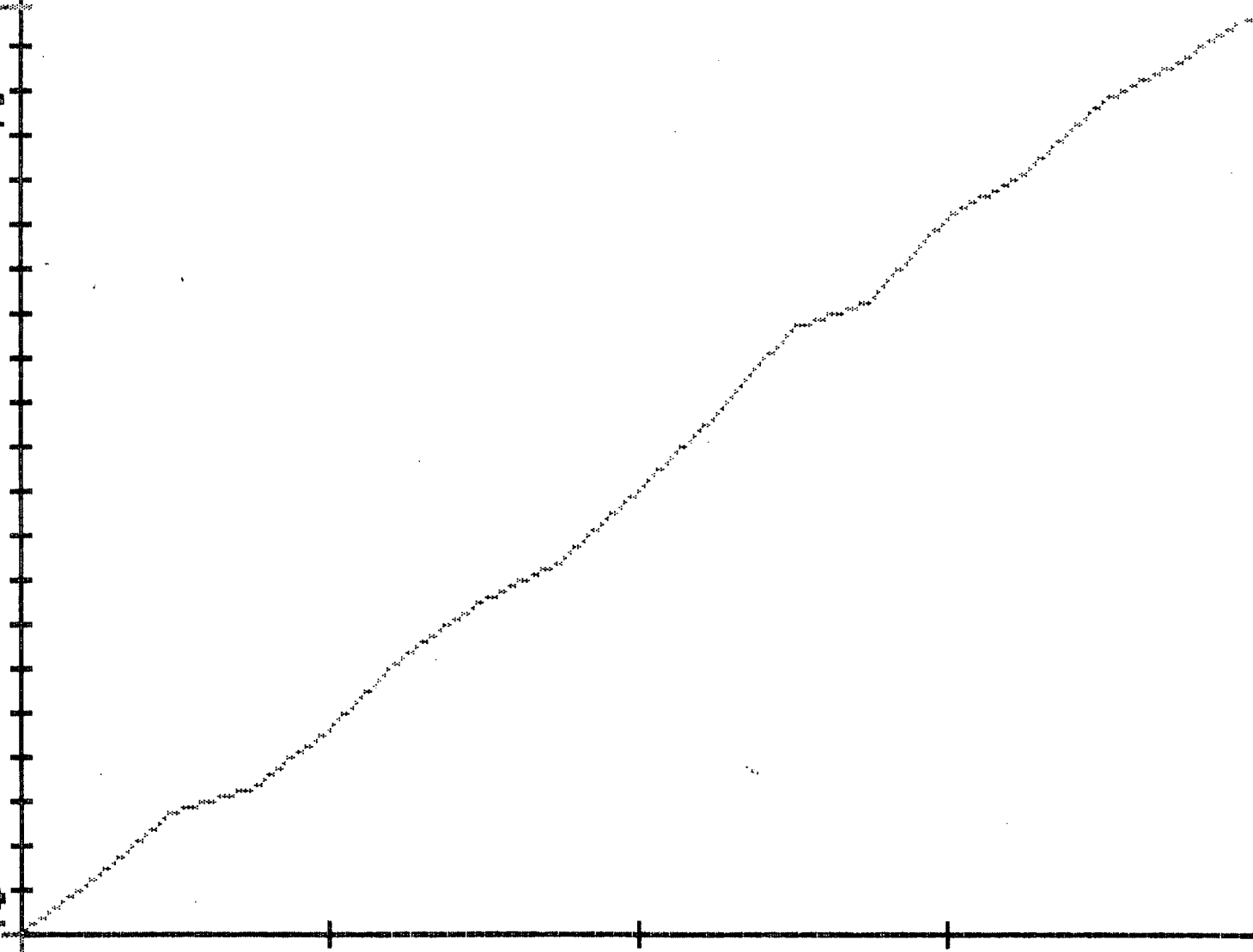
PSIA

57.142

2345/ 100

TIME

0345/ 101



0.179

UNIT 2

AUG  
UPR  
PRESS

**D. 177**

2345/ 100

# TIME

0345/ 101

50.089

UNIT 2

TEMP I DEF DEG

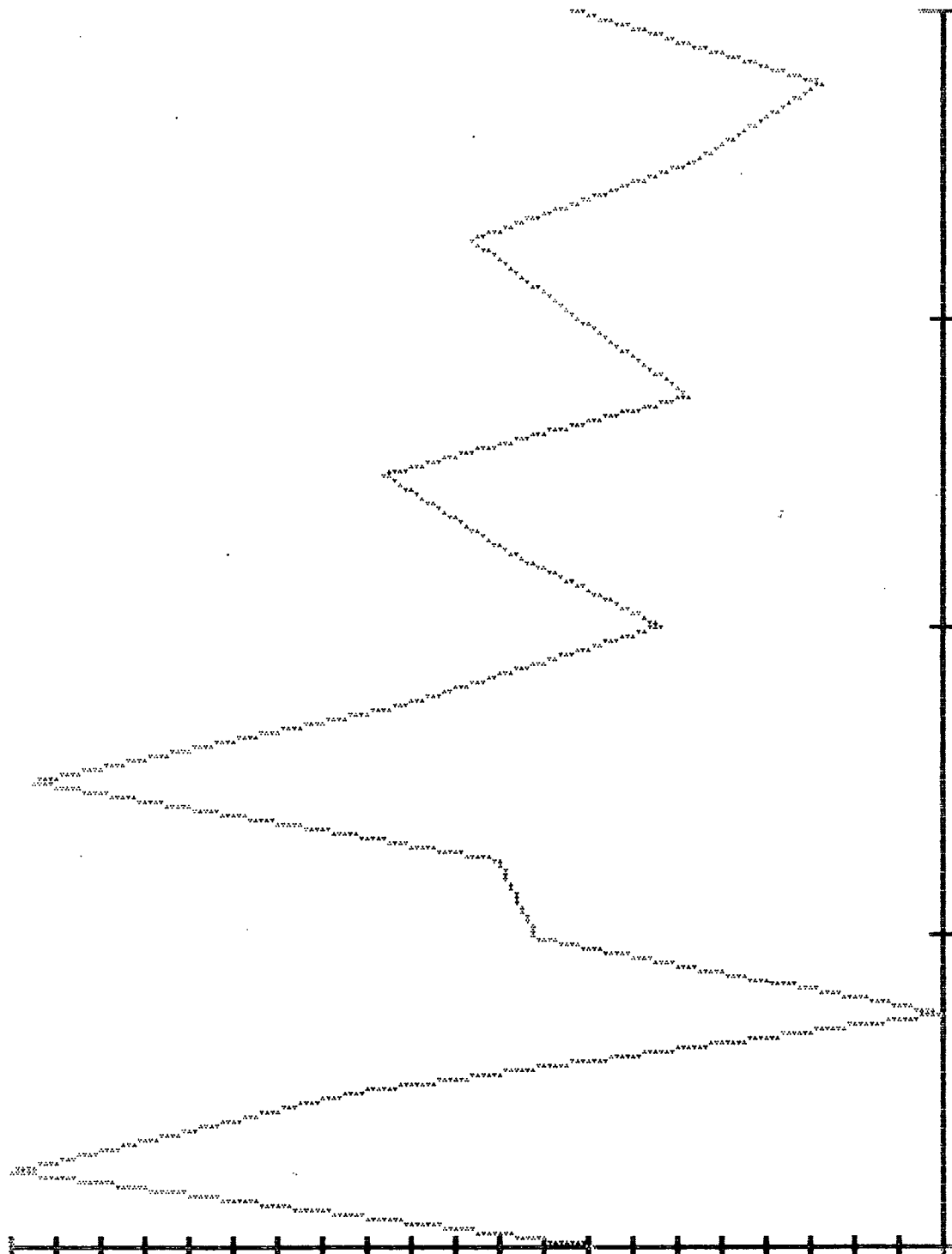
F

49.829

2345/ 100

TIME

0345/ 101



75.052

UNIT 2

TEMPERATURE

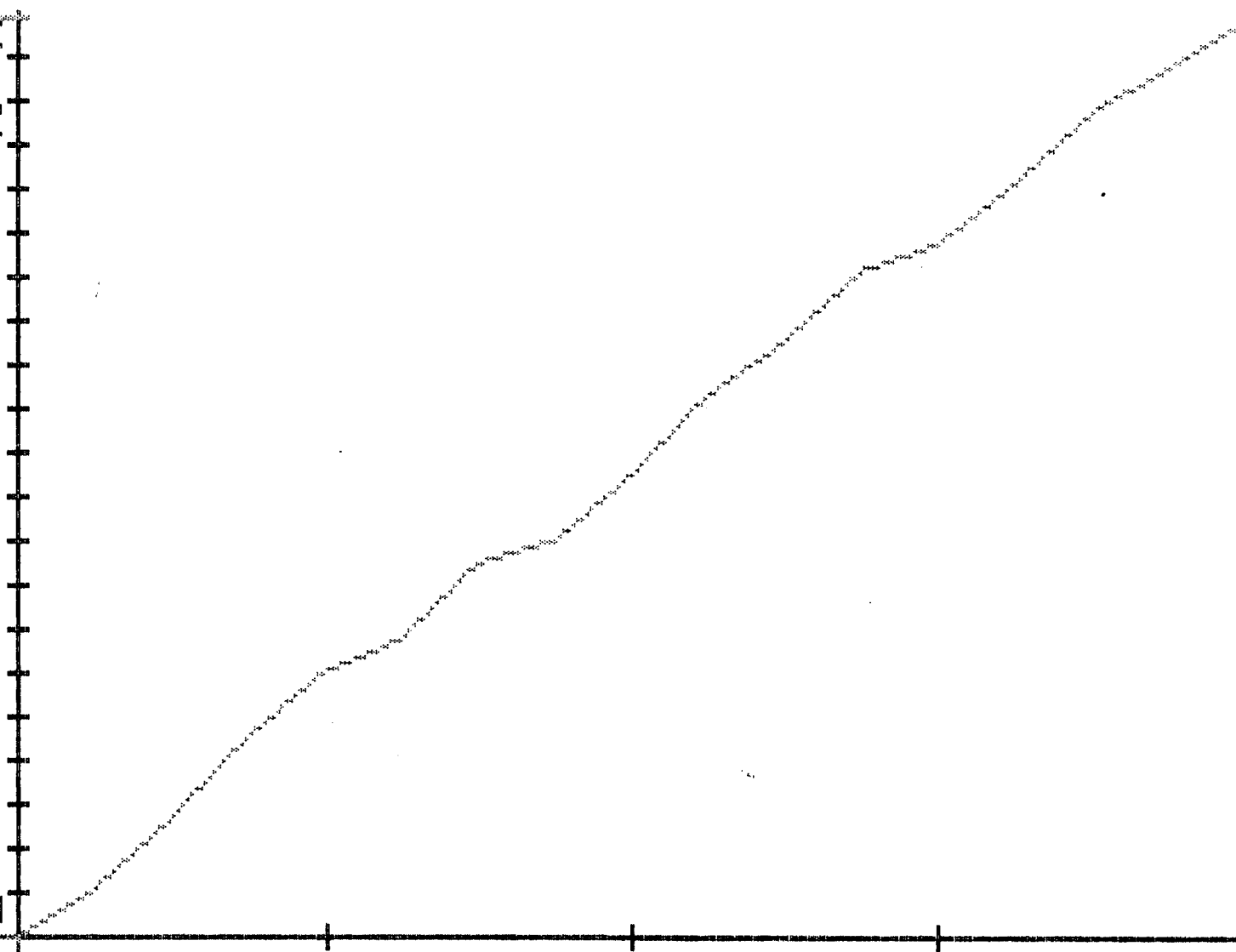
F

74.820

2345/ 100

TIME

0345/ 101



APPENDIX D

INSTRUMENT SELECTION GUIDE CALCULATION

## INSTRUMENT SELECTION GUIDE CALCULATION

Page 1 of 3

## A. TEST PARAMETERS

$$La = 0.1\%/day$$

$$P = 57.1 \text{ psia}$$

$$T = 534^\circ \text{ R}$$

$$T_{dp} = 50.8^\circ \text{ F}$$

$$t = 24 \text{ hours}$$

## B. INSTRUMENT PARAMETERS

## 1. Total Absolute Pressure

$$\text{No. of Sensors} = 2$$

$$\text{Range: } 0 - 100 \text{ psia}$$

$$\text{Sensor sensitivity error (E): } 0.001 \text{ psia}$$

$$\text{Measurement system error (e):}$$

$$\text{Resolution: } 0.0001 \text{ psia}$$

$$\text{Repeatability: } 0.001 \text{ psia}$$

$$e = +/\text{- } ((0.0001)^2 + (0.001)^2)^{1/2}$$

$$e = +/\text{- } 0.001005 \text{ psia}$$

$$e_p = +/\text{- } ((0.001)^2 + (0.001005)^2)^{1/2} / (2)^{1/2}$$

$$e_p = +/\text{- } 0.001 \text{ psia}$$

## 2. Water Vapor Pressure

$$\text{No. of Sensors} = 5$$

$$\text{Sensor sensitivity error (E): } 0.01^\circ \text{ F}$$

Measurement system error ( $e$ ):

Resolution:  $0.014^{\circ} \text{ F}$

Repeatability:  $0.054^{\circ} \text{ F}$

$$e = +/\text{-} ((0.014)^2 + (0.054)^2)^{1/2}$$

$$e = +/\text{-} 0.05579^{\circ} \text{ F}$$

At a dewpoint of  $50.8^{\circ} \text{ F}$ , the equivalent dewpoint temperature change related to dewcell temperature change is  $0.667^{\circ} \text{ F}/^{\circ} \text{ F}$ .

$$E = 0.01^{\circ} \text{ F} (0.667^{\circ} \text{ F}/^{\circ} \text{ F})$$

$$E = 0.00667^{\circ} \text{ F}$$

$$e = 0.05579^{\circ} \text{ F} (0.667^{\circ} \text{ F}/^{\circ} \text{ F})$$

$$e = 0.0372^{\circ} \text{ F}$$

At a dewpoint of  $50.8^{\circ} \text{ F}$ , the equivalent water vapor pressure change (as determined from steam tables) is  $0.006 \text{ psia}/^{\circ} \text{ F}$ .

$$E = 0.00667^{\circ} \text{ F} (0.006 \text{ psia}/^{\circ} \text{ F})$$

$$E = 0.00004 \text{ psia}$$

$$e = 0.0372^{\circ} \text{ F} (0.006 \text{ psia}/^{\circ} \text{ F})$$

$$e = 0.00022 \text{ psia}$$

$$e_{\text{pv}} = +/\text{-} ((0.00004)^2 + (0.00022)^2)^{1/2} / (5)^{1/2}$$

$$e_{\text{pv}} = +/\text{-} 0.0001 \text{ psia}$$

## 3. Temperature

No. of Sensors = 24

Sensor sensitivity error (E):  $0.01^{\circ}\text{F}$

Measurement system error (e):

Resolution:  $0.014^{\circ}\text{F}$

Repeatability:  $0.054^{\circ}\text{F}$

$$e = ((0.014)^2 + (0.054)^2)^{1/2}$$

$$e = 0.005579^{\circ}\text{F} = 0.05579^{\circ}\text{R}$$

$$e_T = +/- ((0.01)^2 + (0.05579)^2)^{1/2} / (24)^{1/2}$$

$$e_T = +/- 0.01157^{\circ}\text{R}$$

## 4. Instrumentation Selection Guide Formula

$$\text{ISG} = +/- 2400/t (2(e_p/P)^2 + 2(e_{pv}/P)^2 + 2(e_T/T)^2)^{1/2}$$

$$\begin{aligned} \text{ISG} = +/- (2400/24) (2(0.001/57.1)^2 + 2(0.0001/57.1)^2 \\ + 2(0.01157/534)^2)^{1/2} \end{aligned}$$

$$\text{ISG} = +/- 0.003 \text{ \%/day}$$



APPENDIX E

GENERAL PHYSICS ILRT COMPUTER PROGRAM DESCRIPTION

## DESCRIPTION OF GENERAL PHYSICS ILRT COMPUTER PROGRAM

The following paragraphs describe the various features and attributes of the General Physics ILRT Computer Program and the process used to certify it for each application.

### REDUNDANCY

The General Physics ILRT team was equipped with two fully operational IBM compatible microcomputers during the ILRT and for on site data reduction and analysis. The computer software and hardware interfaced directly with the ILRT Measurement System Data Acquisition System (Fluke 2285B).

Two computers were brought on site for 100% redundancy, as each computer and its software is capable of independently performing the ILRT. The General Physics ILRT Computer Software is also capable of accepting manual input of raw sensor data and performing all required sensor data conversions if the data logger should cease to function. Each computer was equipped with back-up discs in the unlikely event of a disc "crash."

### SECURITY

The General Physics ILRT Computer Program is written in IBM's BASICA. BASICA is a high level programming language which combines programming ease with user oriented command functions to create an easy to use and understand program. In order to increase speed of operation the program was then compiled into an executable command file. Compiling was accomplished using the IBM Basic Compiler. In addition to execution speed, this had the added benefit of making the program more secure as compiled programs cannot be edited or changed. The program requires a password to change modes of operation, start times, or enter the data editing routine to safeguard the integrity of the raw data files.

## FEATURES

The program itself is designed to be a menu driven program consisting of five separate, menu driven operating modes. These are the:

1. Pressurization Mode
2. Stabilization Mode
3. Test Mode
4. Verification Mode
5. Depressurization Mode

These modes also correspond to the phases of the ILRT. Menu driven means that the user is presented with a list of options that the program can perform and from which the user can choose. It allows for interactive information exchange between the user and the computer and prevents invalid information or user mistakes from crashing the program. Program organization consists of a master menu which controls access to the seven operating modes chained to the individual menus which control these modes. The data processing, information display capabilities and function of each mode is as follows:

1. Pressurization Mode: All data reduction, graphic displays of average temperature, dewpoint, and corrected pressure.
2. Stabilization Mode: All data reduction, automatic comparison of data against ANSI 56.8 and BN-TOP-1 temperature stabilization criteria, notification when criteria is met, graphic displays of average temperature, dewpoint, and corrected pressure.
3. Test Mode: All data reduction, calculation of leakage rates using mass point, total time and point-to-point analysis techniques, display of trend report information required by BN-TOP-1, graphic display of average temperature, dewpoint, pressure and mass, as well as graphic display of mass point measured leakage, 95% UCL; total time measured and calculated leakage and the total time leakage rate at the 95% UCL (as calculated by BN-TOP-1), including a superimposed acceptance criteria line).

4. Verification Test Mode: With input of imposed leakage in SCFM automatically calculates and displays on graph and trend report the acceptance criteria band, plus all graphics displays available in test mode.
5. Depressurization Mode: All data and graphics capabilities of Pressurization Mode. In programs for BWR units, this mode also includes a Drywell to Suppression Chamber Bypass Test routine.

Other reduction and analysis capabilities of the General Physics ILRT computer program include:

1. Containment total pressure conversion from counts to psia (if required), and averaging.
2. Containment drybulb temperature weighted averaging and conversion to absolute units.
3. Containment dewpoint temperature weighted averaging (conversion from Foxboro dewcell element temperature to dewpoint temperature if required) and conversion to partial pressure of water vapor (psia).
4. Data storage of ILRT measurement system inputs for each data point.
5. Weight (mass) point calculations using the ideal gas law.
6. Automated Data Acquisition and/or Manual Data Entry.
7. Sensor performance and deviation information for sensor failure criteria, graphic display of individual sensor performance for selected operating mode.
8. Calculation of ISG formula at beginning of test; acceptance criteria based on number of sensors remaining and actual test duration.

9. Computer System Error Functions automatically checks for error in incoming data, printer or disk drive faults.

The computer program used by General Physics has been previously certified for six tests at the San Onofre Nuclear Generating Station and over a dozen other ILRTs. The initial certification required verification of the program through hand calculations and an independent review by Bechtel Power Corporation. After certification was completed, a calibration set of raw data was used to verify software of the program prior to usage. Additionally, once the computer was linked to the data acquisition system and a complete data stream was available, the input function of each mode of the program was verified by comparing the data acquisition system output to the computer printout data point summary.

GP-R-213850

GENERAL PHYSICS CORPORATION

APPENDIX F

LOCAL LEAKAGE RATE TEST SUMMARIES

## APPENDIX F

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## LOCAL LEAKAGE RATE TEST SUMMARIES

<u>PEN. NO.</u>	<u>SYSTEM</u>	<u>VALVE NO.</u>	<u>TEST DATE</u>	<u>LEAKAGE SCFM</u>
PAH	Personnel Airlock	-	10/27/87	0.16
			5/10/88	0.15
			10/27/88	0.14
			4/27/89	0.06
			11/28/89	2.12
			12/14/89	0.52
			12/15/89	0.04
			4/25/90	0
			1/18/91	0.11
			1/18/91	0
			11/12/91	0.12
--	PPS		6/7/87	0.24 *
			6/16/87	0.52
			1/21/89	0.66 *
			2/26/89	0.72
			3/8/89	0.69 *
			3/10/91	0.70
			3/18/91	0.67 *

\* These totals include leakage from the isolation valves in the two Containment Air Sample penetrations

<u>PEN. NO.</u>	<u>SYSTEM</u>	<u>VALVE NO.</u>	<u>TEST DATE</u>	<u>LEAKAGE SCCM</u>
2	Pressurizer Relief Tank N <sub>2</sub> Supply	RC-550	4/25/87	850
			11/18/88	1197.76
			9/17/90	1123.1
		RC-518	4/25/87	0
			11/18/88	349.35
			9/17/90	0

## APPENDIX F

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## LOCAL LEAKAGE RATE TEST SUMMARIES

<u>PEN. NO.</u>	<u>SYSTEM</u>	<u>VALVE NO.</u>	<u>TEST DATE</u>	<u>LEAKAGE SCCM</u>
4	Primary System Vent Header	WD-1713	5/12/87	226
			12/1/88	29
			11/18/90	Failed
			1/7/91	520
		WD-1966/ WD-1793	4/11/87	Failed
			5/7/87	Failed
			5/12/87	192
			12/1/88	310
			1/7/91	82.8
33	Instrument Air Header	PCV-1716	4/23/87	0
			1/3/89	0
			1/3/91	255.6
		IA-525	4/23/87	0
			1/3/89	0
			1/3/91	153.4
65	Accumulator N <sub>2</sub> Supply	SI-855	5/6/87	170.6
			3/1/88	23.2
			4/17/88	78.3
			1/5/89	32.6
			10/7/90	22.9
		SI-911	1/5/89	273
			10/7/90	248
67	Containment Superimposed Flow Line	VCT-13	4/13/87	610
			11/30/87	195
			10/12/90	0
68	Post Accident Sampling	PAS-5	4/24/87	0
			12/2/88	0
			12/5/90	0
		PAS-6	4/24/87	75
			12/2/88	90
			12/5/90	0



## APPENDIX F

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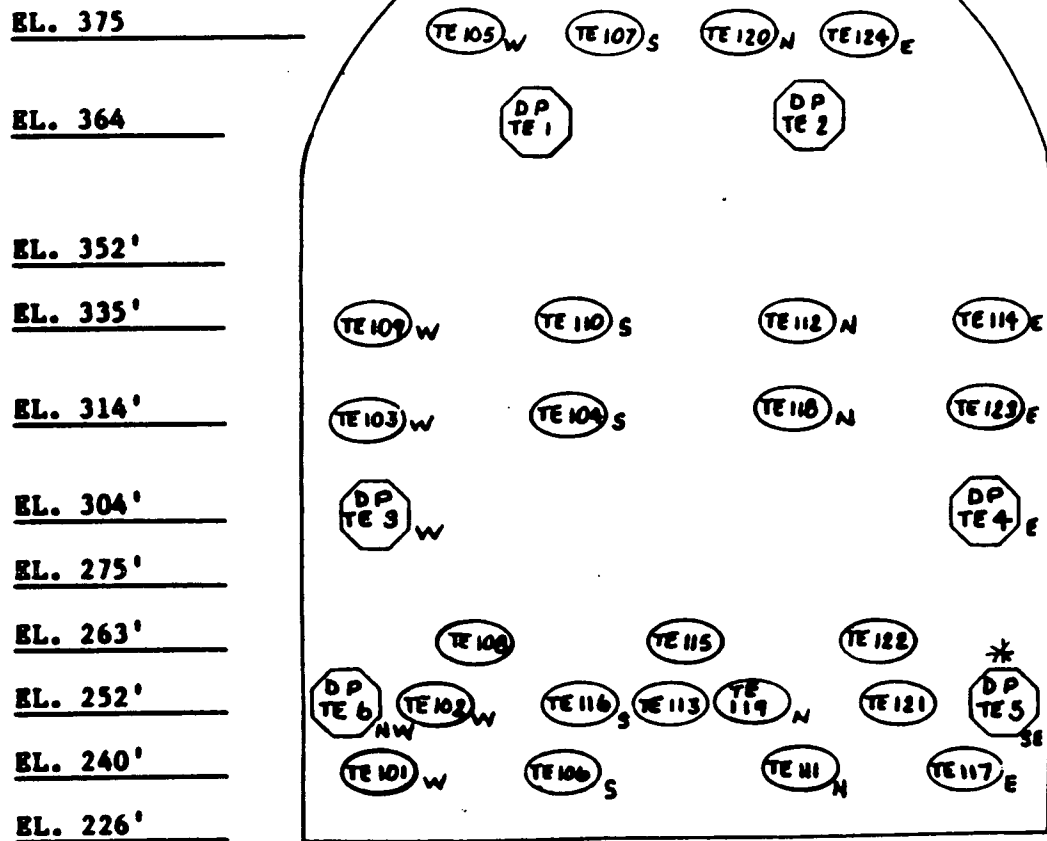
## LOCAL LEAKAGE RATE TEST SUMMARIES

<u>PEN. NO.</u>	<u>SYSTEM</u>	<u>VALVE NO.</u>	<u>TEST DATE</u>	<u>LEAKAGE SCCM</u>
69	Post Accident Sampling	PAS-3	4/24/87	0
			12/2/88	0
			12/5/90	0
		PAS-4	4/24/87	0
			12/2/88	0
			12/5/90	0
70	Post Accident Sampling	PAS-1	4/24/87	0
			12/2/88	0
			12/5/90	0
		PAS-2	4/24/87	0
			12/2/88	0
			12/5/90	0
73	Fire Protection	FP-256	5/8/87	0
			12/9/88	0
			11/29/90	0
		FP-258	5/8/87	0
			12/9/88	0
			11/29/90	0
74	Fire Protection	FP-248	5/8/87	0
			12/9/88	0
			11/29/90	0
		FP-249	5/8/87	0
			12/9/88	0
			11/29/90	255.6

APPENDIX G

SENSOR LOCATIONS AND VOLUME FRACTIONS

# RTD AND DEWCELL LOCATIONS



\* NOT USED FOR TEST

## H.B. ROBINSON RTD AND DEWCELL LOCATIONS

<u>ZONE</u>	<u>ZONE DESCRIPTION</u>	<u>ZONE VOLUME</u>	<u>RTD NO.</u>	<u>LOCATION</u>	<u>RTD VOLUME</u>	<u>VOLUME FRACTION</u>
1	Outside Sec. Shield between El. 228' - 252'	117,735	101	240' West	29,433.75	0.01509
			106	240' South	29,433.75	0.01509
			111	240' North	29,433.75	0.01509
			117	240' East	29,433.75	0.01509
2	Outside Sec. Shield between El. 252' - 275'	111,700	108	263' South	37,233.33	0.01909
			115	263' between HVE-5A & 5B	37,233.33	0.01909
			122	263' North side Equip. Hatch	37,233.34	0.01909
3	Steam Generator Compartments	116,172	102	252' C Pump Bay	38,737	0.01987
			113	252' B Pump Bay	38,717.5	0.01986
			121	252' A Pump Bay	38,717.5	0.01986
4	Reactor Cavity	34,287	116	252' inside Reactor Cavity South	17,143.5	0.00879
			119	252' inside Reactor Cavity North	17,143.5	0.00879
5	Cylinder between El. 275' - 314'	504,103	103	314' West	126,025.75	0.06463
			104	314' South	126,025.75	0.06463
			118	314' North	126,025.75	0.06463
			123	314' East	126,025.75	0.06463

## H.B. ROBINSON RTD AND DEWCELL LOCATIONS

<u>ZONE</u>	<u>ZONE DESCRIPTION</u>	<u>ZONE VOLUME</u>	<u>RTD NO.</u>	<u>LOCATION</u>	<u>RTD VOLUME</u>	<u>VOLUME FRACTION</u>
6	Cylinder between El. 314' - 352'	490,830	109	335' West	122,707.5	0.06293
			110	335' South	122,707.5	0.06293
			112	335' North	122,707.5	0.06293
			114	335' East	122,707.5	0.06293
			Use ends of polar crane			
7	Dome El. 352' - 417'	575,173	105	375' West	143,793.25	0.07374
			107	375' South	143,793.25	0.07374
			120	375' North	143,793.25	0.07374
			124	375' East	143,793.25	0.07374
<u>ZONE</u>	<u>ZONE DESCRIPTION</u>	<u>ZONE VOLUME</u>	<u>DEWCELL NO.</u>	<u>LOCATION</u>	<u>DEWCELL VOLUME</u>	<u>VOLUME FRACTION</u>
1	Cylinder between El. 228' - 275'	379,894	5	253' B Pump Bay	*	0.00000
			6	253' outside Sec.	379,894	0.19482
2	Cylinder between El. 275' - 352'	994,933	3	304' West	497,466.5	0.25511
			4	304' East	497,466.5	0.25511
3	Dome El. 352' - 417'	575,173	1	364' Southeast	287,586.5	0.14748
			2	364' Northeast	287,586.5	0.14748

\* - Dewcell 5 failed during the ILRT and was deleted from the calculations by assigning it a weighting factor of zero.

## H. B. ROBINSON

## SENSOR SINGLE FAILURE ANALYSIS

Page 1 of 3

<u>FAILED RTD NO.</u>	<u>ORIGINAL WEIGHTING FACTOR</u>	<u>NEW WEIGHTING FACTORS</u>
101	0.01509	101 - 0; 106 - 0.02012 111 - 0.02012; 117 - 0.02012
102	0.01987	102 - 0; 113 - 0.029795 121 - 0.029795
103	0.06463	103 - 0; 104 - 0.086173 118 - 0.086173; 123 - 0.086173
104	0.06463	104 - 0; 103 - 0.086173 118 - 0.086173; 123 - 0.086173
105	0.07374	105 - 0; 107 - 0.09832 120 - 0.09832; 124 - 0.09832
106	0.01509	106 - 0; 101 - 0.02012 111 - 0.02012; 117 - 0.02012
107	0.07374	107 - 0; 105 - 0.09832 120 - 0.09832; 124 - 0.09832
108	0.01909	108 - 0; 115 - 0.028635 122 - 0.028635
109	0.06293	109 - 0; 110 - 0.083906 112 - 0.083907; 114 - 0.083907
110	0.06293	110 - 0; 109 - 0.083906 112 - 0.083907; 114 - 0.083907
111	0.01509	111 - 0; 101 - 0.02012 106 - 0.02012; 117 - 0.02012
112	0.06293	112 - 0; 109 - 0.083906 110 - 0.083907; 114 - 0.083907
113	0.01986	113 - 0; 102 - 0.029795 121 - 0.029795

## H. B. ROBINSON

## SENSOR SINGLE FAILURE ANALYSIS

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<u>FAILED RTD NO.</u>	<u>ORIGINAL WEIGHTING FACTOR</u>	<u>NEW WEIGHTING FACTORS</u>
114	0.06293	114 - 0; 109 - 0.083906 110 - 0.083907; 112 - 0.083907
115	0.01909	115 - 0; 108 - 0.028635 122 - 0.028635
116	0.00879	116 - 0; 119 - 0.01758
117	0.01509	117 - 0; 101 - 0.02012 106 - 0.02012; 111 - 0.02012
118	0.06463	118 - 0; 103 - 0.086173 104 - 0.086173; 123 - 0.086173
119	0.00879	119 - 0; 116 - 0.01758
120	0.07374	120 - 0; 105 - 0.09832 107 - 0.09832; 124 - 0.09832
121	0.01986	121 - 0; 102 - 0.029795 113 - 0.029795
122	0.01909	122 - 0; 108 - 0.028635 115 - 0.028635
123	0.06463	123 - 0; 103 - 0.086173 104 - 0.086173; 118 - 0.086173
124	0.07374	124 - 0; 105 - 0.09832 107 - 0.09832; 120 - 0.09832

H. B. ROBINSON

## SENSOR SINGLE FAILURE ANALYSIS

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<u>FAILED DEWCELL NO.</u>	<u>ORIGINAL WEIGHTING FACTOR</u>	<u>NEW WEIGHTING FACTORS</u>
1	0.14748	1 - 0; 2 - 0.29496
2	0.14748	2 - 0; 1 - 0.29496
3	0.25511	3 - 0; 4 - 0.51022
4	0.25511	4 - 0; 3 - 0.51022
5	0.09741	5 - 0; 6 - 0.19482
6	0.09741	6 - 0; 5 - 0.19482



## H. B. ROBINSON

## UNIT 2

## INSTALLED CONSTANTS

RTD 1	WEIGHTING FACTOR	=	0.01509
RTD 2	WEIGHTING FACTOR	=	0.01987
RTD 3	WEIGHTING FACTOR	=	0.06463
RTD 4	WEIGHTING FACTOR	=	0.06463
RTD 5	WEIGHTING FACTOR	=	0.07374
RTD 6	WEIGHTING FACTOR	=	0.01509
RTD 7	WEIGHTING FACTOR	=	0.07374
RTD 8	WEIGHTING FACTOR	=	0.01909
RTD 9	WEIGHTING FACTOR	=	0.06293
RTD 10	WEIGHTING FACTOR	=	0.06293
RTD 11	WEIGHTING FACTOR	=	0.01509
RTD 12	WEIGHTING FACTOR	=	0.06293
RTD 13	WEIGHTING FACTOR	=	0.01986
RTD 14	WEIGHTING FACTOR	=	0.06293
RTD 15	WEIGHTING FACTOR	=	0.01909
RTD 16	WEIGHTING FACTOR	=	0.00879
RTD 17	WEIGHTING FACTOR	=	0.01509
RTD 18	WEIGHTING FACTOR	=	0.06463
RTD 19	WEIGHTING FACTOR	=	0.00879
RTD 20	WEIGHTING FACTOR	=	0.07374
RTD 21	WEIGHTING FACTOR	=	0.01986
RTD 22	WEIGHTING FACTOR	=	0.01909
RTD 23	WEIGHTING FACTOR	=	0.06463
<u>RTD 24</u>	<u>WEIGHTING FACTOR</u>	<u>=</u>	<u>0.07374</u>
WEIGHTING FACTOR SUM		=	1.00000

PRESS 1	WEIGHTING FACTOR	=	0.50000
<u>PRESS 2</u>	<u>WEIGHTING FACTOR</u>	<u>=</u>	<u>0.50000</u>
WEIGHTING FACTOR SUM		=	1.00000

DEWCELL 1	WEIGHTING FACTOR	=	0.14748
DEWCELL 2	WEIGHTING FACTOR	=	0.14748
DEWCELL 3	WEIGHTING FACTOR	=	0.25511
DEWCELL 4	WEIGHTING FACTOR	=	0.25511
DEWCELL 5	WEIGHTING FACTOR	=	0.00000
<u>DEWCELL 6</u>	<u>WEIGHTING FACTOR</u>	<u>=</u>	<u>0.19482</u>
WEIGHTING FACTOR SUM		=	1.00000

CONTAINMENT VOLUME = 1950000 CUBIC FEET

$L_a$  = 0.1 PERCENT WEIGHT PER DAY