Baltimore Gas and Electric Company

Calvert Cliffs Nuclear Power Plant Unit 2

FINAL REPORT
November 1985

Primary Reactor Containment
Integrated Leakage Rate Test

Bechtel Power Corporation

BALTIMORE GAS AND ELECTRIC COMPANY

CALVERT CLIFFS NUCLEAR POWER PLANT

UNIT 2

PRIMARY REACTOR CONTAINMENT

INTEGRATED LEAKAGE RATE TEST REPORT

NOVEMBER 1985

PREPARED BY

BECHTEL POWER CORPORATION

SAN FRANCISCO, CA

SU-089/002/1

CONTENTS

EXECUTIVE SUMMARY

A Primary Containment Integrated Leakage Rate Test (ILRT) was successfully completed at the Calvert Cliffs Nuclear Power Plant, Unitd2, on November 24, 1985. The test met the requirements set forth in 10CFR50, Appendix J.

Listed below is the summary of the test results for both the mass point and total time data analysis techniques. The actual measured leakage (L_{am}) and the 95 percent upper confidence limit (UCL), in units of weight percent per day, are compared to the acceptance criteria.

Mass Point	Test Result	Acceptance Criteria
ILRT Lam	0.052	0.150
ILRT UCL	0.060	0.150
Verification Test Lam	0.243	0.202 Lam 0.302
Total Time		
ILRT Lam	0.050	0.150
ILRT UCL	0.104	0.150
Verification Test Lam	0.251	0.200 Lam 0.300

The total local leakage rate measured for the eight penetrations not in the postLOCA lineup during the ILRT was 0.001%/day.

A chronological summary of events, summary of plant technical data, and discussion of test results are included in this report.

I. INTRODUCTION

This report presents data, analysis, and conclusions pertaining to the Calvert Cliffs Nuclear Power Plant, Unit 2, Integrated Leakage Rate Test (ILRT) performed in November, 1985. The Integrated Leakage Rate Test (Type A) is performed periodically to demonstrate that the combined leakage through the reactor containment and those systems penetrating the containment does not exceed the allowable leakage rate specified in the Plant Technical Specifications.

The successful periodic Type A and supplemental verification tests were performed according to the requirements of the Calvert Cliffs Nuclear Power Plant, Unit 2, Technical Specifications and 10CFR50, Appendix J. The Calvert Cliffs Type A test method is the Absolute Method described in ANSI N45.4-1972, "Leakage Rate Testing of Containment Structures for Nuclear Reactors" and ANSI/ANS 56.8-1981, "Containment System Leakage Testing Requirements." The leakage rate was calculated using formulas from the above ANSI Standards and BN-TOP-1, Rev. 1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants." Type A and verification test durations were according to the criteria of BN-TOP-1.

A 95% upper confidence level was calculated for leakage rate data as required by Reference 6. This is to ensure a 95% probability that the calculated leakage rate value is within the acceptance limits. All calculations were done with Bechtel's ILRT computer program described in Appendix A.

The temperature and pressure history and the containment air mass variations were plotted by the computer program and are contained in Appendix E.

II. TEST SYNOPSIS

Valve line-ups were conducted on all systems to establish post-accident conditions except for shutdown cooling, demineralized water, and three penetrations necessary to conduct the ILRT. The inspection of the containment's accessible interior and exterior surfaces was conducted prior to pressurization. No evidence of structural deterioration was noted which would have affected containment integrity or leak tightness.

Containment pressurization commenced at 12:25 a.m., November 23, 1985. The containment coolers and fans were stopped at 12:00 noon. Test pressure of 50.1 psig was reached at 1:00 p.m., November 23, 1985, and the pressurization line was vented. The temperature stabilization criteria were satisfied during the four hours from 12:00 midnight to 4:00 a.m.

Collection of data to determine the integrated leakage rate commenced at 4:00 a.m., November 24, 1985, and was completed at 12:30 p.m. The verification flow test was initiated at 12:30 p.m., November 24, 1985. The verification flow test was completed satisfactorily and depressurization of the containment commenced at 11:15 p.m., November 24, 1985. After the containment was completely depressurized, a containment entry was made. Determination was made that no measurable water level changes requiring corrections to the measured leakage rate had occurred during the test. A summary of test phases follows:

Test Phase	Time	Duration hr.	Date
Pressurization	0025-1300	12.75	November 23
Stabilization	1300-0400	15.0	November 23-24
ILRT	0400-1230	8.5	November 24
Verification Stabilization	1230-1900	6.5	November 24
Verification Test	1900-2315	4.25	November 24

During the test four temperature sensors were malfunctioning. Temperature sensor 17 failed when pressurization began at 12:25 a.m., November 23. The sensor was destroyed by pressurization air flow turbulence. Sensor 17 volume fraction was reassigned equally among sensors 10, 15, and 16, all below elevation 45 feet. Temperature sensors 2 and 3 decreased about 3°F at 1:00 a.m., November 24, which was inconsistent with adjacent sensors. Sensors 2 and 3 were declared inoperable and volume fractions reassigned to sensors 1, 4, 7, 8, 9, 11, and 13, all in the open volume above elevation 69 feet. Temperature sensor 6 consistently indicated temperatures 5 to 8°F higher than adjacent sensors. Sensor 6 was declared inoperable and its volume fraction reassigned to sensor 14, also at elevation 50 feet and outside the steam generator cavities. Dewpoint sensors 1, 2, 3, and 6 were not operational until 12:00 midnight November 24. The stabilization period was longer than the minimum required because the dew cell power was inadvertently turned off. When the power was turned on, a dramatic jump in calculated air mass was observed, shown clearly in the airmass plot of Appendix E. The reassigned volume fractions were used to calculate the containment dry air mass during the entire test. Plots of sensors are in Appendix I.

III. TEST DATA SUMMARY

A. Plant Information

Owner:	Baltimore Gas and Electric Company
Plant:	Calvert Cliffs Nuclear Power Plant Unit 2
Location:	Lusby, Maryland
Containment Type:	Post-tensioned concrete
Date Test Completed:	November 24, 1985
Docket No.:	50318

B. Technical Data

1.	Containment Net Free Air Volume	2,000,000 cu. ft.
2.	Design Pressure	50 psig
3.	Design Temperature	276°F
4.	Calculated Peak Accident pressure Pa	50 psig
5.	Containment ILRT Average Temperature Limits	60-120°F

C. Type A Test Result

1.	Test Method	Absolute
2.	Leakage Rate Data Analysis Techniques	Total Time per BN-TOP-1 and Mass Point per ANSI/ANS 56.8-1981
3.	Test Pressure	50.0 psig + 0.5 - 0.0
4.	Maximum Allowable Leakage Rate, La, per Technical Specification	0.2%/day
5.	75% of La	0.15%/day

D. Type A Test Results

Integrated Leakage Rate	From Regression Line, %/day (Lam)	At Upper 95% Confidence Limit
a. Mass Point Analysis	0.052	0.060
b. Total Time Analysis	0.050	0.104

E. Verification Test

1.	Imposed flow rate (Li)	12.34 scfm (0.2%/day)
2.	Verification Test Results	Leakage Rate, %/day
	a. Mass Point Analysis	0.243
	b. Total Time Analysis	0.251

3. Verification Test Limits — Test Limit, %/day

a. Mass Point Analysis

(1) Upper Limit (Li + Lam + 0.25 La) — 0.302

(2) Lower Limit (Li + Lam - 0.25 La) — 0.202

b. Total Time Analysis

(1) Upper Limit — 0.300

(2) Lower Limit — 0.200

F. Report Printouts

The Report Printouts of the Type A and Verification Test calculations are provided for the Mass Point and Total Time Analyses (Appendices C through F). Stabilization data are also provided (Appendix B).

G. Local Leakage Rate Test Results - Type B and C Tests

1. LLRT Results - The Type B and C leakage tests were conducted prior to the Type A test. The total as left LLRT measurement for Unit 2 was 20,594.55 sccm. This value converts to 0.012%/day which is less than the technical specification limit of .12%/day. An evaluation of "as left" compared to "as found" data is contained in Appendix H.

2. During the ILRT the following penetrations were not in the postaccident position. The following is the local leakage rate measurement for these penetrations.

Penetration	System	As Left, SCCM
7A	ILRT Instrumentation	5.3
7B	ILRT Instrumentation	2.7
48	Demineralized Water	63.2
41	Shutdown Cooling Return	1716.54
50	ILRT Pressurization	239
	Total:	2026.74 sccm
	%/day:	.001%/day

3. Periodic Type B and Type C Test Results Since Last ILRT

Outage Date	LLRT	Acceptance Criteria
July 1984	23,056.8	.6 La = 207,700 sccm

4. 10CFR50, Appendix J, paragraph V.B.3, requires that leakage test results from Type A, B, and C tests that failed to meet the acceptance criteria of III.A.5(b), III.B.3, and III.C.3, respectively, shall be reported in a separate accompanying summary report that includes an analysis and interpretation of the test data, the least-squares fit analysis of the test data, the instrumentation error analysis, and the structural condition of the containment or components, if any, which contributed to the failure in meeting the acceptance criteria. Since the tests meet the acceptance criteria no further analysis is submitted. Instruments used during local leakage rate testing are calibrated as follows: ± 1% full scale for flowmeters, and ± 0.1% full scale for temperature and pressure gauges. Field checks of flowmeters are performed prior to each test to check calibration.

H. Integrated Leakage Rate Measurement System

The following instrument system was used:

Description	Data	
1. Absolute Pressure		
2 Precision Pressure Gauges Mensor Model 10100	Range: Accuracy: Sensitivity: Repeatability: Calibration Date:	0-100 psia 0.015% reading 0.001 psia 0.001 psia 11/17/85
2. Drybulb Temperature		
18 Temperature Sensors Volumetrics 100 ohm Platinum RTD, part no. VSTD-347	Range: Accuracy: Sensitivity: Repeatability: Calibration Date:	32-120°F 0.20°F 0.01°F 0.01°F 8/30/85
3. Dewpoint Temperature		
6 Dewpoint Sensors EG&G Model 660 Chilled Mirror Hygrometers	Range: Accuracy: Sensitivity: Repeatability: Calibration Date:	40-100°F 0.54°F 0.1° F 0.1°F 8/30/85

Description	Data

4. Flowmeters

2 Mass Flowmeters	Range:	0-10 scfm
(1) TSI Model 2013		0-20 scfm
(2) Model 2014	Accuracy:	1% F.S.
	Sensitivity:	1% F.S.
	Repeatability:	0.1 scfm
	Calibration Date:	11/15/85

5. Overall Instrumentation Selection Guide (ISG) Value (from ANSI/ANS 56.8-1981, Appendix G) based on ILRT instrumentation and 8.5 hour minimum test duration = 0.0077%/day. (Calculations are in Appendix G).

6. Drybulb and Dewpoint Temperature Sensor Volume Fractions - Table 1.

I. Information Retained at Plant

The following information is available for review at the Plant:

1. Listing of all containment penetrations, including the total number of like penetrations, penetration size and function.

2. System lineups (at time of test).

3. A continuous sequential log of events during the test.

4. Documentation of instrumentation calibration and standards.

5. The working copy of test procedure that would include signature sign-off of procedural steps.

6. The procedure and all data from local leakage rate testing of penetrations and valves.

7. The Quality Assurance audit plan that was used to monitor ILRT.

8. A listing of all test exceptions including changes in containment system boundaries instituted by licensee to conclude successful testing.

9. Description of method of leak rate verification of instrument measuring system (superimposed leakage), with calibration information on flowmeters along with calculations that were used to measure the verification leakage rate.

IV. ANALYSIS AND INTERPRETATION

The Integrated Leakage Rate Test results at the upper 95% confidence level are 0.60%/day (Mass Point analysis) and 0.104%/day (Total Time analysis). The local leakage rate for penetrations not in postLOCA lineup is 0.001%/day. The sums of the ILRT upper 95% confidence level and LLRT leakage rates, 0.061%/day (Mass Point analysis) and 0.105%/day (Total Time analysis), satisfy the acceptance criterion that the sum must be less than 0.75 La = 0.150%/day.

Local Leakage Rate Test, repair, and adjustments of containment isolation valves were performed prior to the ILRT. The minimum pathway leakage improvement due to repairs and adjustments is 140,591.24 sccm or 0.081%/day. The as found containment leakage rates, the sum of the minimum pathway leakage improvement and ILRT upper 95% confidence levels, 0.185%/day (Mass Point analysis) and 0.186%/day (Total Time analysis), satisfy the as found acceptance criterion that the sum must be less than La = 0.200%/day.

TABLE 1

DRYBULB AND DEWPOINT TEMPERATURE SENSOR LOCATIONS

No.	Tag No.	Elevation (ft)	Azimuths (degrees)	Distance From Center	Volume Fractions Original	Volume Fractions Reassigned
1	0-TE-5500	165	0	0	.081	.100
*2	0-TE-5501	147	90	33	.081	.000
*3	0-TE-5502	147	270	33	.081	.000
4	0-TE-13465	120	0	45	.072	.100
5	0-TE-5508	50	270	45	.021	.021
*6	0-TE-5513	50	110	45	.043	.000
7	0-TE-5514	115	0	0	.073	.100
8	0-TE-5505	125	90	40	.072	.100
9	0-TE-5506	104	180	30	.073	.100
10	0-TE-5517	30	160	45	.042	.056
11	0-TE-5507	75	210	40	.064	.0805
12	0-TE-5509	65	0	0	.042	.042
13	0-TE-5510	75	150	45	.064	.0805
14	0-TE-5512	50	210	50	.043	.086
15	0-TE-5514	30	210	45	.042	.056
16	0-TE-5516	16	340	30	.042	.056
*17	0-TE-5515	20	90	30	.042	.000
18	0-TE-5511	50	90	40	.022	.022

DEWCELLS

No.	Tag No.	Elevation (ft)	Azimuths (degrees)	Distance From Center	Volume Fractions Original	Volume Fractions Reassigned
1	0-AE-5518	119	60	55	.220	.220
2	0-AE-5520	140	270	35	.220	.220
3	0-AE-5521	69	180	40	.086	.086
4	0-AE-5522	47	180	30	.086	.086
5	0-AE-5523	16	160	45	.168	.168
6	0-AE-5519	119	170	55	.220	.220

* Malfunctioning sensors - not used for leakage rate calculations.

V. REFERENCES

1. Calvert Cliffs, Unit 2, Plant Technical Specifications.

2. Calvert Cliffs Procedure STP M-662-2, Integrated Leakage Rate Test, Unit 2 Containment.

3. 10CFR50, Appendix J, "Reactor Containment Leakage Testing for Water Cooled Power Reactors."

4. ANSI N45.4-1972, "Leakage Rate Testing of Containment Structures for Nuclear Reactors."

5. ANSI/ANS 56.8-1981, "Containment System Leakage Testing Requirements."

6. Bechtel Topical Report BN-TOP-1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants.", Rev. 1, February 1972.

APPENDIX A

DESCRIPTION OF BECHTEL ILRT COMPUTER PROGRAM

APPENDIX A

DESCRIPTION OF BECHTEL ILRT COMPUTER PROGRAM

A. Program and Report Description

1. The Bechtel ILRT computer program is used to determine the integrated leakage rate of a nuclear primary containment structure. The program is used to compute leakage rate based on input values of time, free air volume, containment atmosphere total pressure, drybulb temperature, and dewpoint temperature (water vapor pressure). Leakage rate is computed using the Absolute Method as defined in ANSI/ANS 56.8-1981, "Containment System Leakage Testing Requirements" and BN-TOP-1, Rev 1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants". The program is designed to allow the user to evaluate containment leakage rate test results at the jobsite during containment leakage testing. Current leakage rate values may be obtained at any time during the testing period using one of two computational methods, yielding three different report printouts.

2. In the first printout, the Total Time Report, leakage rate is computed from initial values of free air volume, containment atmosphere drybulb temperature and partial pressure of dry air, the latest values of the same parameters, and elapsed time. These individually computed leakage rates are statistically averaged using linear regression by the method of least squares. The Total Time Method is the computational technique upon which the short duration test criteria of BN-TOP-1, Rev 1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plant," are based.

3. The second printout is the Mass Point Report and is based on the Mass Point Analysis Technique described in ANSI/ANS 56.8-1981, "Containment System Leakage Testing Requirements." The mass of dry air in the containment is computed at each data point (time) using the Equation of State, from current values of containment atmosphere drybulb temperature and partial pressure of dry air. Contained mass is "plotted" versus time and a regression line is fit to the data using the method of least squares. Leakage rate is determined from the statistically derived slope and intercept of the regression line.

4. The third printout, the Trend Report, is a summary of leakage rate values based on Total time and Mass Point computations presented as a function of number of data points and elapsed time (test duration). The Trend Report provides all leakage rate values required for comparision to the acceptance criteria of BN-TOP-1 for conduct of a short duration test.

5. The program is written in a high level language and is designed for use on a micro-computer with direct data input from the data acquisition system. Brief descriptions of program use, formulae

used for leakage rate computations, and program logic are provided in the following paragraphs.

B. Explanation of Program

1. The Bechtel ILRT computer program is written, for use by experienced ILRT personnel, to determine containment integrated leakage rates based on the Absolute Method described in ANSI/ANS 56.8-1981 and BN-TOP-1.

2. Information loaded into the program prior to or at the start of the test:

   a. Number of containment atmosphere drybulb temperature sensors, dewpoint temperature (water vapor pressure) sensors and pressure gages to be used in leakage rate computations for the specific test

   b. Volume fractions assigned to each of the above sensors

   c. Calibration data for above sensors

   d. Test title

   e. Test pressure

   g. Maximum allowable leakage rate at test pressure

3. Data received from the data acquistion system during the test, and used to compute leakage rates:

   a. Time and date

   b. Containment atmosphere drybulb temperatures

   c. Containment atmosphere pressure(s)

   d. Containment atmosphere dewpoint temperatures

   e. Containment free air volume.

4. After all data at a given time are received , a Summary of Measured Data report (refer to "Program Logic," Paragraph D, "Data" option command) is printed.

5. If drybulb and dewpoint temperature sensors should fail during the test, the data from the sensor(s) are not used. The volume fractions for the remaining sensors are recomputed and reloaded into the program for use in ensuing leakage rate computations.

C. Leakage Rate Formulae

1. Computation using the Total Time Method:

a. Measured leakage rate, from data:

$$P_1V_1 = W_1RT_1 \tag{1}$$

$$P_iV_i = W_iRT_i \tag{2}$$

$$L_i = \frac{2400\ (W_1 - W_i)}{\Delta t_i\ W_1} \tag{3}$$

Solving for W_1 and W_i and substituting equations (1) and (2) into (3) yields:

$$L_i = \frac{2400}{\Delta t_i}\left(1 - \frac{T_1P_iV_i}{T_iP_1V_1}\right) \tag{4}$$

where,

W_1, W_i = Weight of contained mass of dry air at times t_1 and t_i respectively, lbm.

T_1, T_i = Containment atmosphere drybulb temperature at times t_1 and t_i respectively, °R.

P_1, P_i = Partial pressure of the dry air component of the containment atmosphere at times t_1 and t_i respectively, psia.

V_1, V_i = Containment free air volume at times t_1 and t_i respectively, (constant or variable during the test), ft^3.

t_1, t_i = Time at 1st and i^{th} data points respectively, hours.

Δt_i = Elapsed time from t_1 to t_i, hours.

R = Specific gas constant for air = 53.35 ft.lbf/lbm.°R.

L_i = Measured leakage rate computed during time interval t_1 to t_i, wt.%/day.

In order to reduce truncation error, the computer program uses the following equivalent formulation:

$$L_i = \frac{-2400}{\Delta t_i}\ \frac{\Delta W_i}{W_1}$$

where,

$$\frac{\Delta W_i}{W_1} = \frac{W_i - W_1}{W_1}$$

$$= \frac{\frac{\Delta P_i}{P_1} + \frac{\Delta V_i}{V_1} + \frac{\Delta P_i \Delta V_i}{P_1 V_1} - \frac{\Delta T_i}{T_1}}{1 + \frac{\Delta T_i}{T_1}}$$

$$\Delta P_i = P_i - P_1$$
$$\Delta V_i = V_i - V_1$$
$$\Delta T_i = T_i - T_1$$

b. Calculated leakage rate from regression analysis,

$$\bar{L} = a + b \Delta t_N \quad (5)$$

where:

$\bar{L}$ = Calculated leakage rate, wt.%/day, as determined from the regression line.

$$a = (\Sigma L_i - b\Sigma \Delta t_i)/N \quad (6)$$

$$b = \frac{N(\Sigma L_i \Delta t_i) - (\Sigma L_i)(\Sigma \Delta t_i)}{N(\Sigma \Delta t_i^2) - (\Sigma \Delta t_i)^2} \quad (7)$$

N = Number of data points

$$\Sigma = \sum_{i=1}^{N}$$

c. Calculated leakage rate at the 95% confidence level.

$$\bar{L}_{95} = a + b \Delta t_N + S_{\bar{L}} \quad (8)$$

where:

$\bar{L}_{95}$ = Calculated leakage rate at the 95% confidence level, wt.%/day, at elapsed time Δt_N.

For $\Delta t_N < 24$

$$S_{\bar{L}} = t_{0.025;N-2} \left[(\Sigma L_i^2 - a\Sigma L_i - b\Sigma L_i \Delta t_i)/(N-2)\right]^{1/2} \times \left[1 + \frac{1}{N} + (\Delta t_N - \overline{\Delta t})^2 / (\Sigma \Delta t_i^2 - (\Sigma \Delta t_i)^2/N)\right]^{1/2} \quad (9a)$$

where, $t_{0.025;N-2} = 1.95996 + \frac{2.37226}{N-2} + \frac{2.82250}{(N-2)^2}$;

For $\Delta t_N \geq 24$

$$S_{\bar{L}} = t_{0.025;N-2} \left[(\Sigma L_i^2 - a\Sigma L_i - b\Sigma L_i \Delta t_i)/(N-2)\right]^{1/2} \times \left[\frac{1}{N} + (\Delta t_N - \overline{\Delta t})^2 / (\Sigma \Delta t_i^2 - (\Sigma t_i)^2/N)\right]^{1/2} \quad (9b)$$

where, $t_{0.025;N-2} = \dfrac{1.6449(N-2)^2 + 3.5283(N-2) + 0.85602}{(N-2)^2 + 1.2209(N-2) - 1.5162}$

$$\overline{\Delta t} = \frac{\Sigma \Delta t_i}{N}$$

2. Computation using the Mass Point Method

a. Contained mass of dry air from data:

$$W_i = 144 \frac{P_i V_i}{R T_i} \quad (10)$$

where:

All symbols as previously defined.

b. Calculated leakage rate from regression analysis, $W = a + b\,\Delta t$

$$\overline{L} = -2400 \frac{b}{a} \quad (11)$$

where:

$\overline{L}$ = Calculated leakage rate, wt.%/day, as determined from the regression line.

$$a = (\Sigma W_i - b\Sigma \Delta t_i)/N \quad (12)$$

$$b = \frac{N(\Sigma W_i \Delta t_i) - (\Sigma W_i)(\Sigma \Delta t_i)}{N(\Sigma \Delta t_i^2) - (\Sigma \Delta t_i)^2} \quad (13)$$

Δt_i = Total elapsed time at time of i^{th} data point, hours

N = Number of data points

W_i = Contained mass of dry air at i^{th} data point, lbm, as computed from equation (10).

$$\Sigma = \sum_{i=1}^{N}$$

Inorder to reduce truncation error, the computer program uses the following equivalent formulation:

$$a = W_1 \left[1 + \left(\Sigma \frac{\Delta W_i}{W_1} - \frac{b}{W_1} \Sigma \Delta t_i \right)/N \right]$$

$$b = W_1 \left[\frac{N \left(\Sigma \frac{\Delta W_i}{W_1} \Delta t_i \right) - \Sigma \frac{\Delta W_i}{W_1} \Sigma \Delta t_i}{N(\Sigma \Delta t_i^2) - (\Sigma \Delta t_i)^2} \right]$$

where, $\frac{\Delta W_i}{W_1}$ is as previously defined.

c. Calculated leakage rate at the 95% confidence level.

$$\bar{L}_{95} = \frac{-2400}{a} (b - S_b) \quad (14)$$

where:

$\bar{L}_{95}$ = Calculated leakage rate at the 95% confidence level, wt.%/day.

$$S_b = t_{0.025;N-2} \frac{S_N^{1/2}}{[N\Sigma\Delta t_i^2 - (\Sigma\Delta t_i)^2]^{1/2}} \qquad (15)$$

where, $t_{0.025;N-2} = \dfrac{1.6449(N-2)^2 + 3.5283\,(N-2)^2 + 0.85602}{(N-2)^2 + 1.2209\,(N-2) - 1.5162}$

$$S = \left\{\frac{\Sigma[W_i - (a + b\,\Delta t_i)]^2}{N-2}\right\}^{1/2}$$

$$= W_1 \left\{\frac{1}{N-2}\left[\Sigma(\Delta W_i/W_1)^2 - [\Sigma(\Delta W_i/W_1)]^2/N - \frac{[\Sigma(\Delta W_i/W_1)\,\Delta t_i - \Sigma(\Delta W_i/W_1)(\Sigma\Delta t_i)/N]^2}{\Sigma(\Delta t_i^2) - (\Sigma\,\Delta t_i)^2/N}\right]\right\}^{1/2}$$

D. Program Logic

1. The Bechtel ILRT computer program logic flow is controlled by a set of user options. The user options and a brief description of their associated function are presented below.

OPTION COMMAND	FUNCTION
	After starting the program execution, the user either enters the name of the file containing previously entered data or initializes a new data file.
DATA	Enables user to enter raw data. When the system requests values of time, volume, temperature, pressure and vapor pressure, the user enters the appropriate data. After completing the data entry, a summary is printed out. The user then verifies that the data were entered correctly. If errors are detected, the user will then be given the opportunity to correct the errors. After the user verifies that the data were entered correctly, a Corrected Data Summary Report of time, data, average temperature, partial pressure of dry air, and water vapor pressure is printed.
TREND	A Trend Report is printed.
TOTAL	A Total Time Report is printed.
MASS	A Mass Point Report is printed.
TERM	Enables user to sign-off temporarily or permanently. All data is saved on a file for restarting.
CORR	Enables user to correct previously entered data.
LIST	A Summary Data Report is printed.
READ	Enable the computer to receive the next set of data from the data acquisition system directly.
PLOT	Enables user to plot summary data, individual sensor data or air mass versus time.
DELETE	Enables user to delete a data point.
INSERT	Enables user to reinstate a previously deleted data point.
VOLFRA	Enable user to change volume fractions.

OPTION COMMAND	FUNCTION
TIME	Enable the user to specify the time interval for a report or plot.
VERF	Enable the user to input imposed leakage rate and calcaluted ILRT leakage rates at start of verification test.

E. COMPUTER REPORT AND DATA PRINTOUT

MASS POINT REPORT

The Mass Point Report presents leakage rate data (wt%/day) as determined by the Mass Point Method. The "Calculated Leakage Rate" is the value determined from the regression analysis. The "Containment Air Mass" values are the masses of dry air in the containment (lbm). These air masses, determined from the Equation of State, are used in the regression analysis.

TOTAL TIME REPORT

The Total Time Report presents data leakage rate (wt%/day) as determined by the Total Time Method. The "Calculated Leakage Rate" is the value determined from the regression analysis. The "Measured Leakage Rates" are the leakage rate values determined using Total Time calculations. These values of leakage rate are used in the regression analysis.

TREND REPORT

The Trend Report presents leakage rates as determined by the Mass Point and Total Time methods in percent of the initial contained mass of dry air per day (wt%/day), versus elapsed time (hours) and number of data points.

SUMMARY DATA REPORT

The Summary Data report presents the actual data used to calculate leakage rates by the various methods described in the "Computer Program" section of this report. The six column headings are TIME, DATE, TEMP, PRESSURE, VPRS, and VOLUME and contain data defined as follows:

1. TIME: Time in 24-hour notations (hours and minutes).

2. DATE: Calendar date (month and day).

3. TEMP: Containment weighted-average drybulb temperature in absolute units, degrees Rankine (°R).

4. PRESSURE: Partial pressure of the dry air component of the containment atmosphere in absolute units (psia).

5. VPRS: Partial pressure of water vapor of the containment atmosphere in absolute units (psia).

6. VOLUME: Containment free air volume (cu. ft.).

F. SUMMARY OF MEASURED DATA AND SUMMARY OF CORRECTED DATA

The Summary of Measured Data presents the individual containment atmosphere drybulb temperatures, dewpoint temperatures, absolute total pressure and free air volume measured at the time and date.

1. TEMP 1 through TEMP N are the drybulb temperatures, where N = No. of RTD's. The values in the right-hand column are temperatures (°F), multiplied by 100, as read from the data acquisition system (DAS). The values in the left-hand column are the corrected temperatures expressed in absolute units (°R).

2. PRES 1 through PRES N are the total pressures, absolute, were N = No. of pressure sensors. The right-hand value, in parentheses, is a number in counts as read from the DAS. This count value is converted to a value in psia by the computer via the instrument's calibration table, counts versus psia. The left-hand column is the absolute total pressure, psia.

3. VPRS 1 through VPRS N are the dewpoint temperatures (water vapor pressures), where N = No. of dewpoint sensors. The values in the right-hand column are temperatures (°F), multiplied by 100 as read from the DAS. The values in the left-hand column are the water vapor pressures (psia) from the steam tables for saturated steam corresponding to the dewpoint (saturation) temperatures in the center column.

The Summary of Corrected Data presents corrected temperature and pressure values and calculated air mass determined as follows:

1. TEMPERATURE (°R) is the volume weighted average containment atmosphere drybulb temperature derived from TEMP 1 through TEMP N.

2. CORRECTED PRESSURE (psia) is the partial pressure of the dry air component of the containment atmosphere, absolute. The volume weighted average containment atmosphere water vapor pressure is subtracted from the volume weighted average total pressure, yielding the partial pressure of the dry air.

3. VAPOR PRESSURE (psia) is the volume weighted average containment atmosphere water vapor pressure, absolute derived from VPRS 1 through VPRS N.

4. VOLUME (cu. ft.) is the containment free air volume.

5. CONTAINMENT AIR MASS (lbm) is the calculated mass of dry air in the containment. The mass of dry air is calculated using the containment free air volume and the above TEMPERATURE and CORRRECTED PRESSURE of the dry air.

APPENDIX B

ST\BILIZATION SUMMARY DATA

CALVERT CLIFFS - UNIT 2 ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 2000000.
VRATET = .250 VRATEM = .252

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
1300	1123	534.062	64.5922	.3640	2000000.
1315	1123	534.094	64.5621	.3684	2000000.
1330	1123	534.134	64.5526	.3720	2000000.
1345	1123	534.213	64.5470	.3756	2000000.
1400	1123	534.289	64.5441	.3796	2000000.
1415	1123	534.346	64.5453	.3833	2000000.
1430	1123	534.397	64.5522	.3848	2000000.
1445	1123	534.493	64.5603	.3855	2000000.
1500	1123	534.580	64.5679	.3863	2000000.
1515	1123	534.637	64.5766	.3870	2000000.
1530	1123	534.708	64.5837	.3878	2000000.
1545	1123	534.789	64.5910	.3884	2000000.
1600	1123	534.853	64.5973	.3890	2000000.
1615	1123	534.924	64.6040	.3897	2000000.
1630	1123	534.969	64.6094	.3902	2000000.
1645	1123	535.027	64.6156	.3909	2000000.
1700	1123	535.092	64.6210	.3914	2000000.
1715	1123	535.119	64.6270	.3918	2000000.
1730	1123	535.175	64.6309	.3924	2000000.
1745	1123	535.192	64.6362	.3930	2000000.
1800	1123	535.255	64.6412	.3934	2000000.
1815	1123	535.294	64.6447	.3938	2000000.
1830	1123	535.323	64.6487	.3942	2000000.
1845	1123	535.391	64.6523	.3946	2000000.
1900	1123	535.400	64.6557	.3952	2000000.
1915	1123	535.434	64.6598	.3955	2000000.
1930	1123	535.486	64.6634	.3958	2000000.
1945	1123	535.524	64.6652	.3960	2000000.
2000	1123	535.551	64.6686	.3966	2000000.
2015	1123	535.554	64.6718	.3969	2000000.
2030	1123	535.599	64.6754	.3972	2000000.
2045	1123	535.628	64.6780	.3975	2000000.
2100	1123	535.646	64.6805	.3979	2000000.
2115	1123	535.697	64.6838	.3982	2000000.
2130	1123	535.738	64.6879	.3985	2000000.
2145	1123	535.758	64.6919	.3989	2000000.
2200	1123	535.780	64.6945	.3993	2000000.
2215	1123	535.828	64.6986	.3996	2000000.
2230	1123	535.875	64.7027	.3999	2000000.
2245	1123	535.900	64.7057	.4003	2000000.
2300	1123	535.934	64.7103	.4007	2000000.
2315	1123	535.962	64.7144	.4010	2000000.
2330	1123	536.024	64.7178	.4015	2000000.
2345	1123	536.035	64.7219	.4019	2000000.

CALVERT CLIFFS - UNIT 2 ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 2000000.
VRATET = .250 VRATEM = .252

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
0	1124	536.105	64.8591	.2726	2000000.
15	1124	536.264	64.8768	.2726	2000000.
30	1124	536.437	64.8944	.2723	2000000.
45	1124	536.525	64.9060	.2725	2000000.
100	1124	536.640	64.9163	.2725	2000000.
115	1124	536.698	64.9250	.2723	2000000.
130	1124	536.758	64.9340	.2726	2000000.
145	1124	536.838	64.9414	.2726	2000000.
200	1124	536.878	64.9480	.2729	2000000.
215	1124	536.946	64.9538	.2730	2000000.
230	1124	536.993	64.9607	.2730	2000000.
245	1124	537.029	64.9653	.2733	2000000.
300	1124	537.079	64.9728	.2733	2000000.
315	1124	537.132	64.9780	.2735	2000000.
330	1124	537.189	64.9833	.2736	2000000.
345	1124	537.215	64.9870	.2738	2000000.
400	1124	537.259	64.9913	.2740	2000000.

CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE STABILIZATION

FROM A STARTING TIME AND DATE OF: 0 1124 1985

TIME (HOURS)	TEMP (°R)	AVE ΔT (4HRS)	ANSI AVE ΔT (1HR)	DIFF	BN-TOP-1 AVE ΔT (2HRS)
.00	536.10				
.25	536.26				
.50	536.44				
.75	536.52				
1.00	536.64				
1.25	536.70				
1.50	536.76				
1.75	536.84				
2.00	536.98				.387*
2.25	536.95				.341*
2.50	536.99				.278*
2.75	537.03				.252*
3.00	537.08				.220*
3.25	537.13				.217*
3.50	537.19				.215*
3.75	537.21				.189*
4.00	537.26	.208	.179	.11*	.095*

* INDICATES TEMPERATURE STABILIZATION HAS BEEN SATISFIED

APPENDIX C

ILRT TREND REPORT

CALVERT CLIFFS - UNIT 2 ILRT
TREND REPORT

TIME AND DATE AT START OF TEST: 400 1124 1985

NO. PTS	END TIME	TOTAL TIME ANALYSIS MEAS.	CALCULATED	UCL	MASS POINT ANALYSIS CALCULATED	UCL
4	445	-.011	.025	.869	.011	.165
5	500	.056	.050	.362	.045	.130
6	515	.019	.038	.246	.030	.084
7	530	.076	.061	.222	.060	.110
8	545	-.015	.032	.191	.021	.077
9	600	.005	.022	.161	.011	.055
10	615	-.021	.006	.133	-.007	.032
11	630	.014	.007	.122	-.002	.030
12	645	.001	.003	.109	-.004	.023
13	700	.002	.001	.099	-.004	.018
14	715	.016	.003	.095	.001	.020
15	730	-.003	.000	.087	-.002	.015
16	745	.035	.007	.092	.008	.027
17	800	.007	.006	.087	.007	.024
18	815	.033	.011	.090	.014	.030
19	830	.032	.015	.091	.019	.034
20	845	.057	.023	.099	.030	.047
21	900	.045	.027	.102	.035	.051
22	915	.025	.028	.099	.034	.049
23	930	.028	.028	.098	.034	.047
24	945	.048	.032	.100	.038	.051
25	1000	.051	.036	.102	.042	.055
26	1015	.057	.040	.105	.047	.060
27	1030	.029	.039	.103	.045	.057
28	1045	.051	.042	.104	.048	.059
29	1100	.041	.043	.104	.048	.058
30	1115	.040	.044	.103	.048	.058
31	1130	.040	.044	.103	.048	.057
32	1145	.040	.045	.102	.048	.056
33	1200	.060	.048	.104	.051	.060
34	1215	.051	.049	.104	.052	.061
35	1230	.045	.050	.104	.052	.060

APPENDIX D

ILRT SUMMARY DATA, MASS POINT, AND TOTAL TIME REPORTS

CALVERT CLIFFS - UNIT 2 ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 2000000.
VRATET = .250 VRATEM = .252

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
400	1124	537.259	64.9913	.2740	2000000.
415	1124	537.302	64.9967	.2740	2000000.
430	1124	537.357	65.0020	.2741	2000000.
445	1124	537.379	65.0061	.2745	2000000.
500	1124	537.439	65.0116	.2744	2000000.
515	1124	537.464	65.0155	.2745	2000000.
530	1124	537.511	65.0188	.2746	2000000.
545	1124	537.511	65.0225	.2749	2000000.
600	1124	537.543	65.0254	.2749	2000000.
615	1124	537.556	65.0285	.2752	2000000.
630	1124	537.589	65.0303	.2754	2000000.
645	1124	537.601	65.0326	.2756	2000000.
700	1124	537.630	65.0361	.2755	2000000.
715	1124	537.656	65.0380	.2756	2000000.
730	1124	537.663	65.0405	.2756	2000000.
745	1124	537.706	65.0419	.2757	2000000.
800	1124	537.704	65.0443	.2757	2000000.
815	1124	537.745	65.0464	.2760	2000000.
830	1124	537.762	65.0483	.2761	2000000.
845	1124	537.802	65.0497	.2762	2000000.
900	1124	537.814	65.0524	.2764	2000000.
915	1124	537.810	65.0545	.2763	2000000.
930	1124	537.825	65.0556	.2767	2000000.
945	1124	537.870	65.0578	.2770	2000000.
1000	1124	537.898	65.0603	.2769	2000000.
1015	1124	537.924	65.0621	.2771	2000000.
1030	1124	537.902	65.0641	.2771	2000000.
1045	1124	537.940	65.0644	.2773	2000000.
1100	1124	537.940	65.0659	.2773	2000000.
1115	1124	537.957	65.0679	.2777	2000000.
1130	1124	537.974	65.0696	.2775	2000000.
1145	1124	537.991	65.0715	.2776	2000000.
1200	1124	538.035	65.0721	.2780	2000000.
1215	1124	538.030	65.0732	.2779	2000000.
1230	1124	538.028	65.0740	.2780	2000000.

CALVERT CLIFFS - UNIT 2 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 400 1124 1985
TEST DURATION: 8.50 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
400	537.259	64.9913	653026.		
415	537.302	64.9967	653028.	-2.2	-8.8
430	537.357	65.0020	653014.	13.8	23.1
445	537.379	65.0061	653028.	-13.8	-2.9
500	537.439	65.0116	653010.	17.5	15.3
515	537.464	65.0155	653019.	-9.0	5.1
530	537.511	65.0188	652995.	24.6	20.6
545	537.511	65.0225	653033.	-37.9	-4.0
600	537.543	65.0254	653023.	9.7	1.4
615	537.556	65.0285	653039.	-15.5	-5.7
630	537.589	65.0303	653016.	22.3	3.8
645	537.601	65.0326	653025.	-8.4	.4
700	537.630	65.0361	653025.	.2	.4
715	537.656	65.0380	653012.	12.7	4.3
730	537.663	65.0405	653028.	-16.4	-.7
745	537.706	65.0419	652990.	38.3	9.6
800	537.704	65.0443	653018.	-27.8	2.0
815	537.745	65.0464	652988.	29.5	8.8
830	537.762	65.0483	652987.	1.2	8.6
845	537.802	65.0497	652952.	35.1	15.6
900	537.814	65.0524	652965.	-12.8	12.2
915	537.810	65.0545	652990.	-25.6	6.8
930	537.825	65.0556	652984.	6.1	7.6
945	537.870	65.0578	652951.	33.6	13.1
1000	537.898	65.0603	652943.	7.7	13.8
1015	537.924	65.0621	652929.	14.0	15.5
1030	537.902	65.0641	652975.	-46.4	7.8
1045	537.940	65.0644	652933.	42.7	13.8
1100	537.940	65.0659	652948.	-15.1	11.1
1115	537.957	65.0679	652947.	.5	10.8
1130	537.974	65.0696	652944.	3.5	10.9
1145	537.991	65.0715	652942.	1.8	10.8
1200	538.035	65.0721	652895.	47.0	16.4
1215	538.030	65.0732	652911.	-16.2	13.9
1230	538.028	65.0740	652922.	-10.6	12.2

FREE AIR VOLUME USED (CU. FT.)	=2000000.
REGRESSION LINE	
INTERCEPT (LBM)	= 653044.
SLOPE (LBM/HR)	= -14.3
MAXIMUM ALLOWABLE LEAKAGE RATE	= .200
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	= .150
THE UPPER 95% CONFIDENCE LIMIT	= .060
THE CALCULATED LEAKAGE RATE	= .052

CALVERT CLIFFS - UNIT 2 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 400 1124 1985
TEST DURATION: 8.50 HOURS

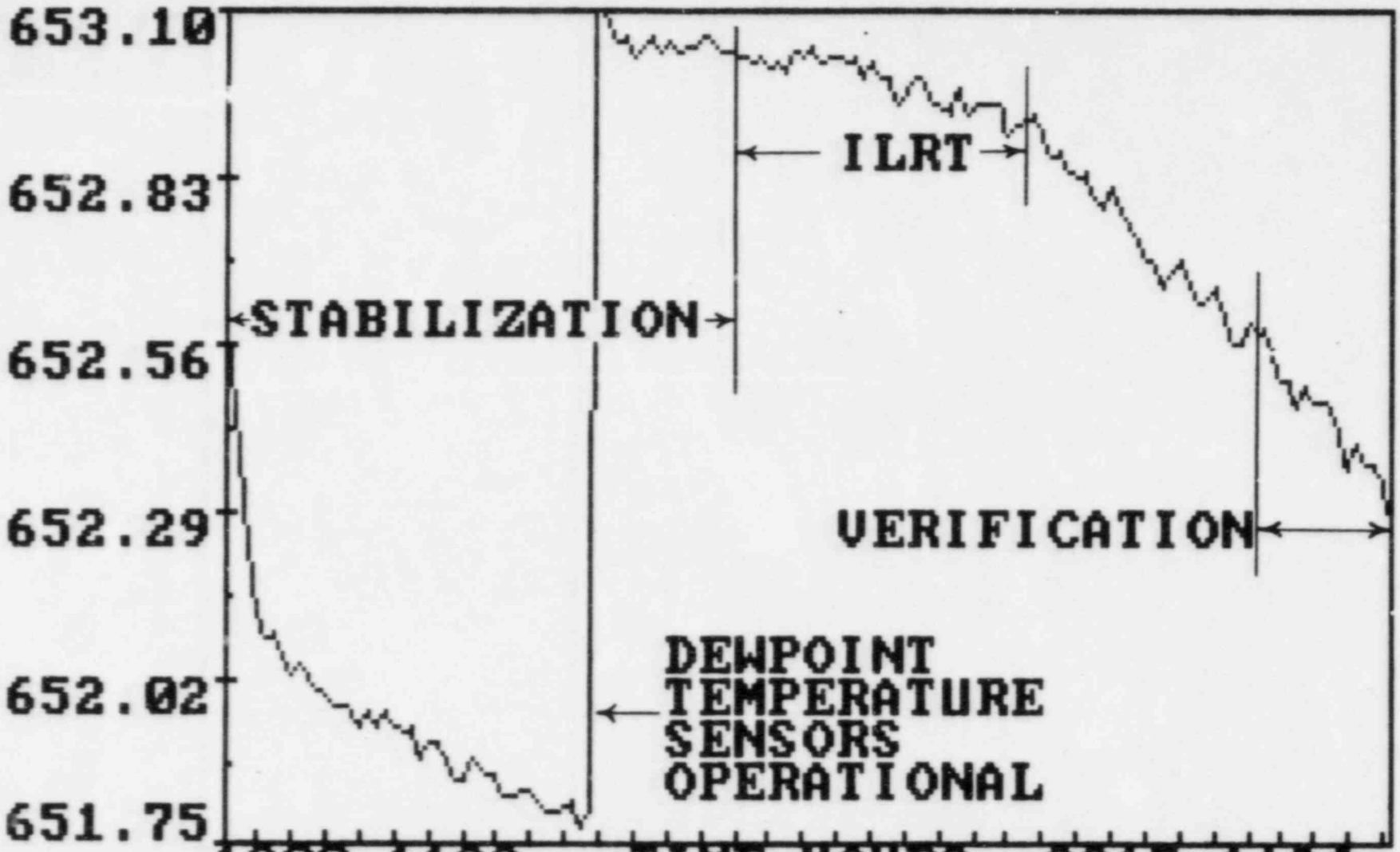
TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
400	537.259	64.9913	
415	537.302	64.9967	-.032
430	537.357	65.0020	.085
445	537.379	65.0061	-.011
500	537.439	65.0116	.056
515	537.464	65.0155	.019
530	537.511	65.0188	.076
545	537.511	65.0225	-.015
600	537.543	65.0254	.005
615	537.556	65.0285	-.021
630	537.589	65.0303	.014
645	537.601	65.0326	.001
700	537.630	65.0361	.002
715	537.656	65.0380	.016
730	537.663	65.0405	-.003
745	537.706	65.0419	.035
800	537.704	65.0443	.007
815	537.745	65.0464	.033
830	537.762	65.0483	.032
845	537.802	65.0497	.057
900	537.814	65.0524	.045
915	537.810	65.0545	.025
930	537.825	65.0556	.028
945	537.870	65.0578	.048
1000	537.898	65.0603	.051
1015	537.924	65.0621	.057
1030	537.902	65.0641	.029
1045	537.940	65.0644	.051
1100	537.940	65.0659	.041
1115	537.957	65.0679	.040
1130	537.974	65.0696	.040
1145	537.991	65.0715	.040
1200	538.035	65.0721	.060
1215	538.030	65.0732	.051
1230	538.028	65.0740	.045

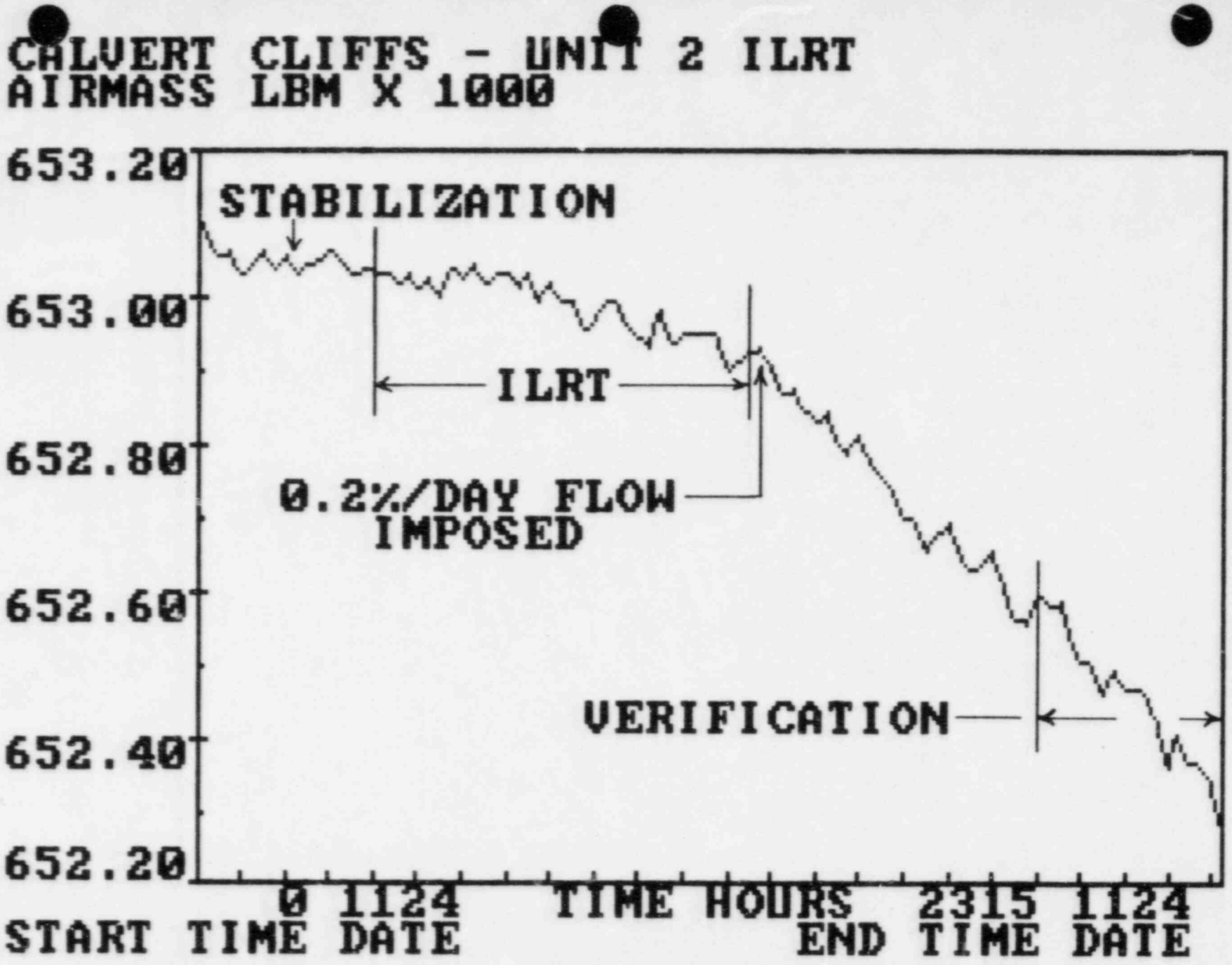
MEAN OF THE MEASURED LEAKAGE RATES	=	.030
MAXIMUM ALLOWABLE LEAKAGE RATE	=	.200
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	=	.150
THE UPPER 95% CONFIDENCE LIMIT	=	.104
THE CALCULATED LEAKAGE RATE	=	.050

APPENDIX E

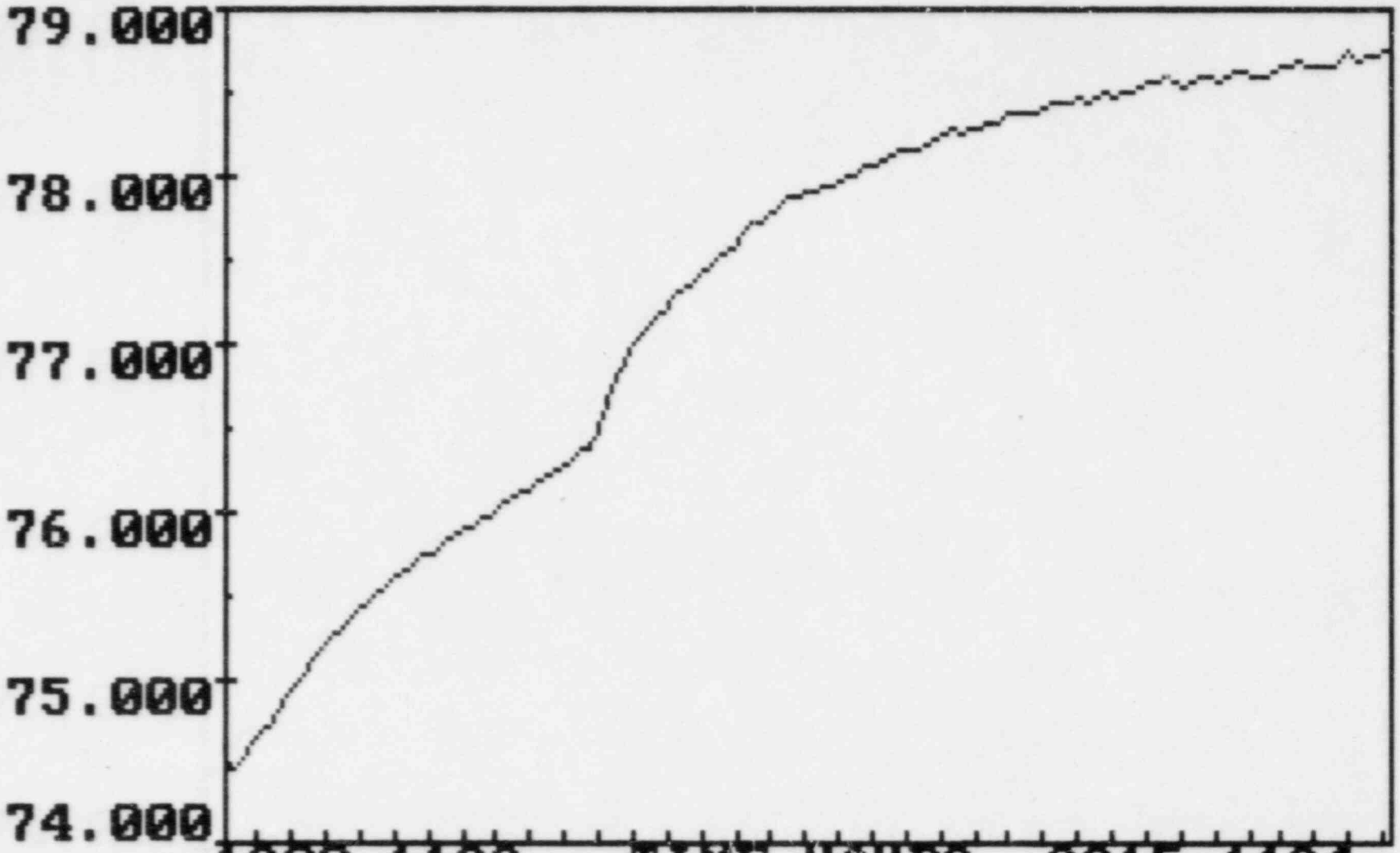
PLOTS: AIRMASS, TEMPERATURE, PRESSURE, VAPOR PRESSURE, AND LEAKAGE RATE

CALVERT CLIFFS - UNIT 2 ILRT
AIRMASS LBM X 1000

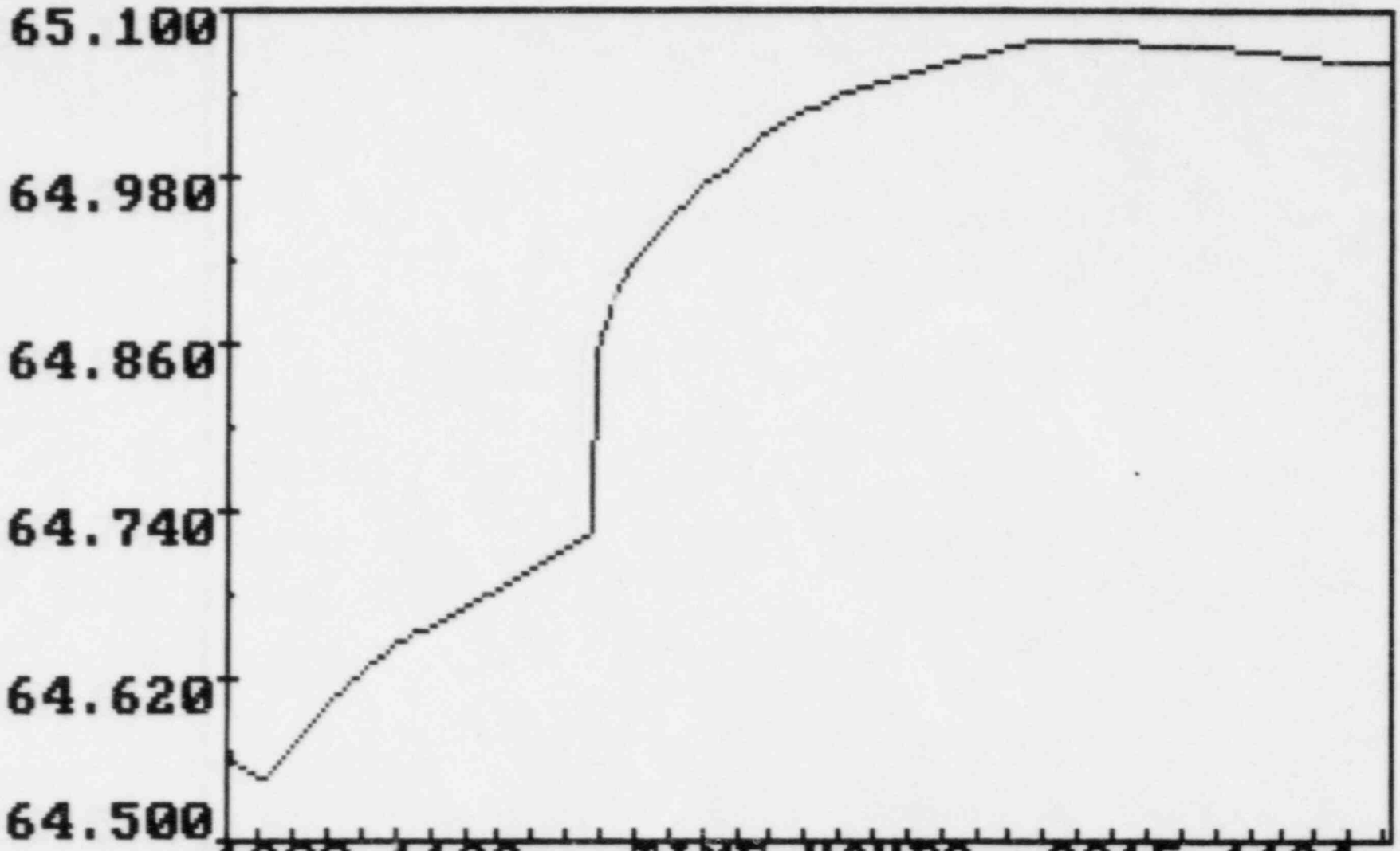



CALVERT CLIFFS - UNIT 2 ILRT
AIRMASS LBM X 1000
653.20
653.00
652.80
652.60
652.40
652.20
STABILIZATION
ILRT
0.2%/DAY FLOW
IMPOSED
VERIFICATION
0 1124
START TIME DATE
TIME HOURS
2315 1124
END TIME DATE

CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE DEGREES F

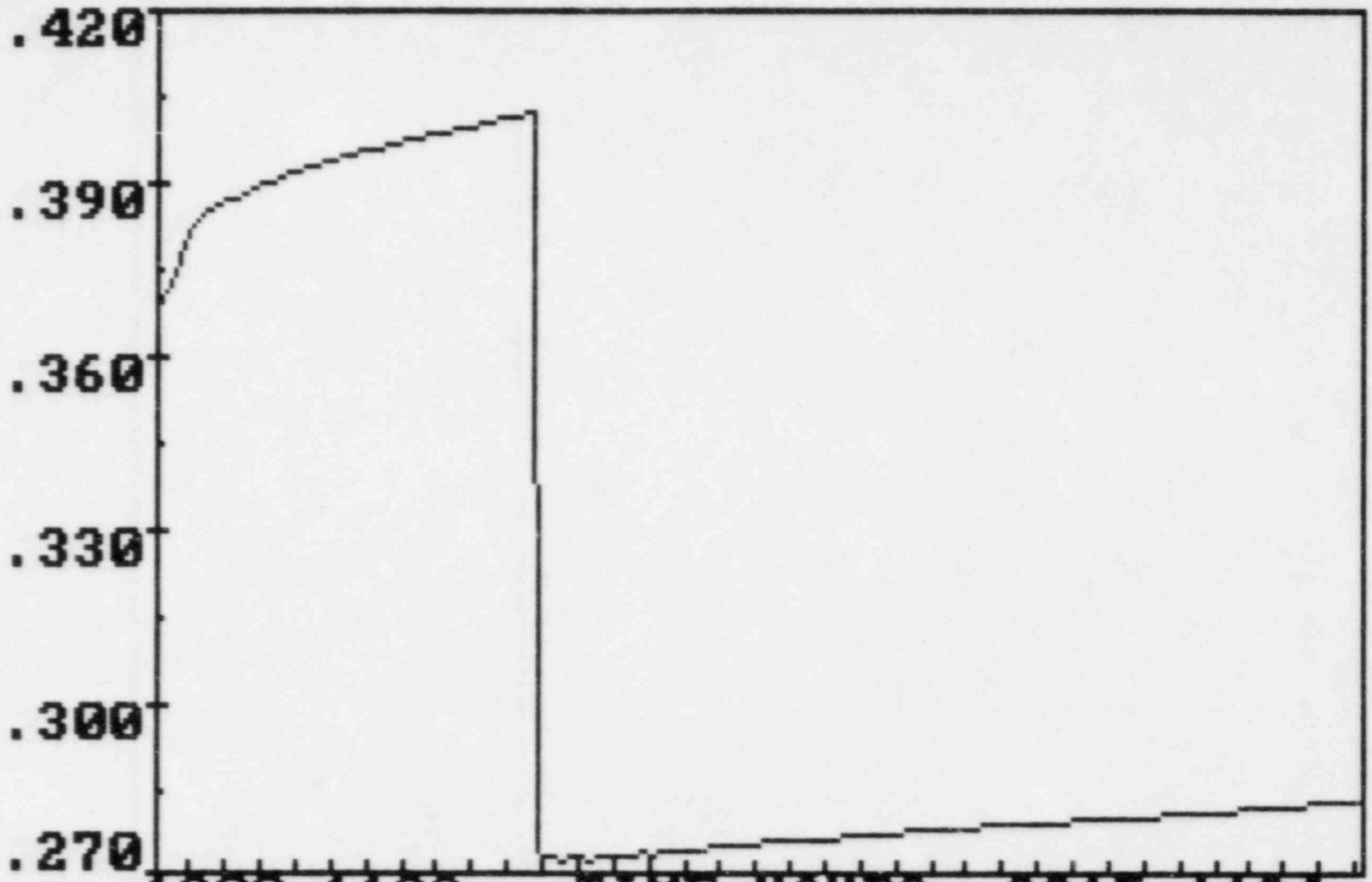


CALVERT CLIFFS - UNIT 2 ILRT
PRESSURE PSIA (DRY AIR)

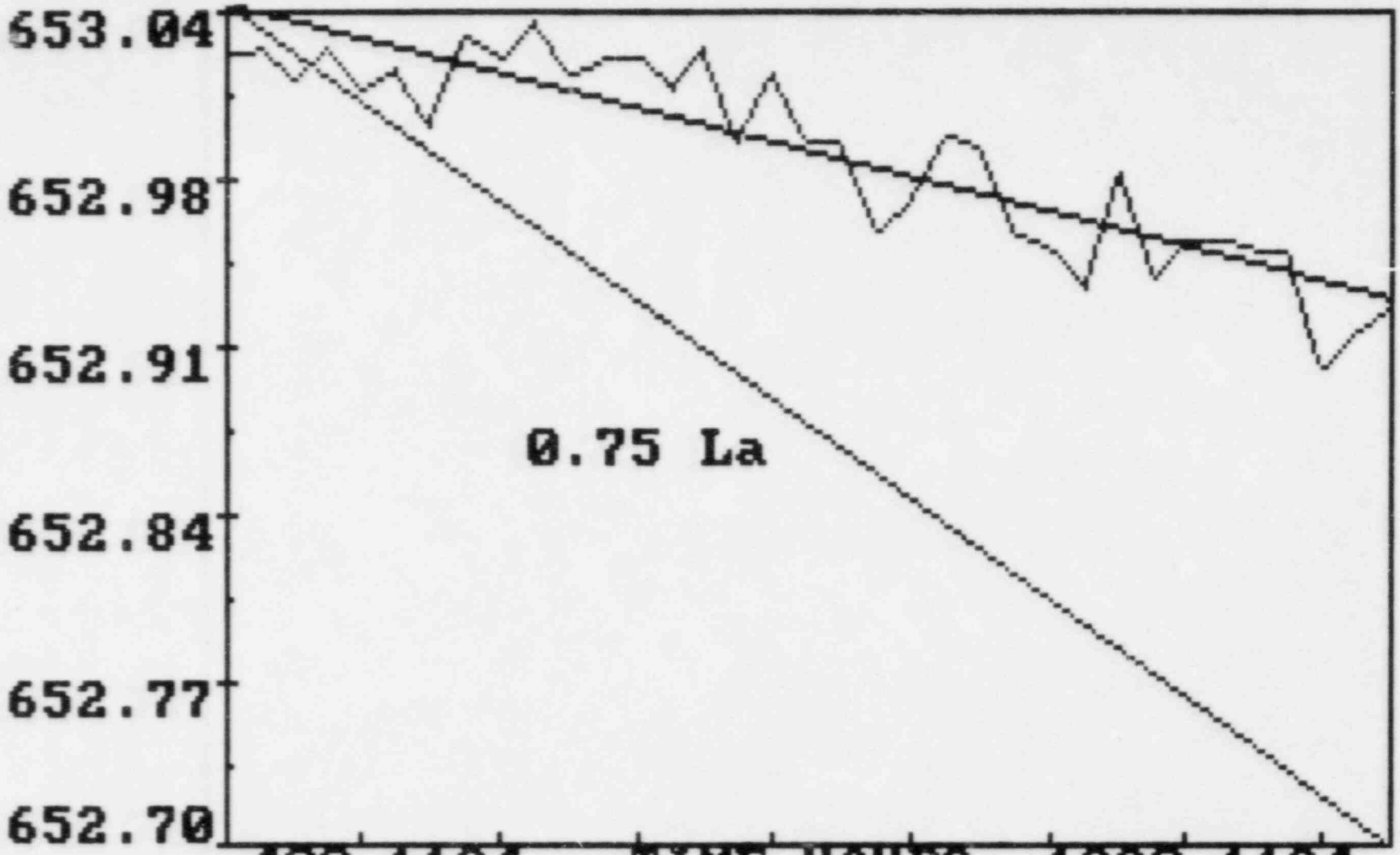


CALVERT CLIFFS - UNIT 2 ILRT

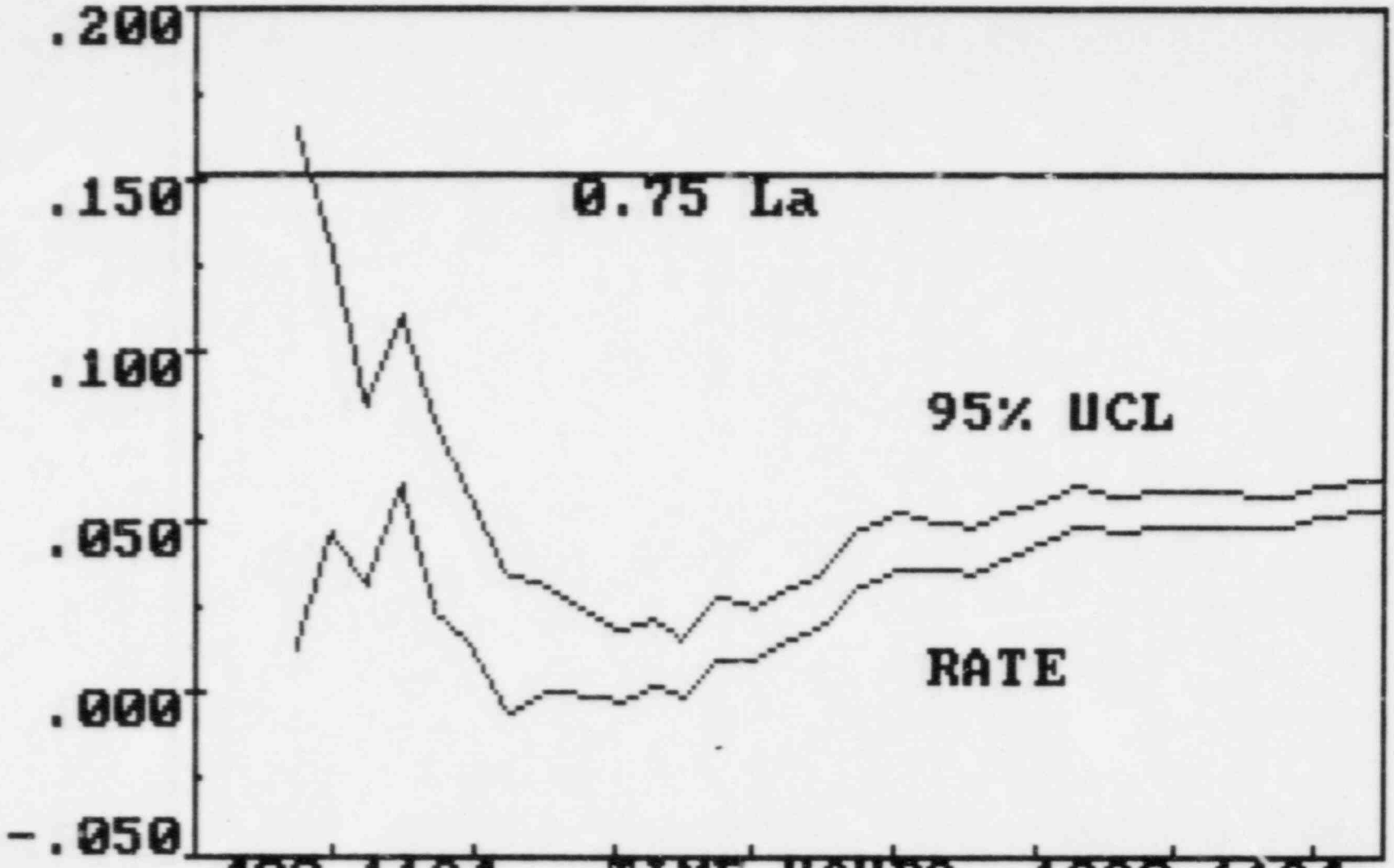
VAPOR PRESSURE PSIA



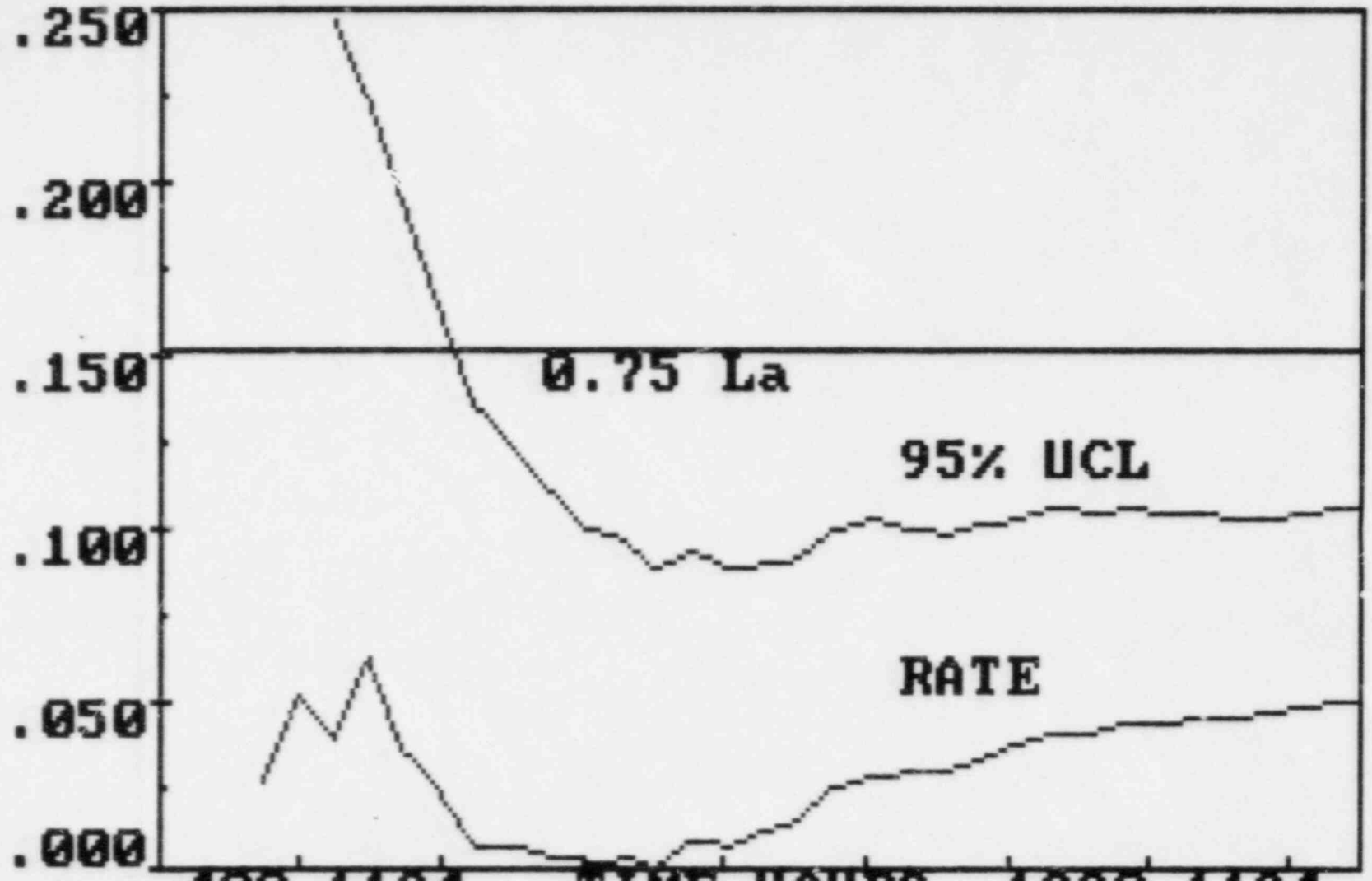
CALVERT CLIFFS - UNIT 2 ILRT
AIRMASS LBM X 1000 AND REGRESSION LINE

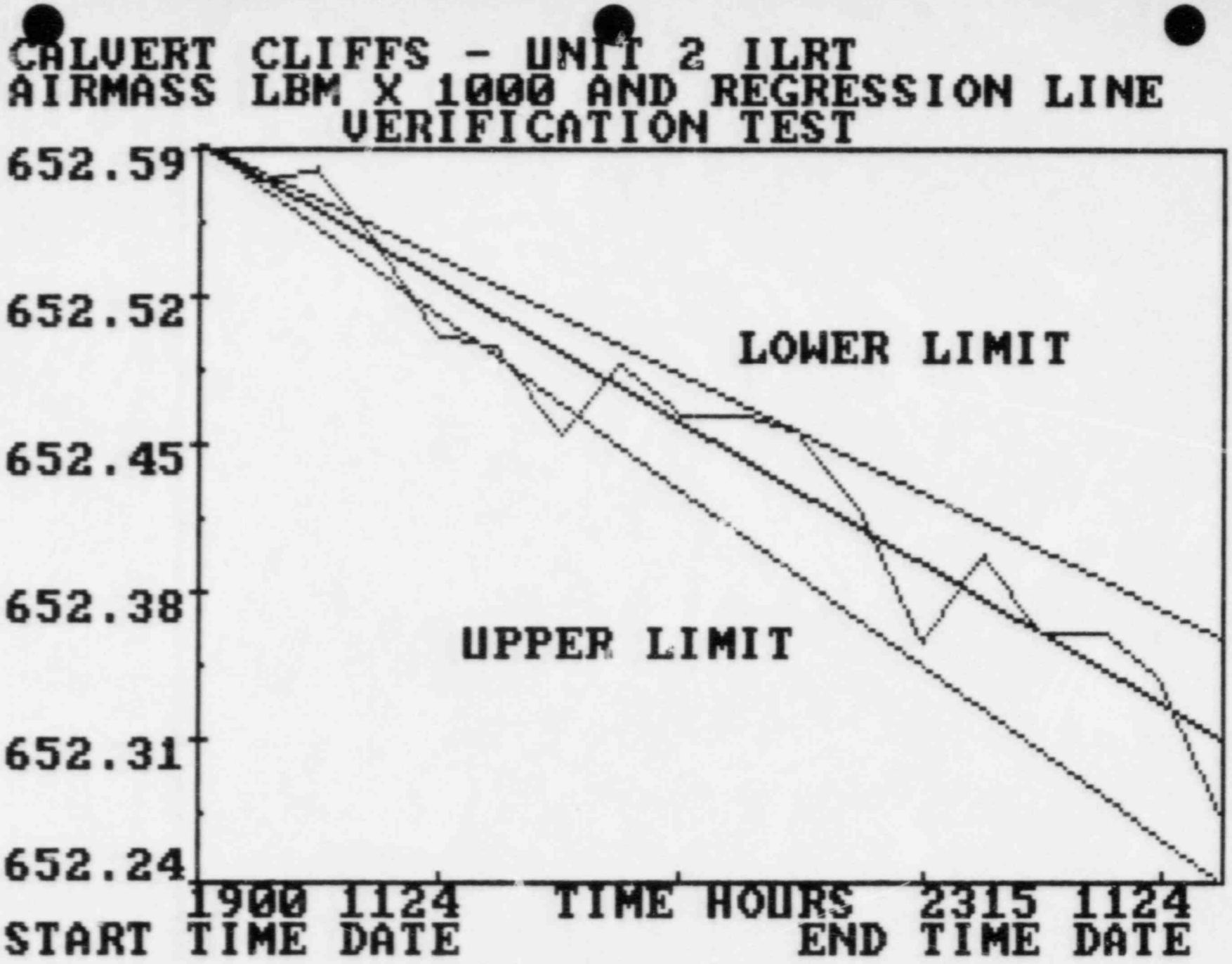


CALVERT CLIFFS - UNIT 2 ILRT
MASS POINT LEAKAGE RATE AND UCL - %/DAY

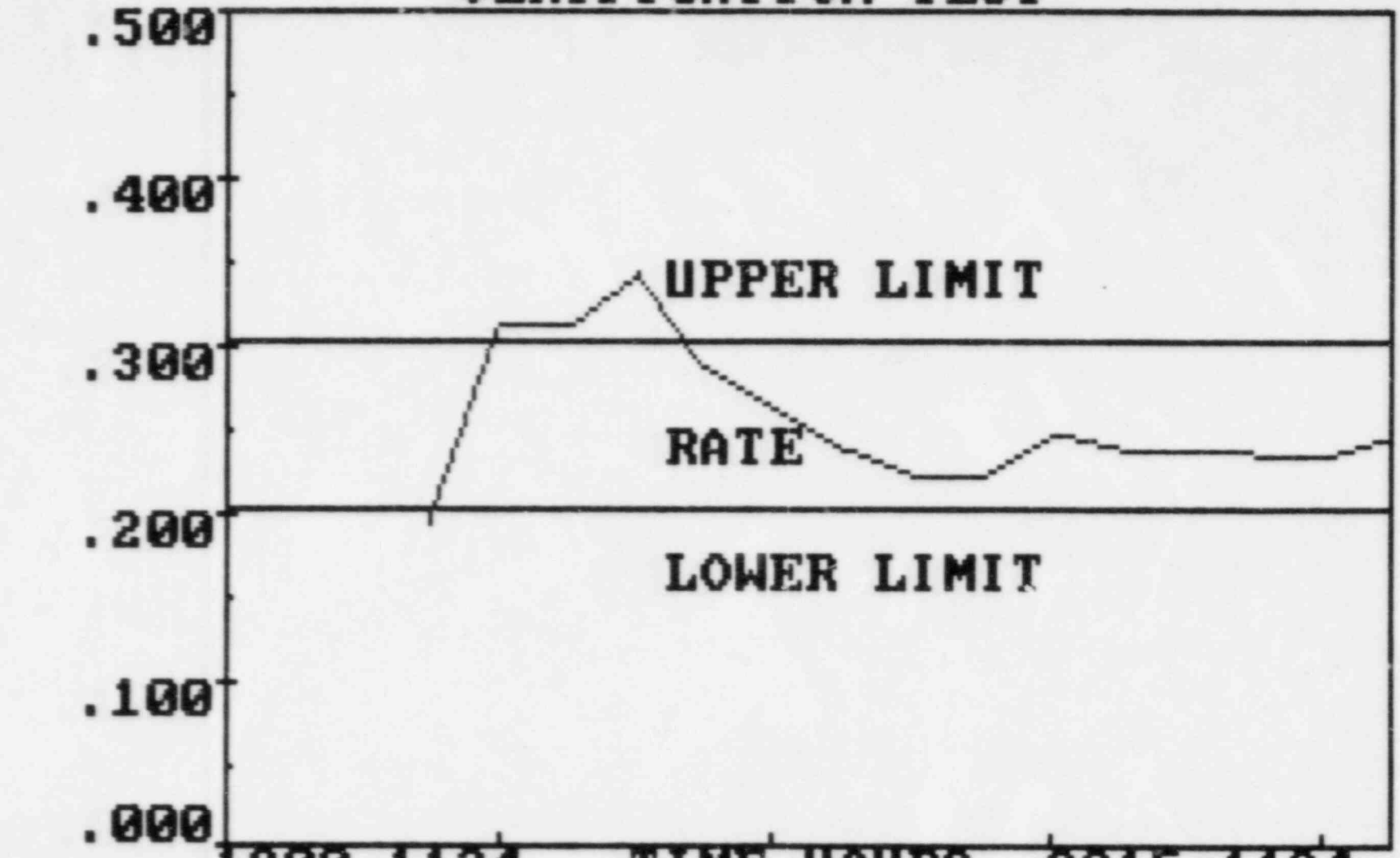


CALVERT CLIFFS - UNIT 2 ILRT
TOTAL TIME LEAKAGE RATE AND UCL - %/DAY

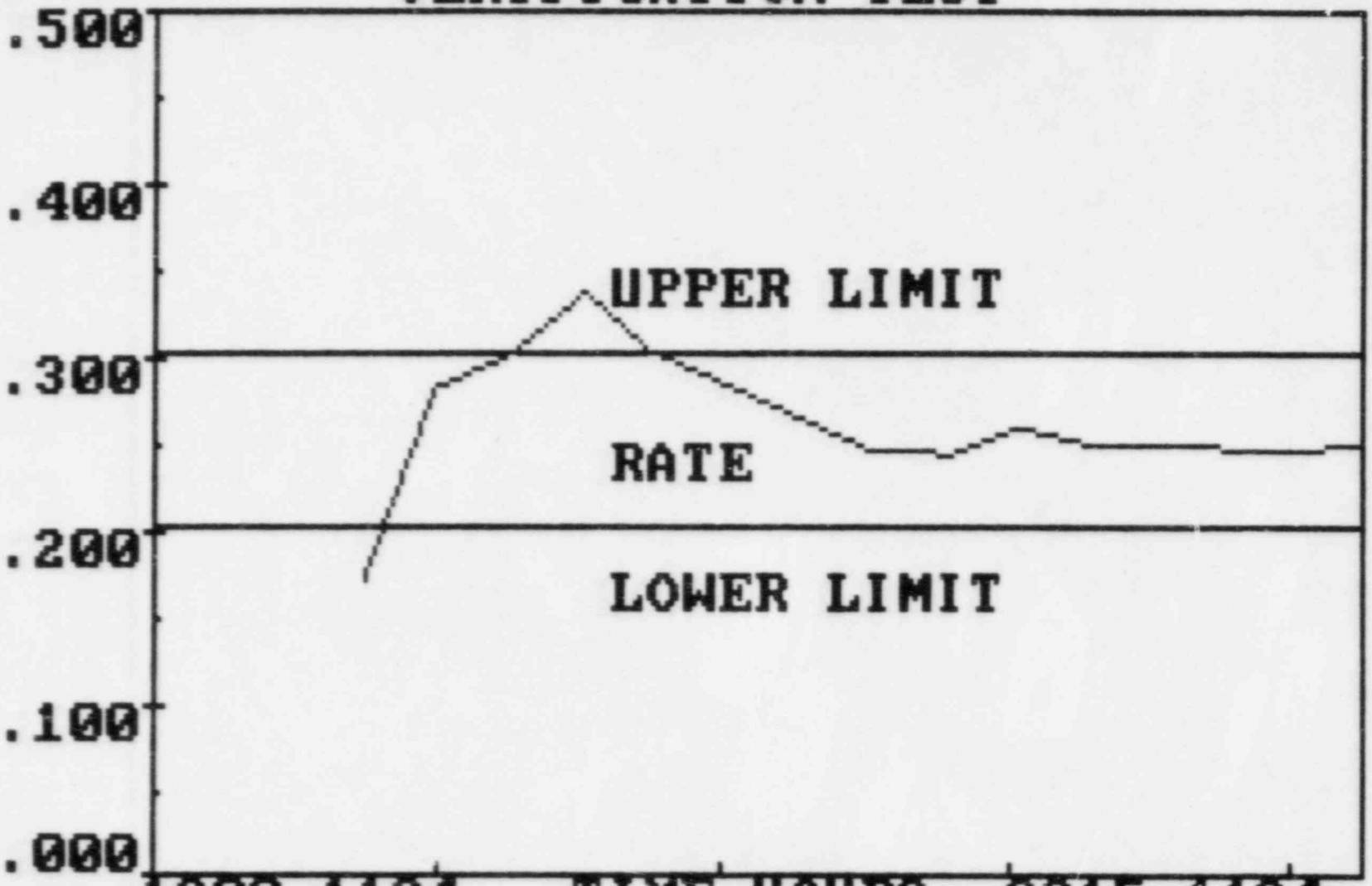



CALVERT CLIFFS - UNIT 2 ILRT
AIRMASS LBM X 1000 AND REGRESSION LINE
VERIFICATION TEST
652.59
652.52
652.45
652.38
652.31
652.24
LOWER LIMIT
UPPER LIMIT
1900 1124
TIME HOURS
2315 1124
START TIME DATE
END TIME DATE

CALVERT CLIFFS - UNIT 2 ILRT
MASS POINT LEAKAGE RATE - %/DAY
VERIFICATION TEST



CALVERT CLIFFS - UNIT 2 ILRT
TOTAL TIME LEAKAGE RATE - %/DAY
VERIFICATION TEST



APPENDIX F

VERIFICATION FLOW SUMMARY AND DATA

CALVERT CLIFFS - UNIT 2 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 1900 1124 1985
TEST DURATION: 4.25 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
1900	538.261	65.0691	652590.		
1915	538.262	65.0678	652575.	15.1	60.4
1930	538.254	65.0673	652581.	-5.5	19.3
1945	538.282	65.0672	652545.	35.3	59.8
2000	538.304	65.0653	652500.	45.3	90.2
2015	538.309	65.0654	652494.	6.0	76.9
2030	538.338	65.0649	652455.	39.2	90.3
2045	538.305	65.0643	652488.	-33.3	58.3
2100	538.316	65.0632	652464.	23.8	62.9
2115	538.304	65.0617	652464.	.3	56.1
2130	538.311	65.0615	652454.	10.1	54.5
2145	538.339	65.0613	652418.	36.2	62.7
2200	538.389	65.0614	652357.	60.7	77.7
2215	538.351	65.0608	652398.	-41.2	59.1
2230	538.376	65.0602	652361.	36.7	65.3
2245	538.377	65.0601	652359.	2.1	61.6
2300	538.395	65.0601	652337.	22.0	63.2
2315	538.442	65.0594	652274.	63.9	74.5

FREE AIR VOLUME USED (CU. FT.) =2000000.
REGRESSION LINE
INTERCEPT (LBM) = 652591.
SLOPE (LBM/HR) = -66.1
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT = .302
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT = .202
THE CALCULATED LEAKAGE RATE = .243

CALVERT CLIFFS - UNIT 2 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 1900 1124 1985
TEST DURATION: 4.25 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
1900	538.261	65.0691	
1915	538.262	65.0678	.222
1930	538.254	65.0673	.071
1945	538.282	65.0672	.220
2000	538.304	65.0653	.332
2015	538.309	65.0654	.283
2030	538.338	65.0649	.332
2045	538.305	65.0643	.215
2100	538.316	65.0632	.232
2115	538.304	65.0617	.206
2130	538.311	65.0615	.200
2145	538.339	65.0613	.231
2200	538.389	65.0614	.286
2215	538.351	65.0608	.217
2230	538.376	65.0602	.240
2245	538.377	65.0601	.226
2300	538.395	65.0601	.232
2315	538.442	65.0594	.274

MEAN OF THE MEASURED LEAKAGE RATES = .236
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT = .300
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT = .200
THE CALCULATED LEAKAGE RATE = .251

CALVERT CLIFFS - UNIT 2 ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 2000000.
VRATET = .250 VRATEM = .252

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
1230	1124	538.028	65.0740	.2780	2000000.
1245	1124	538.031	65.0749	.2781	2000000.
1300	1124	538.050	65.0748	.2782	2000000.
1315	1124	538.081	65.0745	.2785	2000000.
1330	1124	538.077	65.0746	.2784	2000000.
1345	1124	538.100	65.0743	.2788	2000000.
1400	1124	538.110	65.0745	.2785	2000000.
1415	1124	538.097	65.0742	.2788	2000000.
1430	1124	538.134	65.0741	.2789	2000000.
1445	1124	538.145	65.0741	.2789	2000000.
1500	1124	538.122	65.0739	.2791	2000000.
1515	1124	538.149	65.0741	.2790	2000000.
1530	1124	538.166	65.0738	.2792	2000000.
1545	1124	538.182	65.0736	.2794	2000000.
1600	1124	538.213	65.0736	.2795	2000000.
1615	1124	538.216	65.0734	.2796	2000000.
1630	1124	538.236	65.0723	.2797	2000000.
1645	1124	538.215	65.0720	.2796	2000000.
1700	1124	538.199	65.0717	.2799	2000000.
1715	1124	538.228	65.0717	.2798	2000000.
1730	1124	538.246	65.0711	.2800	2000000.
1745	1124	538.242	65.0709	.2802	2000000.
1800	1124	538.227	65.0709	.2802	2000000.
1815	1124	538.254	65.0702	.2803	2000000.
1830	1124	538.290	65.0697	.2804	2000000.
1845	1124	538.292	65.0692	.2804	2000000.
1900	1124	538.261	65.0691	.2805	2000000.
1915	1124	538.262	65.0678	.2808	2000000.
1930	1124	538.254	65.0673	.2808	2000000.
1945	1124	538.282	65.0672	.2809	2000000.
2000	1124	538.304	65.0653	.2813	2000000.
2015	1124	538.309	65.0654	.2812	2000000.
2030	1124	538.338	65.0649	.2812	2000000.
2045	1124	538.305	65.0643	.2813	2000000.
2100	1124	538.316	65.0632	.2815	2000000.
2115	1124	538.304	65.0617	.2814	2000000.
2130	1124	538.311	65.0615	.2816	2000000.
2145	1124	538.339	65.0613	.2818	2000000.
2200	1124	538.389	65.0614	.2818	2000000.
2215	1124	538.351	65.0608	.2818	2000000.
2230	1124	538.376	65.0602	.2819	2000000.
2245	1124	538.377	65.0601	.2820	2000000.
2300	1124	538.395	65.0601	.2821	2000000.
2315	1124	538.442	65.0594	.2823	2000000.

APPENDIX G

ISG CALCULATIONS

ISG CALCULATION
(ANSI/ANS 56.8 - 1981)

****

CALIBRATION DATA

	# OF SENSORS	SENSITIVITY(E)	REPEATABILITY(r)
TEMPERATURE(T)	14	0.0100 deg. F	0.0100 deg. F
PRESSURE(P)	2	0.0010 psia	0.0010 psia
VAPOR PRESS(Pv)	6	0.1000 deg. F	0.1000 deg. F

Length of Test(t) 8.5 hrs

Test Pressure(P) 50.5 psig ==> 65.5 psia

From Steam Table 0.0108 psi/deg. F (at 65 deg. F)

La 0.2000 wt%/day

INSTRUMENT MEASUREMENT ERRORS

$$\sigma T = [(ET)^2 + (rT)^2]^{1/2} / [\# \text{ of sensors}]^{1/2}$$

σT = 0.0038 deg. F

$$\sigma P = [(EP)^2 + (rP)^2]^{1/2} / [\# \text{ of sensors}]^{1/2}$$

σP = 0.0010 psia

$$\sigma Pv = [(EPv)^2 + (rPv)^2]^{1/2} / [\# \text{ of sensors}]^{1/2}$$

σPv = 0.0006 psia

INSTRUMENT SELECTION GUIDE

$$ISG = 2400/t[\ 2(\sigma P/P)^2 + 2(\sigma Pv/P)^2 + 2(\sigma T/T)^2\ ]^{1/2}$$

ISG = 0.0077 wt%/day

25% of La 0.0500 wt%/day

****

APPENDIX H

LOCAL LEAKAGE RATE TEST EVALUATION

APPENDIX H

LOCAL LEAKAGE RATE TESTING EVALUATION

During refueling outages, local leakage rate testing (LLRT) is commenced at the beginning of the outage and completed in approximately six to eight weeks. The ILRT, if scheduled for that outage, is conducted after the completion of the LLRT.

During the LLRT, repairs and adjustments are made to some systems which may change that penetration's leak rate. The term "As Found" indicates the leak rate before repairs and adjustments and the term "As Left" is the leak rate after repairs and adjustments. An evaluation of the difference between "As Found" and "As Left" can give only some indication of what the ILRT results would be if conducted prior to repairs and adjustments.

Table 1 is a comparison of the "As Found" and "As Left" data for those penetrations which had repairs and adjustments performed during the LLRT. Units of measured leak rate are standard cubic centimeters per minute (sccm).

APPENDIX H

LOCAL LEAKAGE RATE TEST RESULTS
REPAIRS AND ADJUSTMENTS

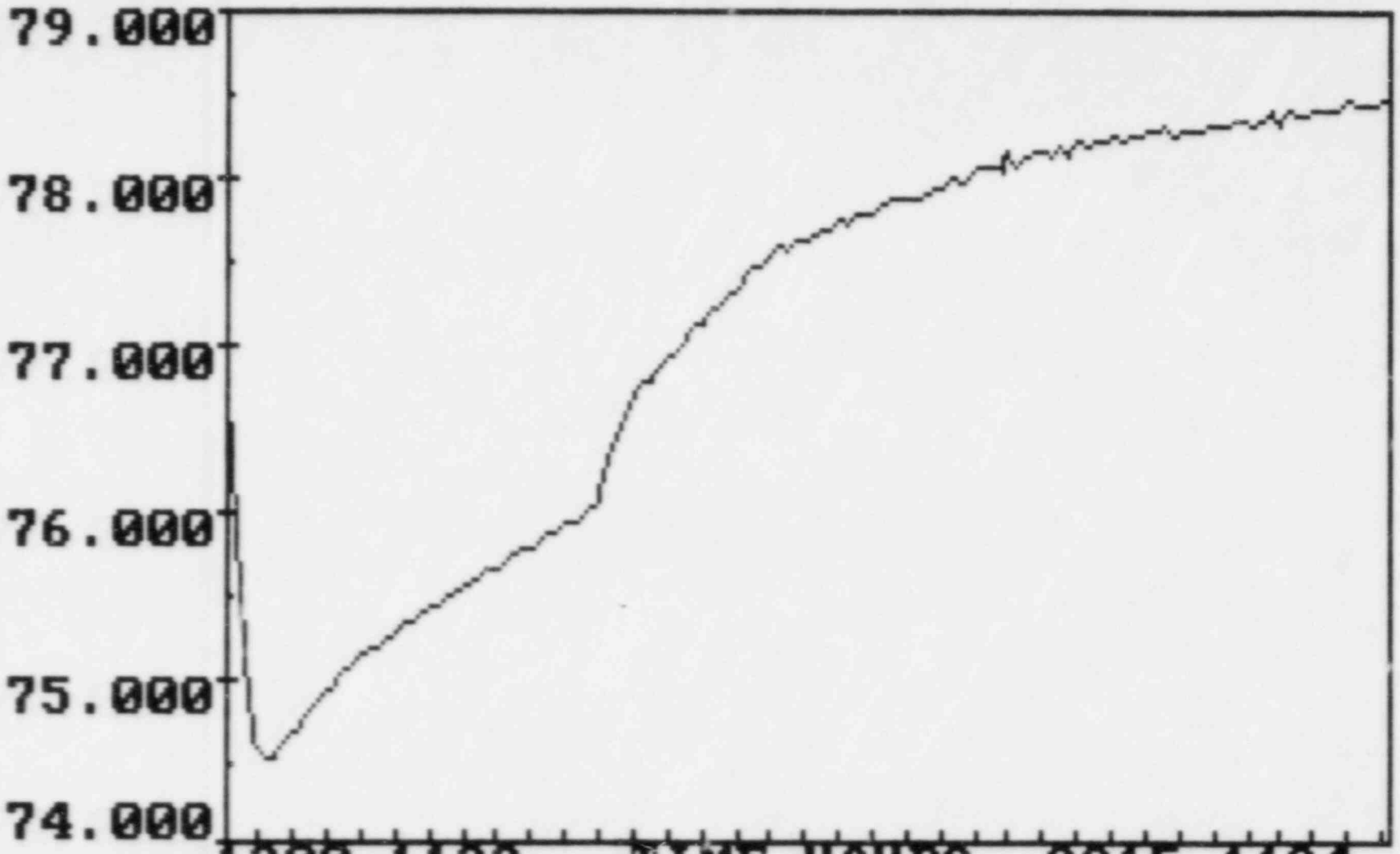
PENETRATION	"AS FOUND"	"AS LEFT"
1A	215	36.2
1C	8.2	5.4
2A	11.0	11.0
2B	1779.2	631.5
7A	9.6	5.3
7B	7.3	2.7
8	34.4	640
9	60.8	60.8
10	280	280
13	486.16	2771.11
14	3264.3	833.5
20A	503	210
20C	443	33.4
41	36714.85	1716.54
42	.8	72.5
48A	75.1	75.1
50	15.3	239
62	75	32.9
64	104,716.98	462
67	21.8	11.6
68	6806	6806
69	1850	1850
	157,377.79	16786.55

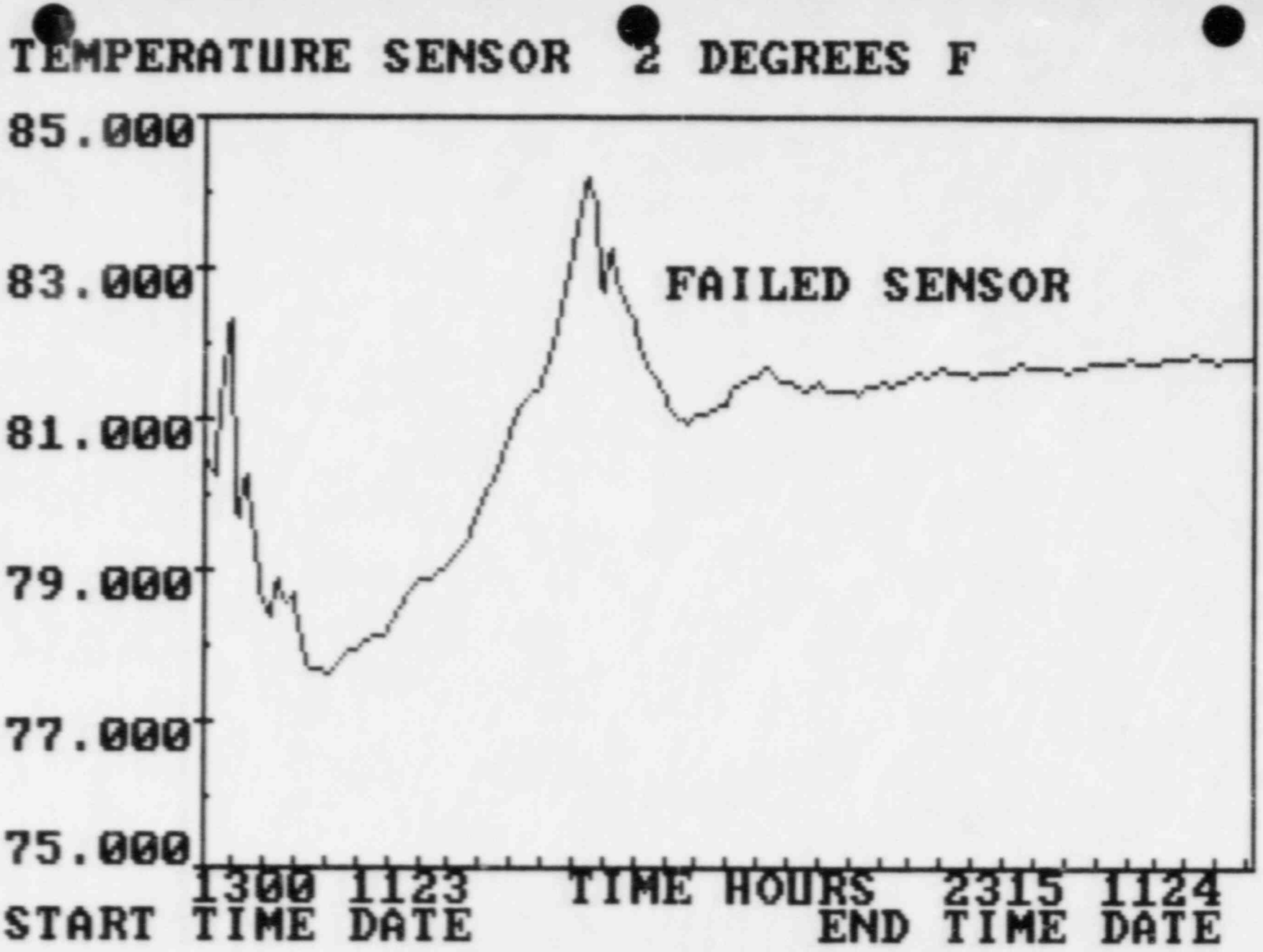
TOTAL SYSTEM - "AS FOUND" 161,185.79
- "AS LEFT" 20,594.55

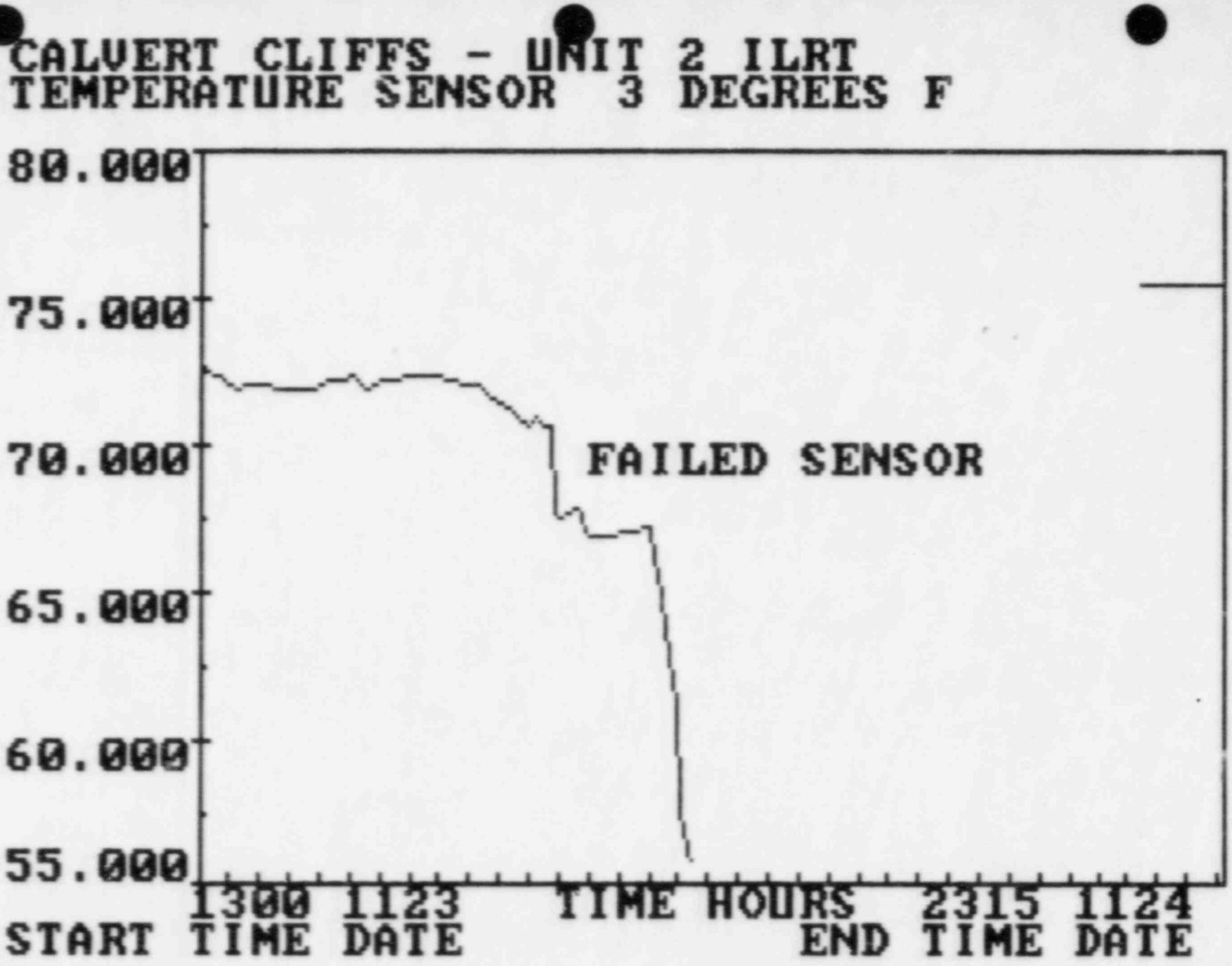
APPENDIX I

SENSOR PLOTS

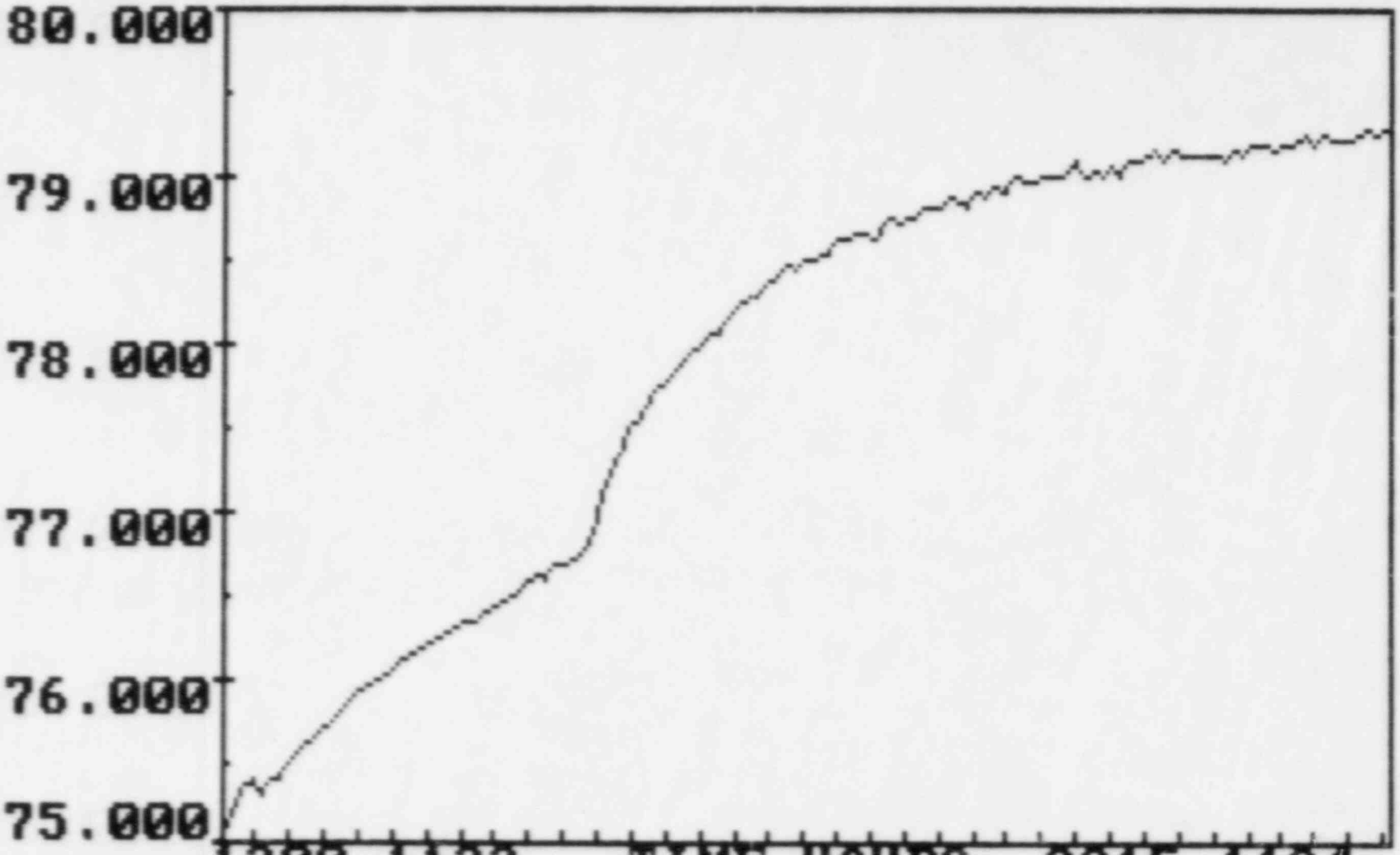
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 1 DEGREES F



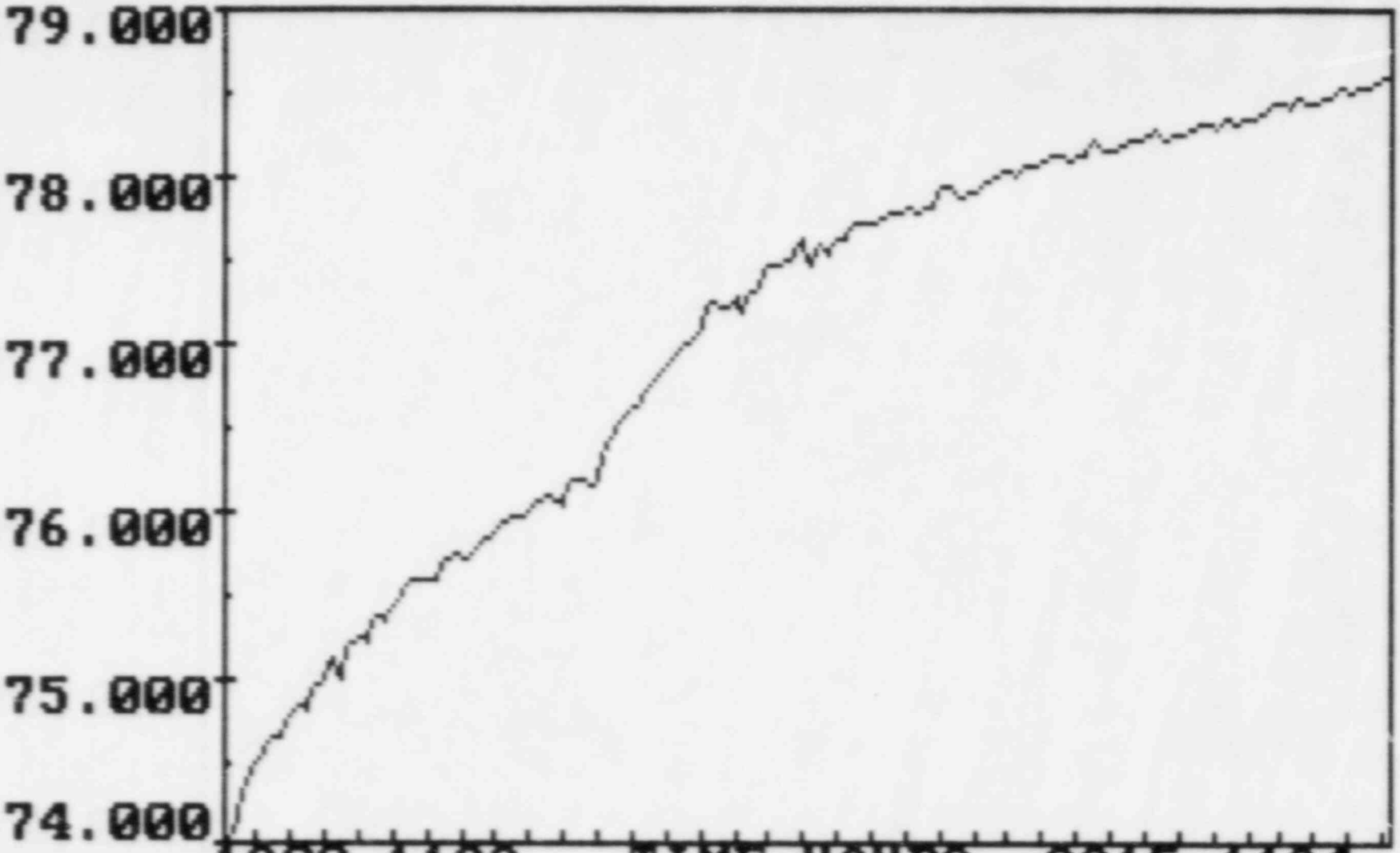

TEMPERATURE SENSOR 2 DEGREES F
85.000
83.000
81.000
79.000
77.000
75.000
FAILED SENSOR
1300 1123
START TIME DATE
TIME HOURS
2315 1124
END TIME DATE

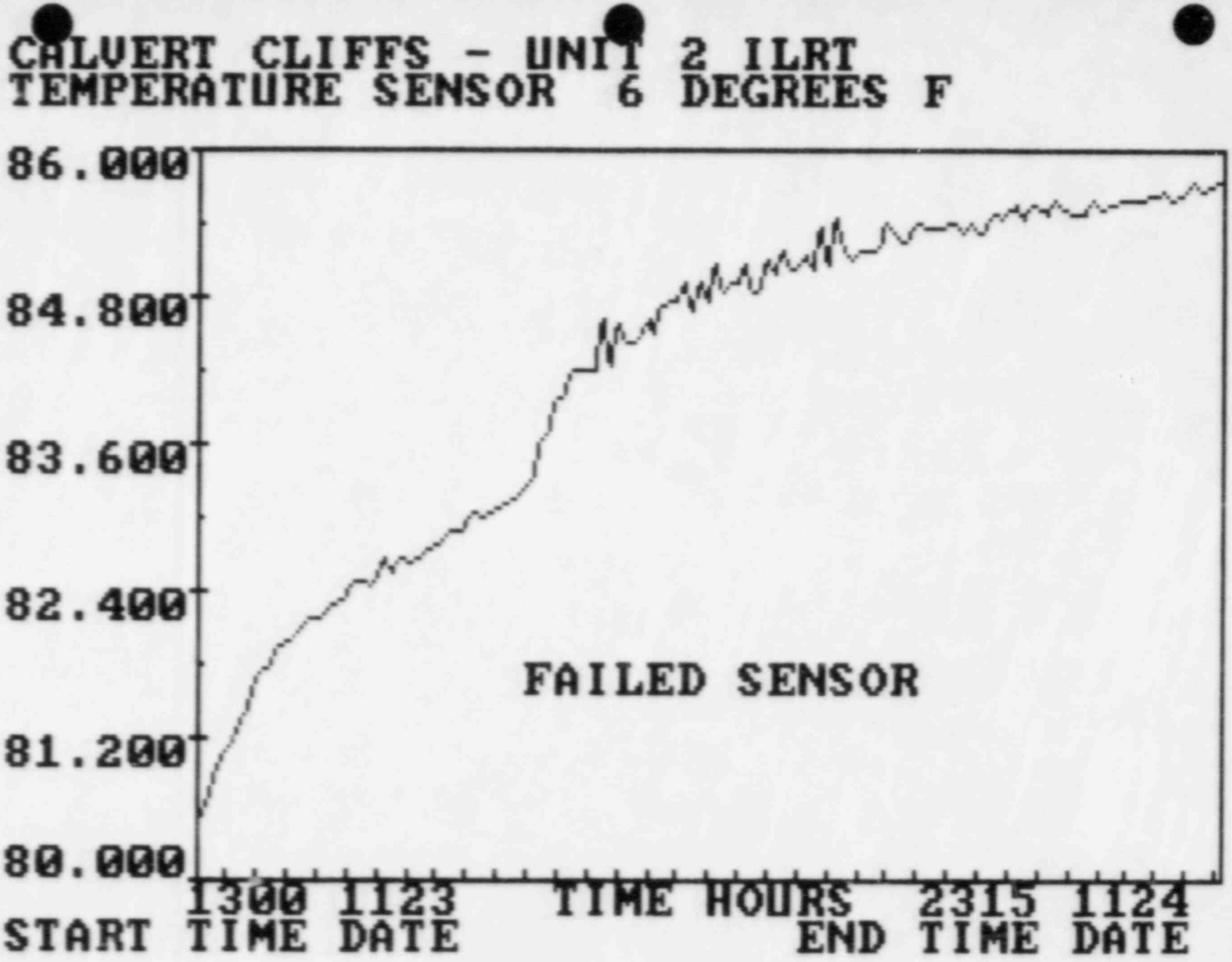

CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 3 DEGREES F
80.000
75.000
70.000
65.000
60.000
55.000
FAILED SENSOR
1300 1123 TIME HOURS 2315 1124
START TIME DATE
END TIME DATE

CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 4 DEGREES F

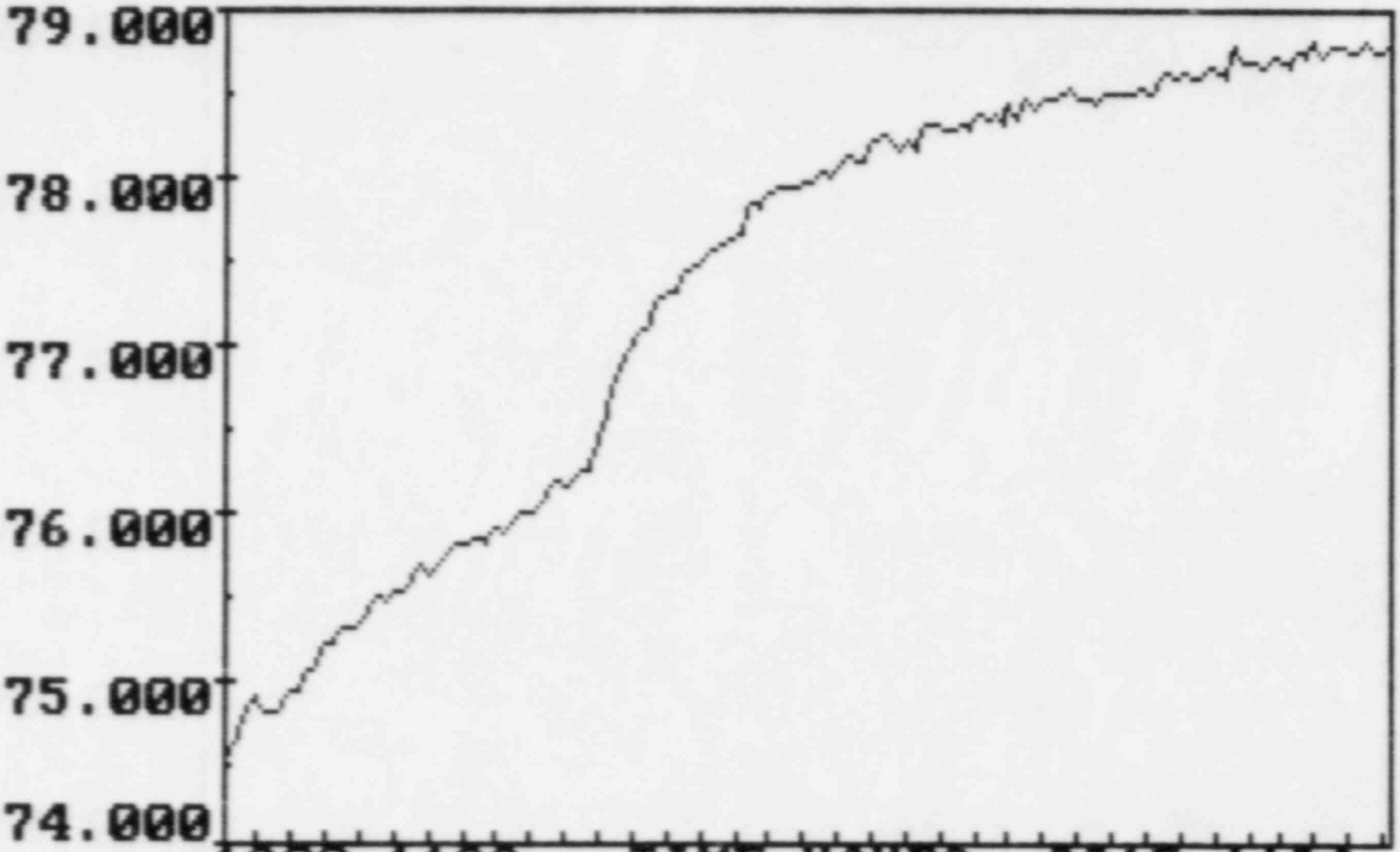


CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 5 DEGREES F

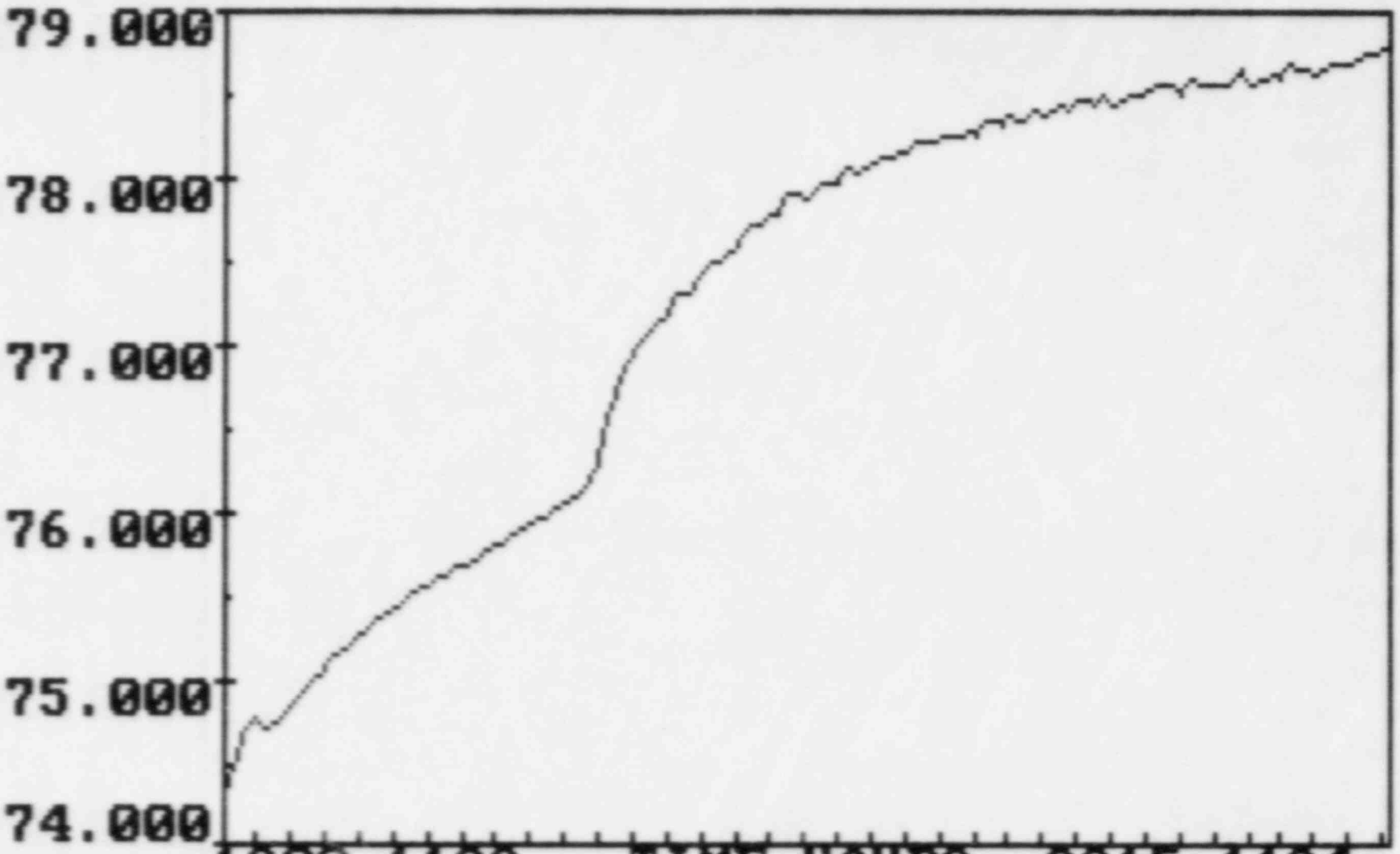



CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 6 DEGREES F
86.000
84.800
83.600
82.400
81.200
80.000
FAILED SENSOR
1300 1123 TIME HOURS 2315 1124
START TIME DATE
END TIME DATE

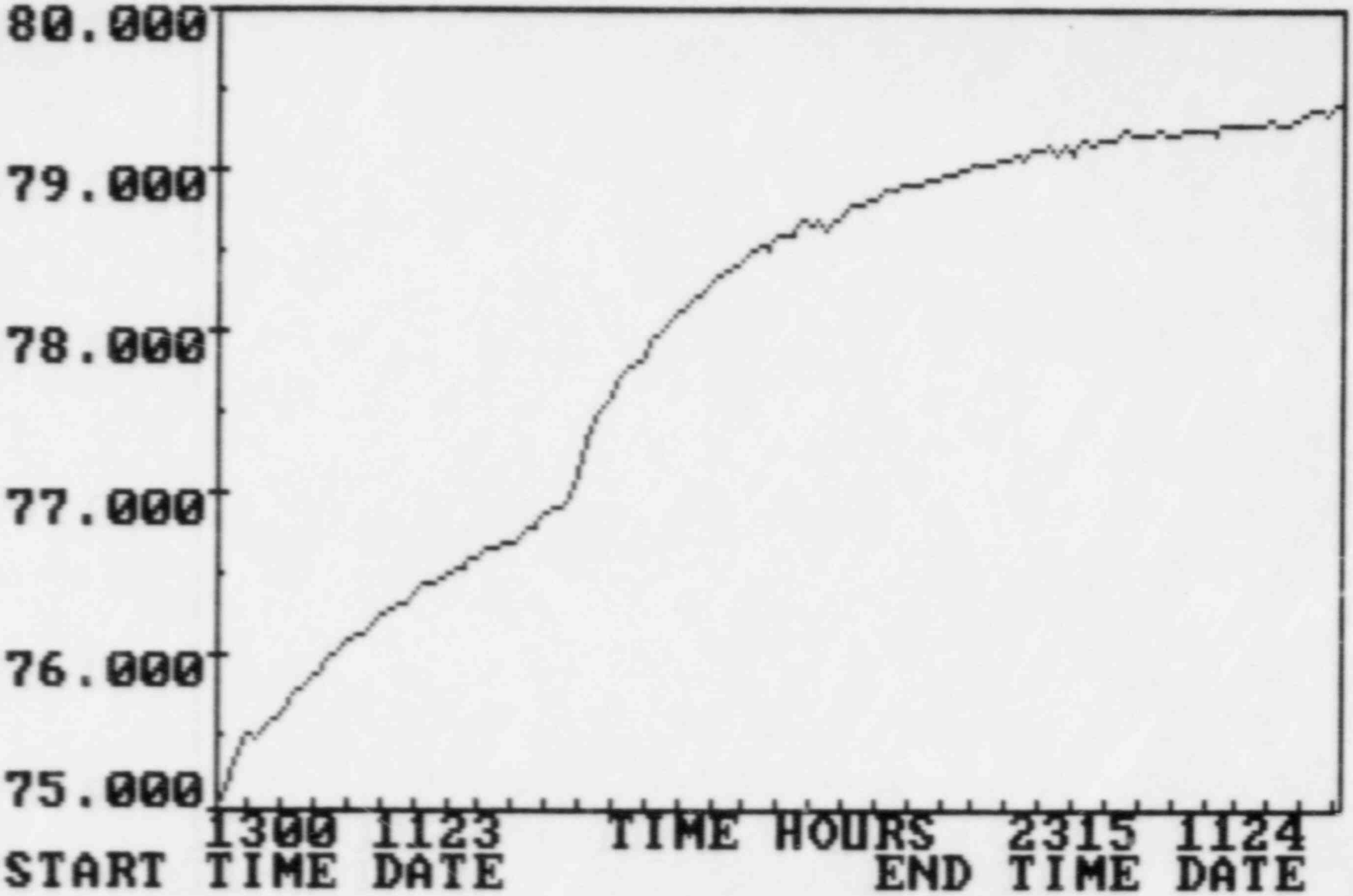
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 7 DEGREES F



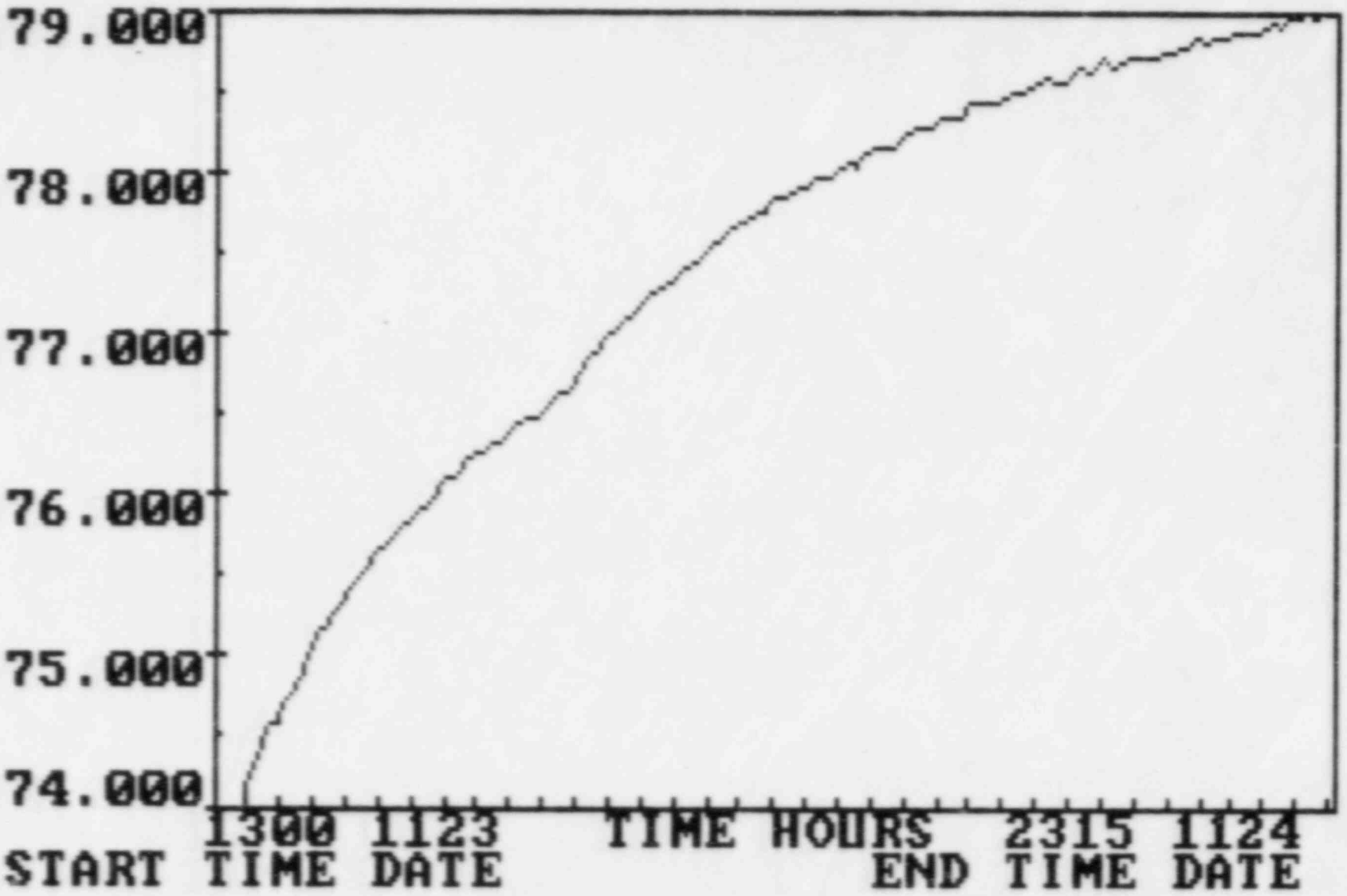
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 8 DEGREES F



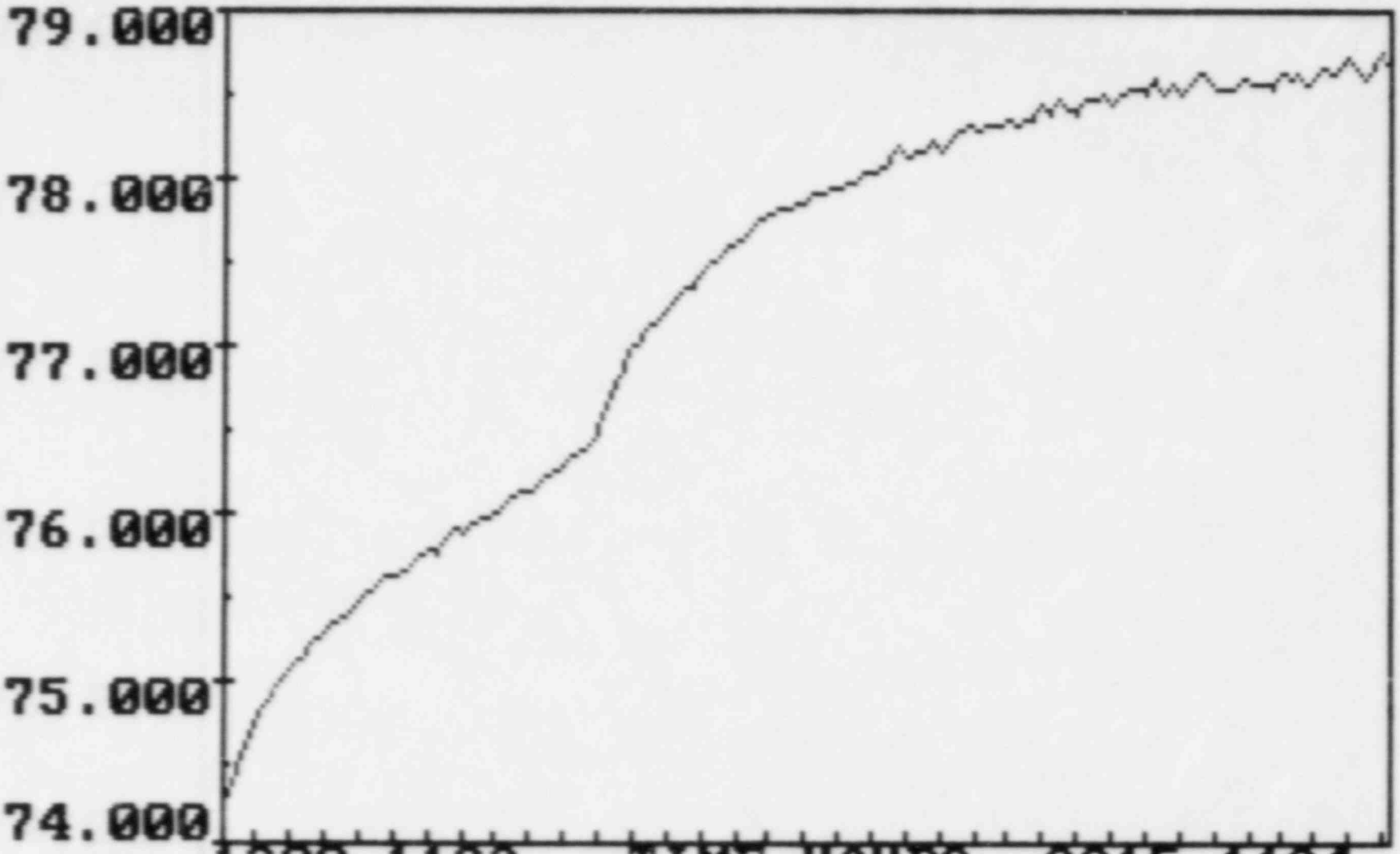
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 9 DEGREES F



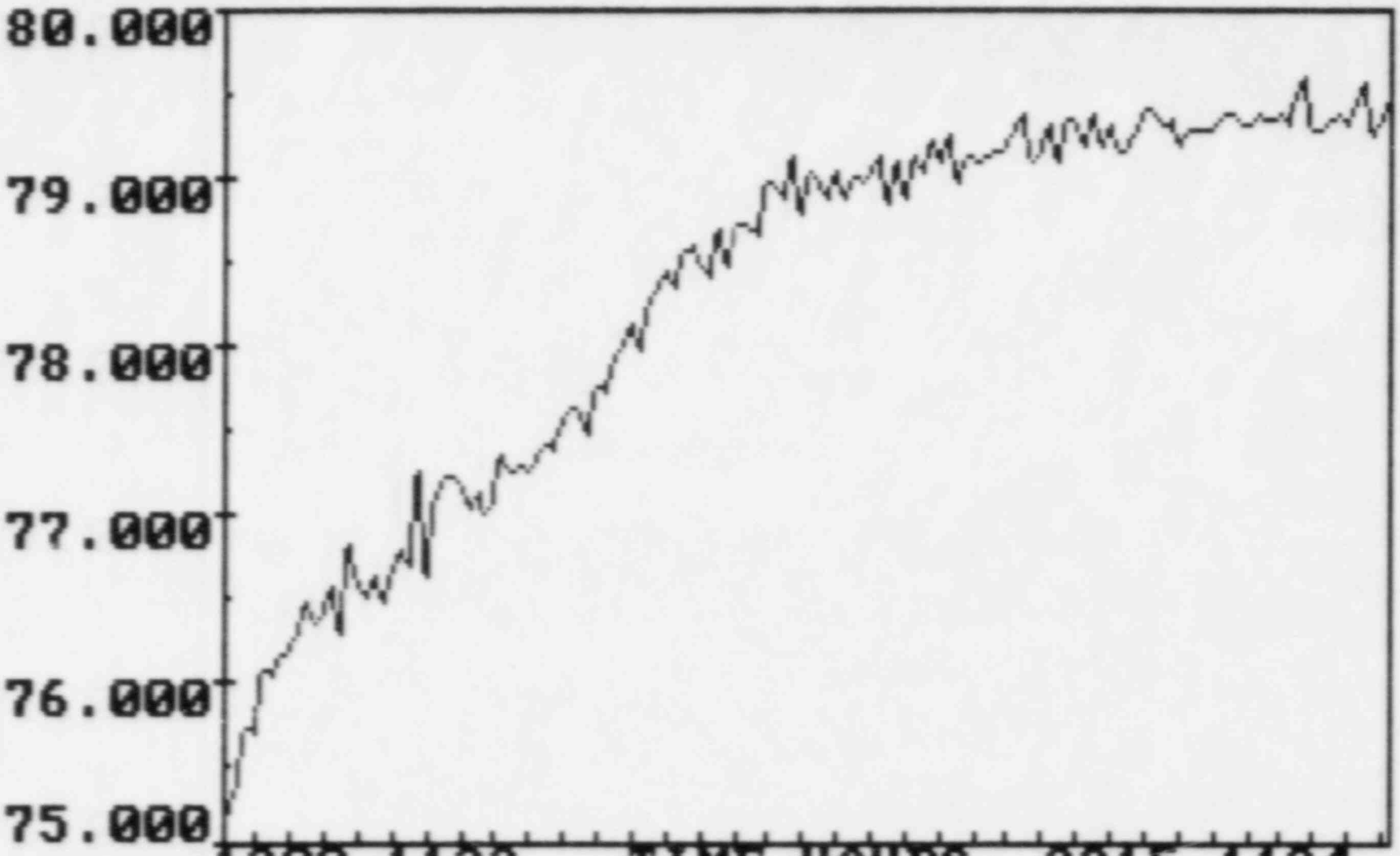
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 10 DEGREES F



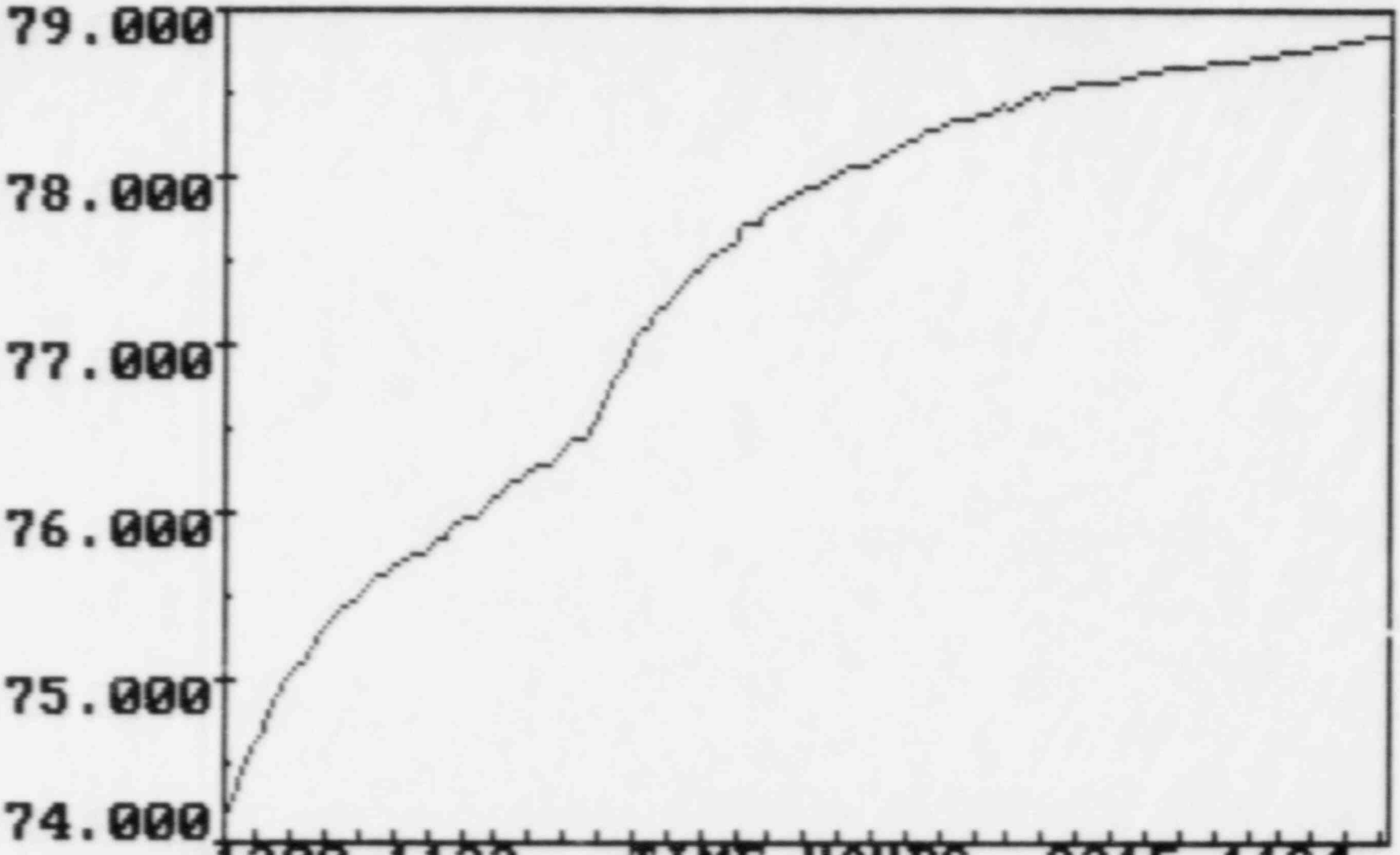
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 11 DEGREES F



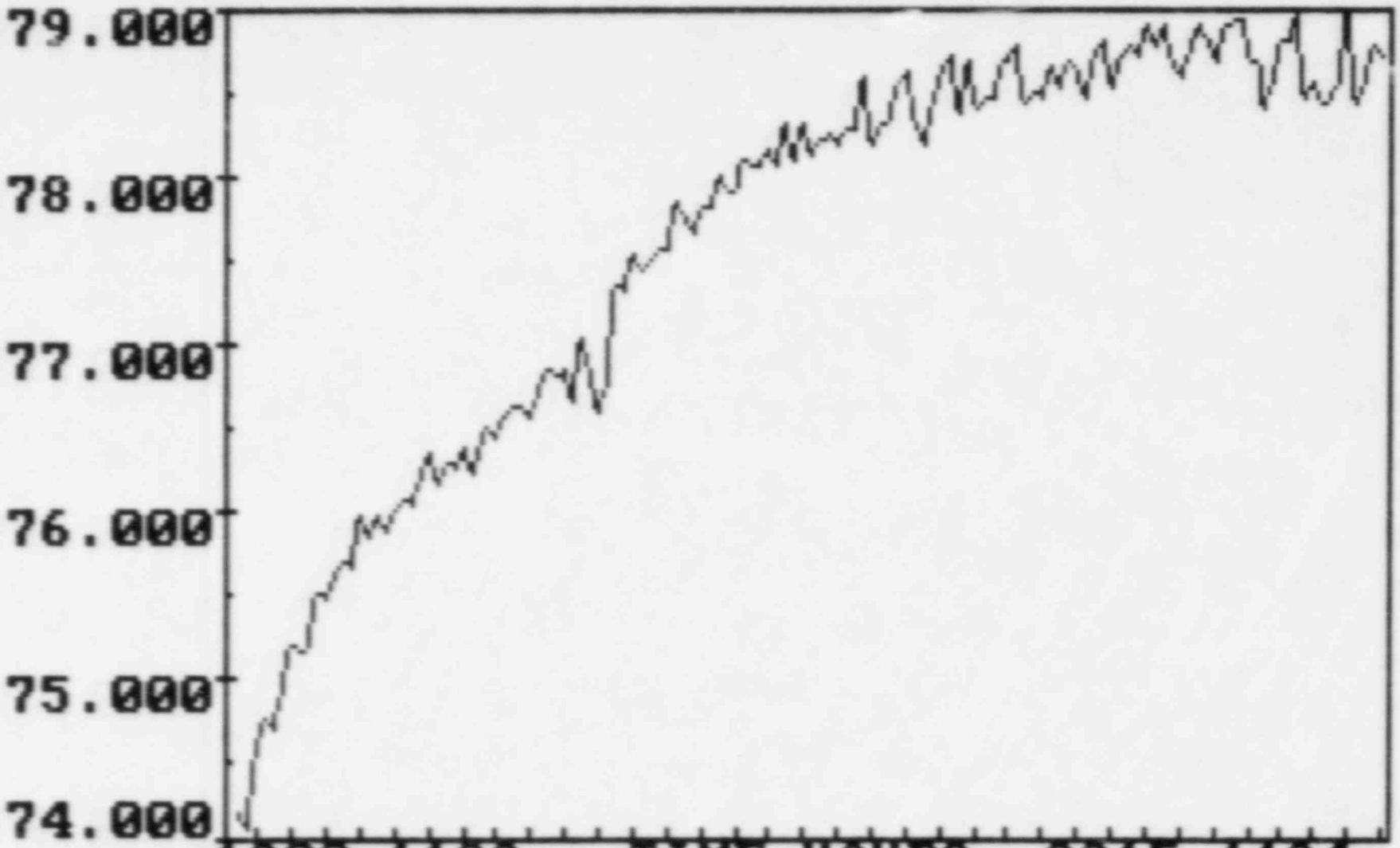
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 12 DEGREES F



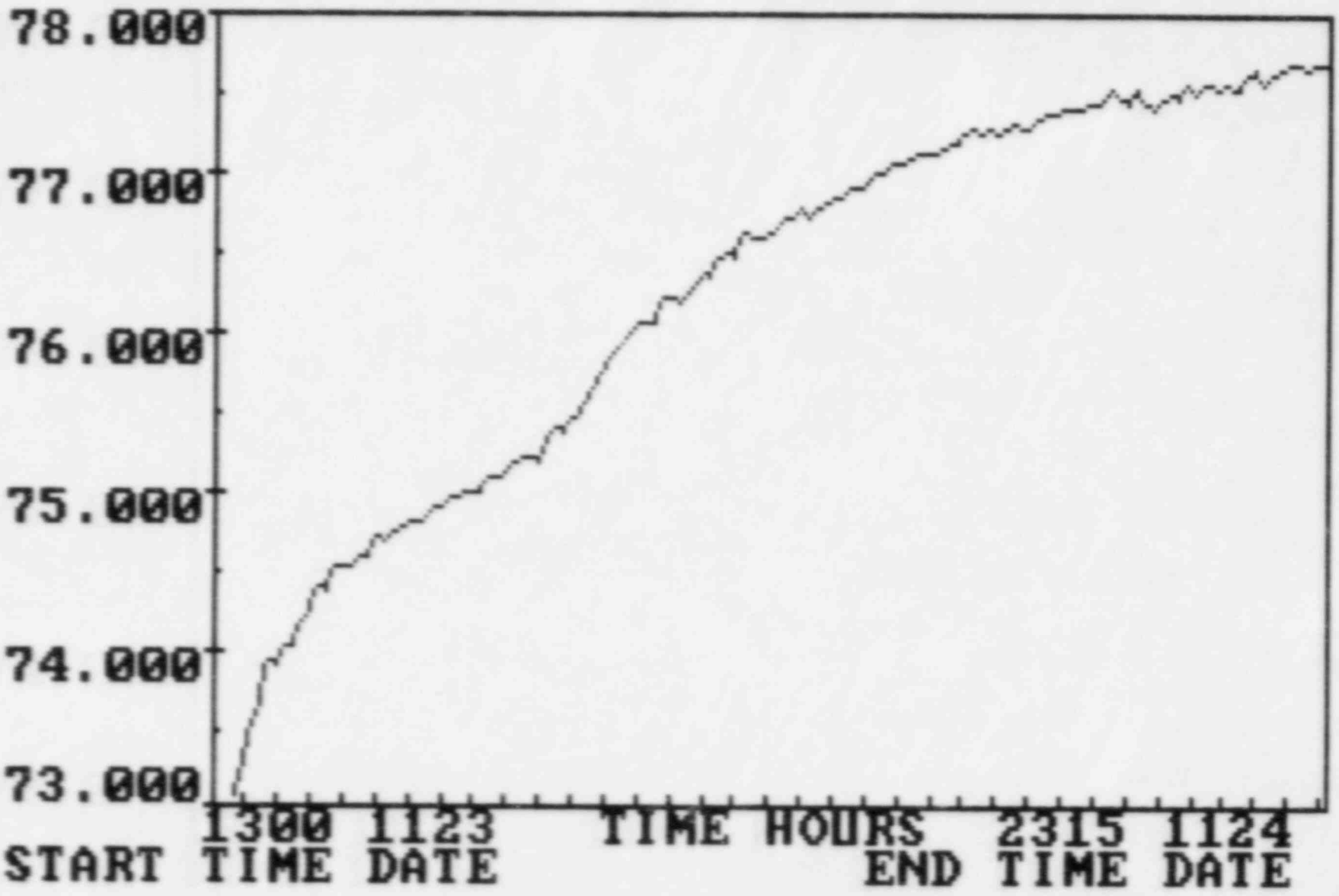
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 13 DEGREES F



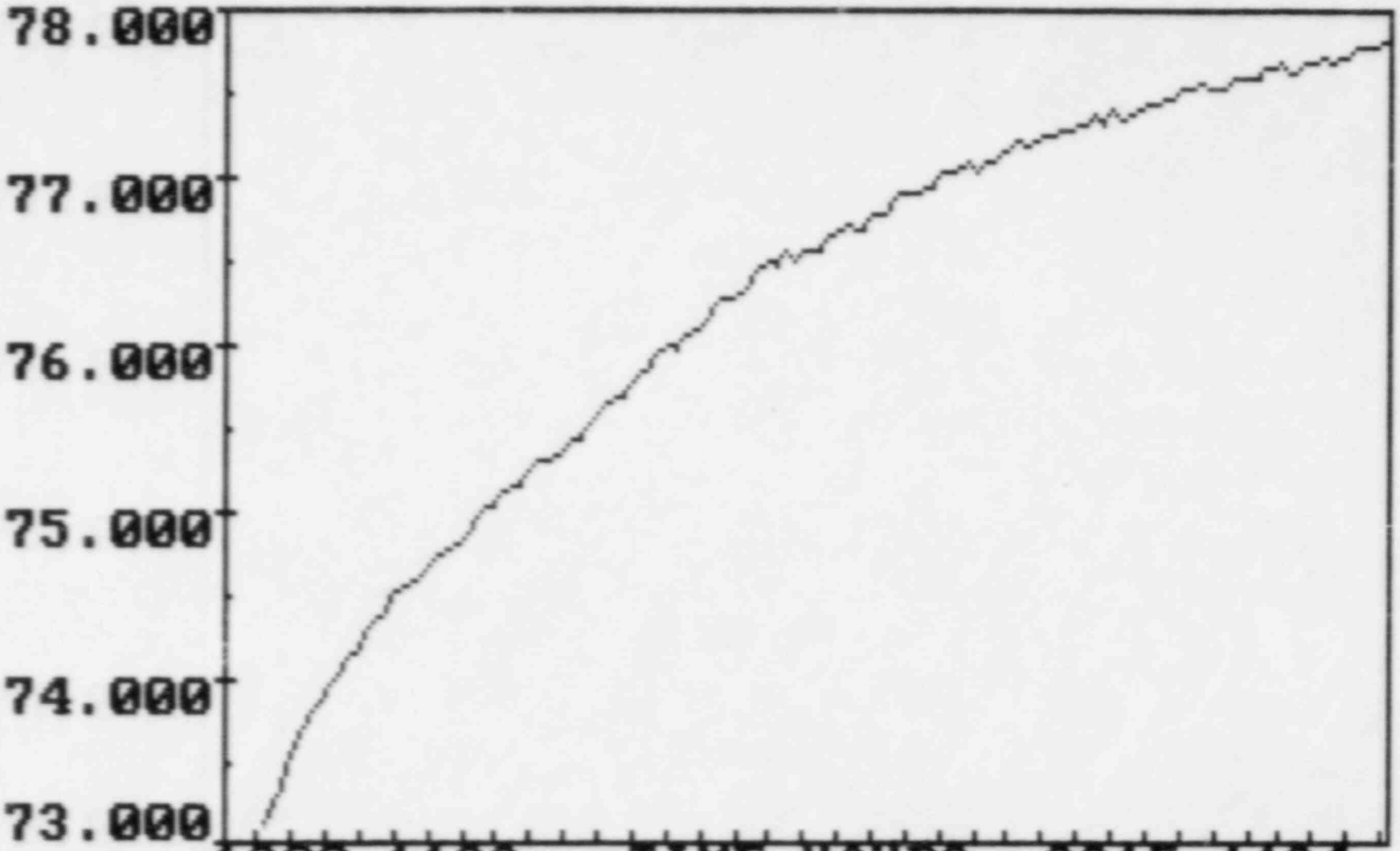
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 14 DEGREES F



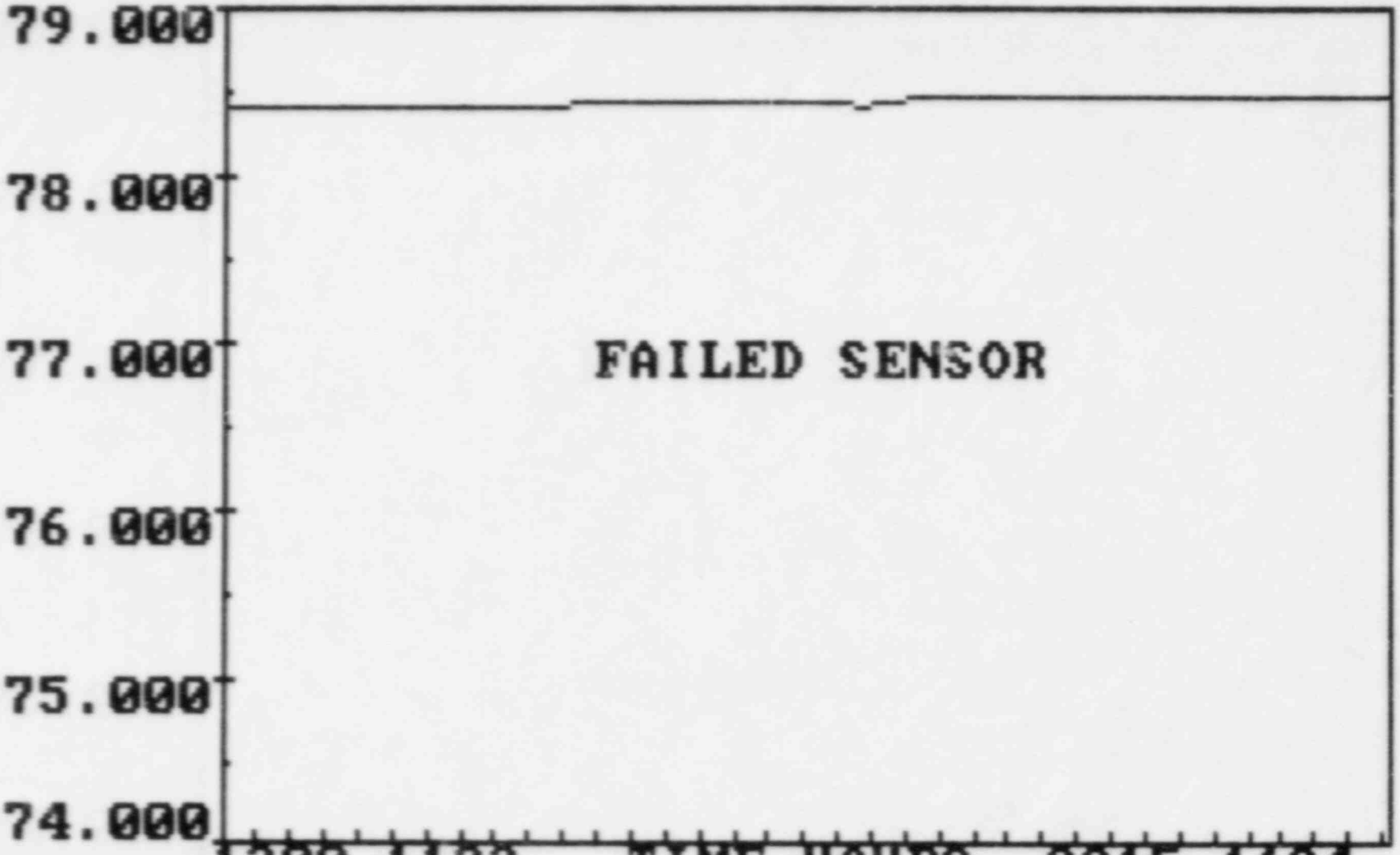
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 15 DEGREES F



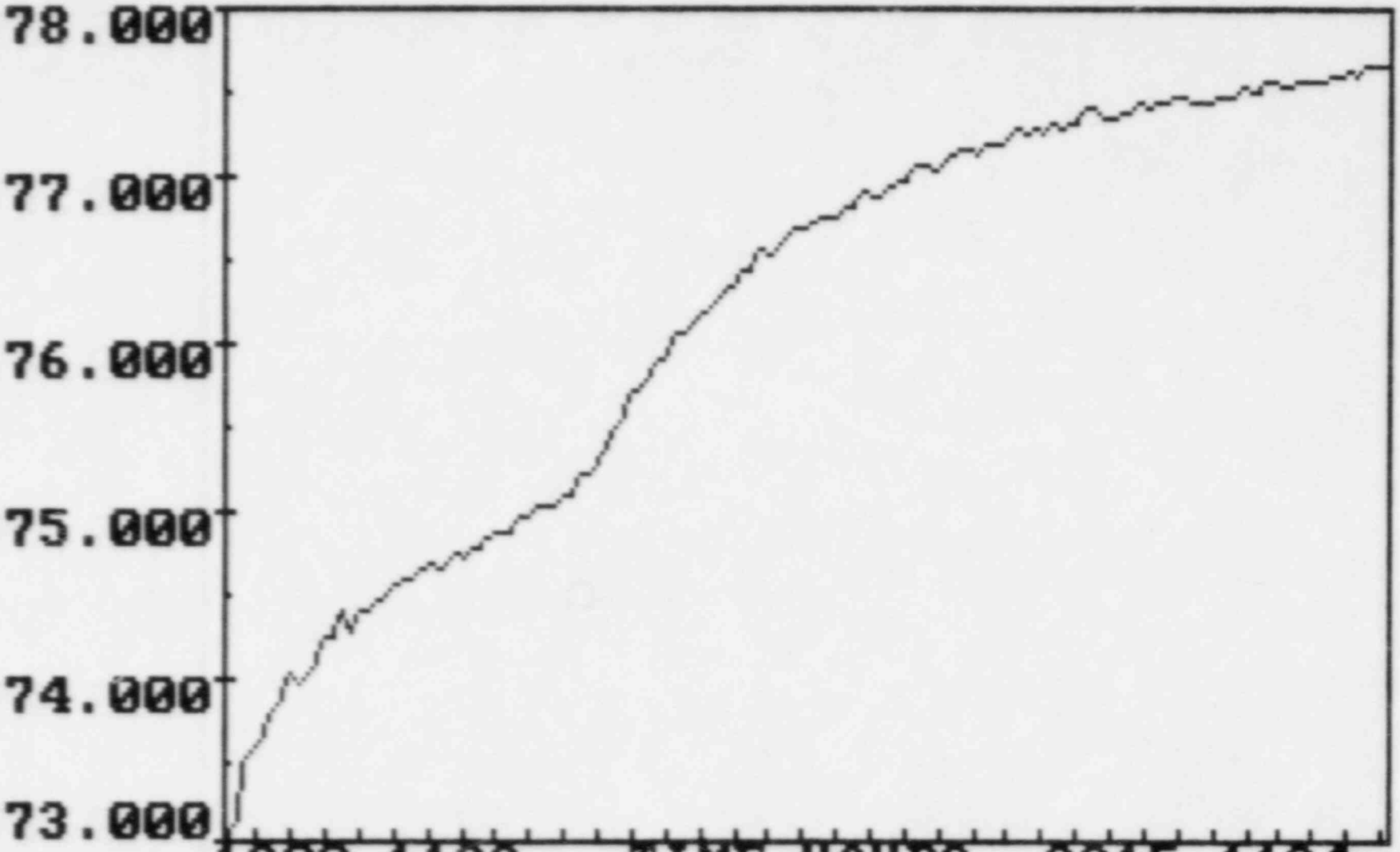
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 16 DEGREES F



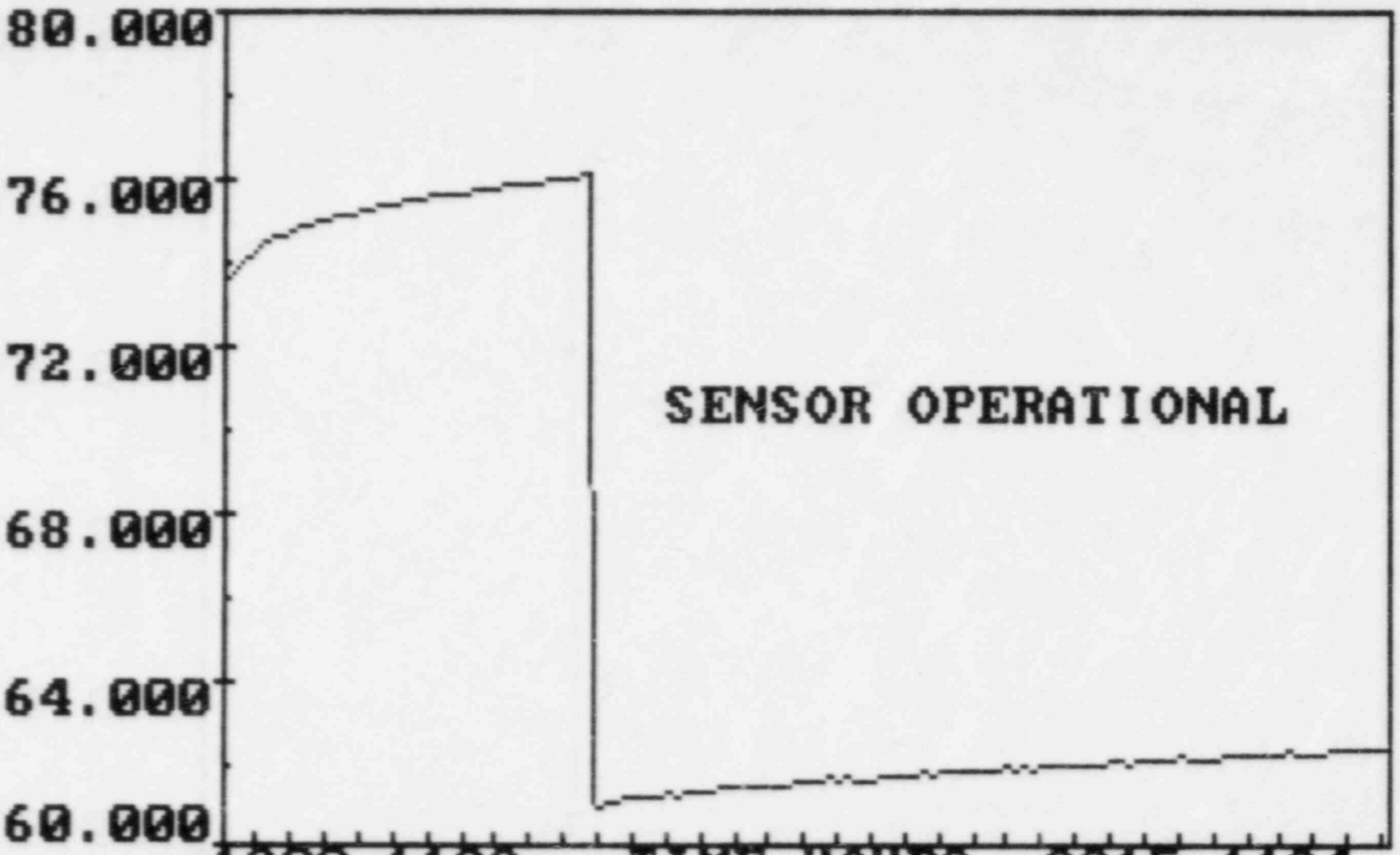
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 17 DEGREES F



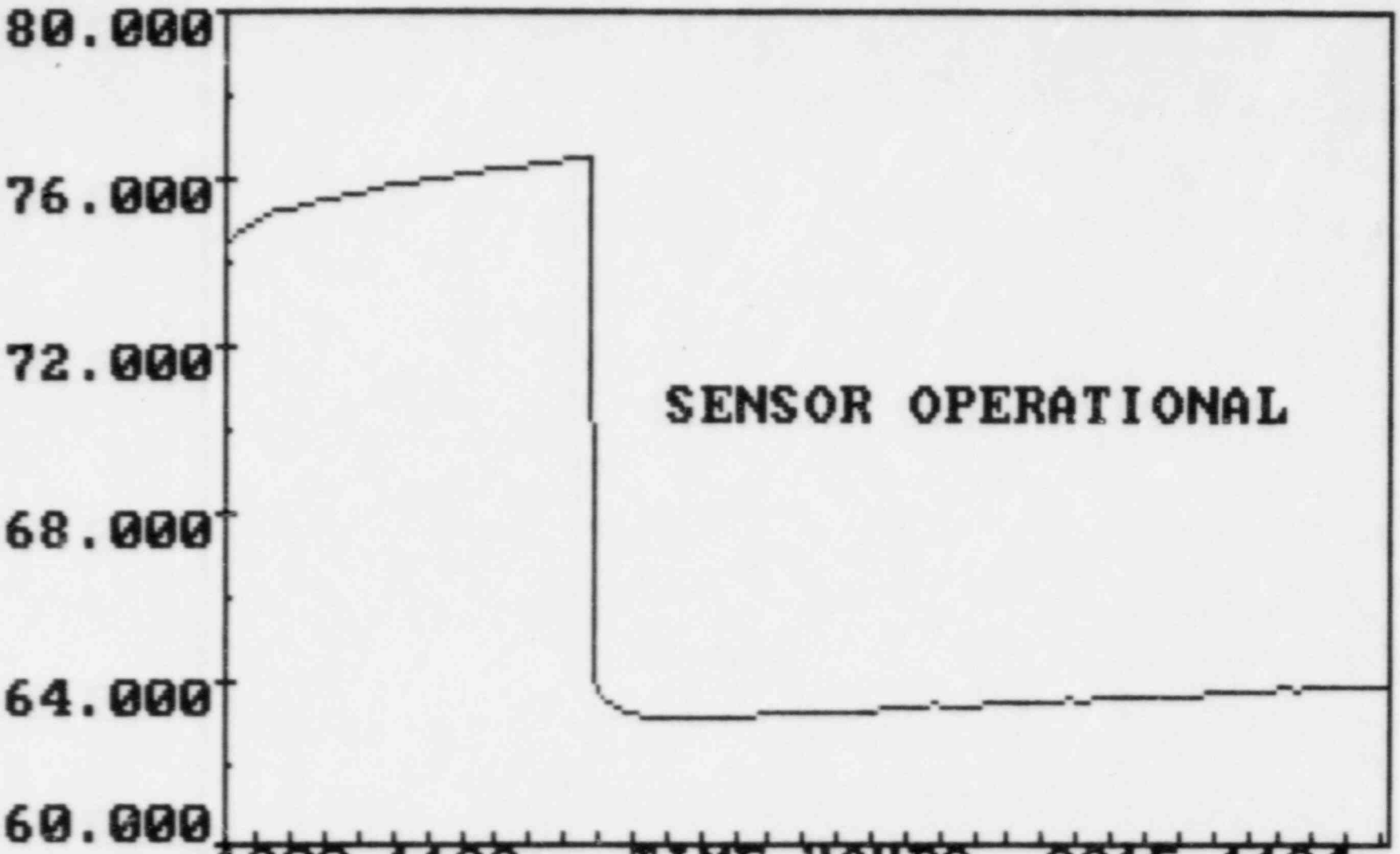
CALVERT CLIFFS - UNIT 2 ILRT
TEMPERATURE SENSOR 18 DEGREES F



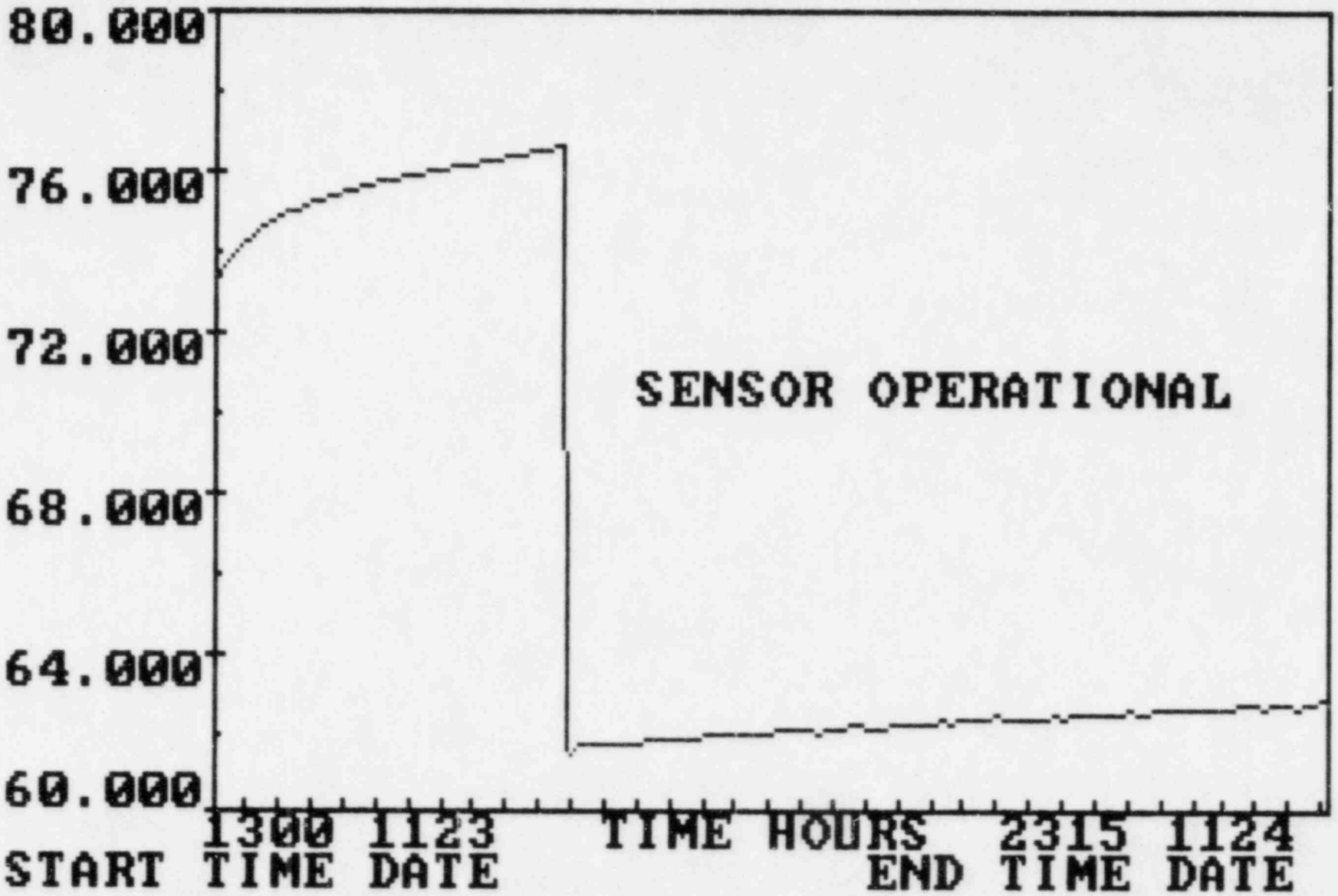
CALVERT CLIFFS - UNIT 2 ILRT
DEWPOINT TEMPERATURE SENSOR 1 DEG. F



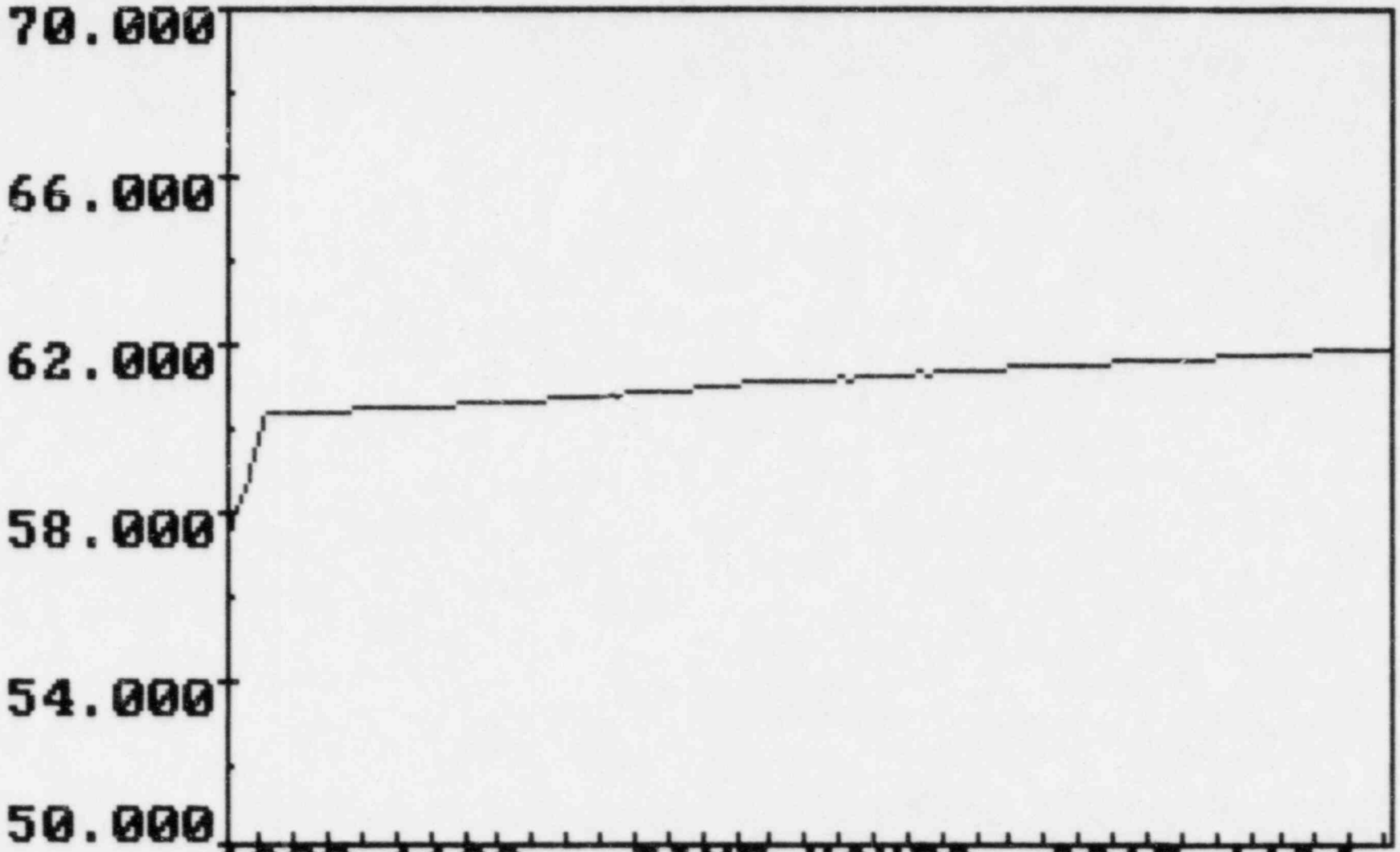
CALVERT CLIFFS - UNIT 2 ILRT
DEWPOINT TEMPERATURE SENSOR 2 DEG. F



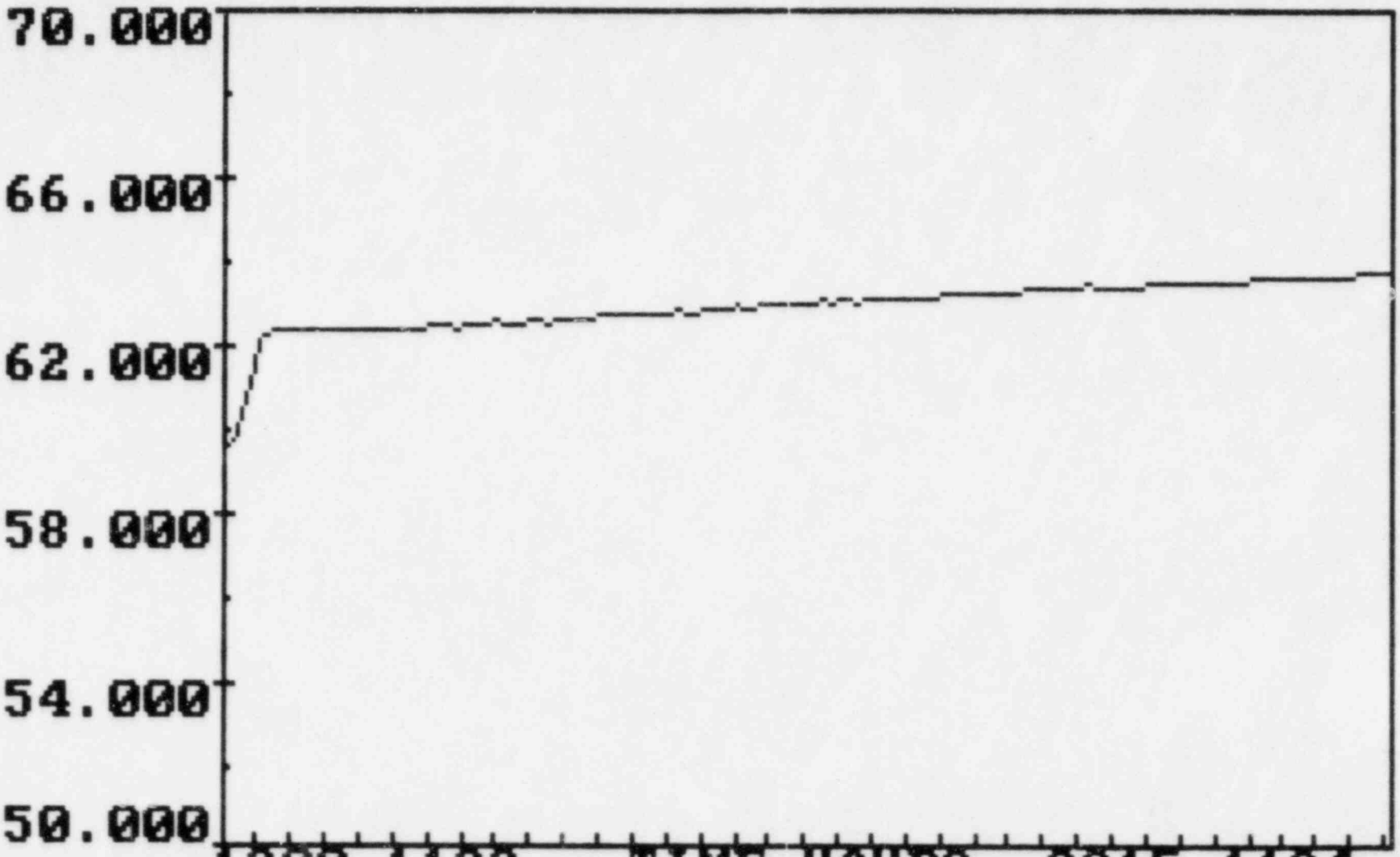
CALVERT CLIFFS - UNIT 2 ILRT
DEWPOINT TEMPERATURE SENSOR 3 DEG. F



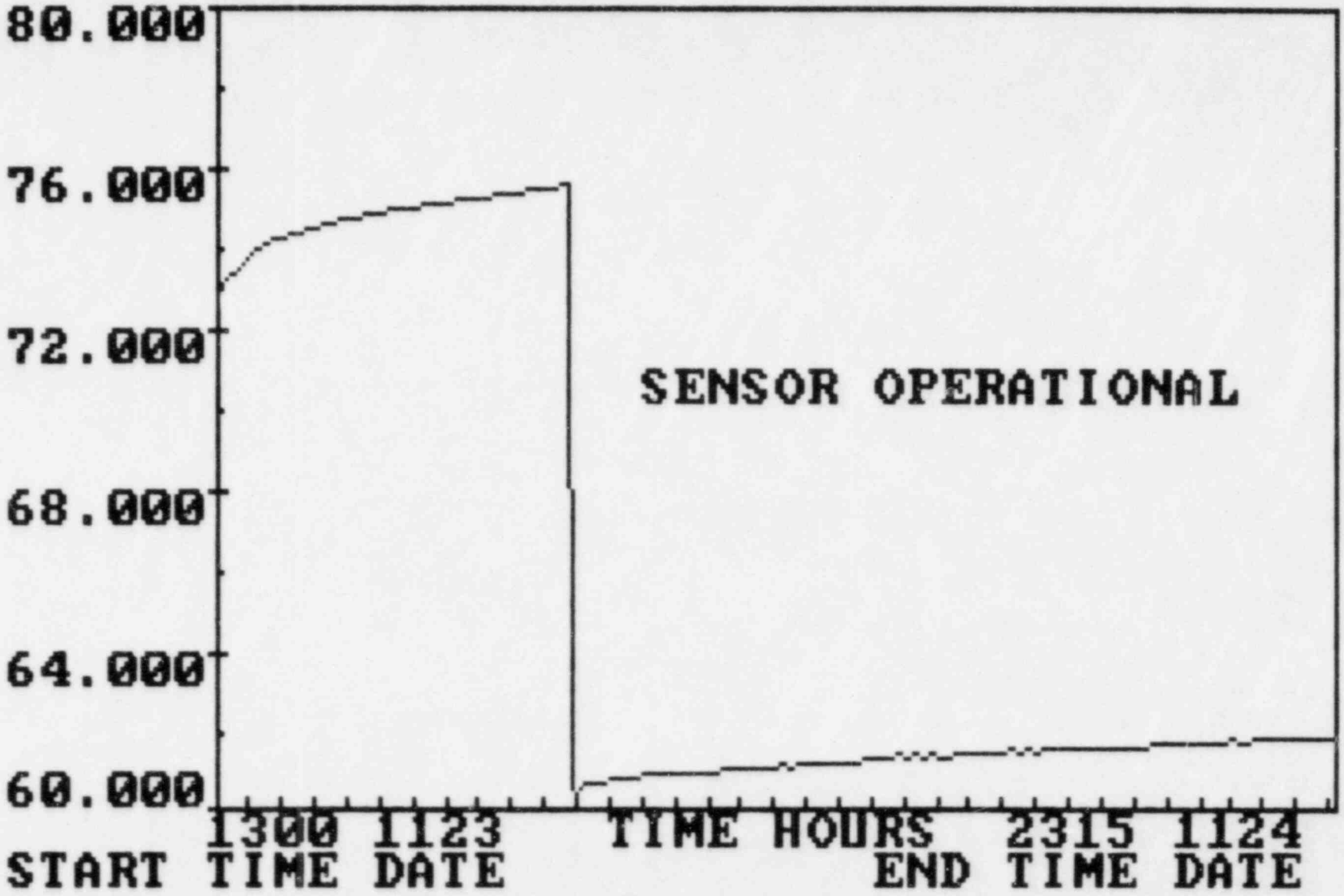
CALVERT CLIFFS - UNIT 2 ILRT
DEWPOINT TEMPERATURE SENSOR 4 DEG. F



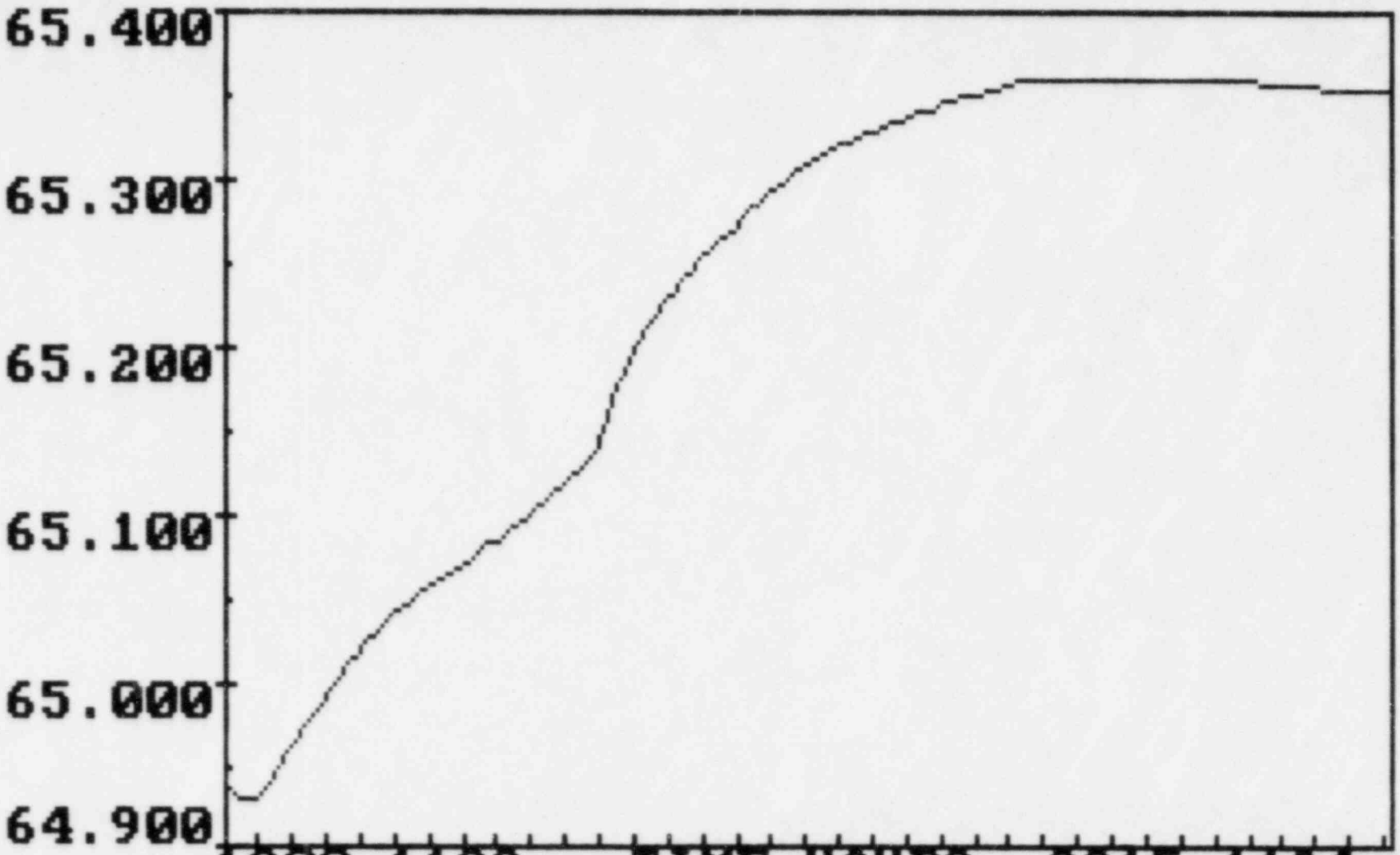
CALVERT CLIFFS - UNIT 2 ILRT
DEWPOINT TEMPERATURE SENSOR 5 DEG. F



CALVERT CLIFFS - UNIT 2 ILRT
DEWPOINT TEMPERATURE SENSOR 6 DEG. F



CALVERT CLIFFS - UNIT 2 ILRT
PRESSURE SENSOR 1 PSIA



CALVERT CLIFFS - UNIT 2 ILRT
PRESSURE SENSOR 2 PSIA