South Carolina Electric and Gas Company

V.C. SUMMER NUCLEAR PLANT

Primary Reactor Containment Integrated Leakage Rate Test

Final Report
October 1984

Bechtel Power Corporation

SOUTH CAROLINA ELECTRIC AND GAS COMPANY

VIRGIL C. SUMMER NUCLEAR STATION

UNIT 1

FIRST PERIODIC
REACTOR CONTAINMENT BUILDING
INTEGRATED LEAKAGE RATE TEST
FINAL REPORT

Prepared by

Bechtel Power Corporation

SU-072

TABLE OF CONTENTS

1. SUMMARY

This report presents data, analyses, and conclusions pertaining to the V. C. Summer Nuclear Station (VCSNS), Unit 1, first periodic Integrated Leakage Rate Test (ILRT) performed in October 1984. Included in the report is a presentation of the Local Leakage Rate Test Results required by the U.S. Code of Federal Regulations, 10CFR50, Appendix J, for adjustment of the ILRT results.

A 24-hour ILRT was successfully performed at the beginning of the VCSNS first refueling outage from 2145 on October 7, to 2145 on October 8, 1984. The ILRT was followed by a successful verification (imposed leakage) test to ensure satisfactory instrument performance. The following is a summary of test results expressed in weight percent per day:

	Test Result	Acceptance Criteria
Total Time Method		
ILRT Lam	0.087	0.150
ILRT UCL*	0.094	0.150
Verification Lam	0.287	0.233 to 0.333
Mass Point Method		
ILRT Lam	0.089	0.150
ILRT UCL*	0.091	0.150
Verification Lam	0.268	0.235 to 0.335

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

Although the test was performed over a 24-hour period, satisfactory results were obtained after the initial eight hours from 2145 October 7, to 0545 on October 8. Results of the 8-hour test period are included in this report also.

* UCL = 95 percent Upper Confidence Level

2. TEST SYNOPSIS

The reactor containment building Integrated Leakage Rate Test (Type A) is performed to demonstrate that leakage through the primary reactor containment and systems or components penetrating primary containment does not exceed the allowable leakage rate specified in the V.C. Summer Nuclear Station, Unit 1, Final Safety Analysis Report.

The successful periodic Type A and supplemental verification tests were performed according to the requirements of the V.C. Summer Nuclear Station, Unit 1, Final Safety Analysis Report and 10CFR50, Appendix J. The Type A test method used is the absolute method described in ANSI N45.4-1972, "Leakage Rate Testing of Containment Structures for Nuclear Reactors." The leakage rate was calculated using formulas from the above ANSI standard 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 in accordance with 10CFR50, Appendix J, and BN-TOP-1.

The test results are reported in accordance with the requirements of 10CFR50, Appendix J, Section V.

The containment leakage rate testing method applied was the Absolute Method as described in References 5 and 6. This is a direct application of the ideal gas law: $PV = WRT$. The Total Time and Mass Point techniques (References 5 and 6) were used to calculate the leakage rate. The Total Time Analysis technique measures leakage rate based on the most recent data point and the data point taken at the start of the test. The overall calculated leakage rate is determined by applying linear regression analysis to all measured leakage rate data at the end of the test period. The Mass Point technique calculates the containment air mass at each data point. The leakage rate is then determined by applying linear regression analysis to the measured air masses.

Ninety-five percent confidence levels were calculated for leakage rate data as required by References 5 and 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, containment air mass, and total time leakage rate were plotted by the computer program. These plots are in Appendix B.

Pressurization started at 1035 on October 6, 1984. Test pressure was reached at 2145 on October 6, 1984, and the required stabilization period was started. During the next 24 hours leakage paths were discovered that did not permit a successful test. Penetration 212, containment blowdown, was isolated with a blind flange. This penetration is closed with flanges during normal operation. Valves were relied upon for isolation during the ILRT for convenience. Although a drop in leakage rate was noticed, additional leakage still

existed. After a thorough walkdown of the containment penetrations, the remaining leakage was suspected to be steam generator in-leakage.

Consequently, the steam generators were filled with water. Subsequent measurements confirmed an acceptable leakage rate. Following the successful test, the manual isolation valve on each steam generator sample line (penetrations 220, 225, and 411) was found to be open. The leakage path on each line was through the open vent between the automatic sample line isolation valve and the containment liner, through the closed automatic isolation valve, through the open manual valve which was to be closed in accordance with the ILRT valve lineup, and into the steam generator. The automatic isolation valves seat with pressure on the steam generator side of the valve. Pressure on the downstream (containment liner) side of the valve will tend to unseat the valve. An investigation into the sample lines showed the lines to be seismic category one, safety class 2, and missile protected. In other words, these lines are extensions of the containment boundary. The vent valves should have been closed to achieve a correct isolation of the containment for the ILRT. These valves are closed during normal operation and were opened only for the ILRT. (See sketch in Appendix J).

The difference in leakage rates prior to filling the steam generators with water and after filling was approximately 14 scfm. Following the ILRT the steam generators' water levels were re-established at their levels which existed prior to filling. Local leakage rates for each sample line were measured through the vent path which existed during the ILRT. The sum of the three local leakage rates was approximately 13.5 scfm. Considering measurement uncertainty, the leakage is considered to be due to the improperly aligned manual sample isolation valves.

Other penetrations either blocked or not aligned for the test were the RCP seal injection and return line, penetrations 221, 229, 408 and 410; RHR hot leg suction, penetration 226; RHR cold leg injection, penetration 227; component cooling water, penetrations 312 and 330; nuclear gas sample system, penetration 405; breathing air, penetration 324; and service air, penetration 310.

Results of post ILRT local testing on these penetrations are presented in Section 3 of this report, TEST DATA SUMMARY. Section 4, ANALYSIS AND INTERPRETATION, incorporates the local test results into the ILRT calculated and 95 percent UCL values.

The Residual Heat Removal (RHR) system was required to be in service during the ILRT. Local leakage rate test results on RHR penetrations are reported in Appendix I. Safety injection accumulators were pressurized during the ILRT. Pressure was monitored; no decrease was detected, so containment leakage was not masked by accumulator leakage. Similarly, one of the two power-operated relief valves' accumulators was pressurized. No pressure loss was observed. An analysis was done to quantify the pressure drop required to mask a failed test. Results showed that the pressure drop required was

discernable (See Appendix K) on permanent plant instrumentation. Finally, the breathing air system was isolated from the containment, but not depressurized. Local leakage rate testing post-ILRT showed no in-leakage through the containment isolation valves.

The 24-hour test period ended at 2145 on October 8. The calculated Total Time leakage rate was 0.087%/day with an upper confidence limit of 0.094%/day. Corresponding Mass Point leakage rate values were 0.089%/day and 0.091%/day. With a maximum post test leakage based on maximum penetration leakage values following repair to isolation valves of 0.014%/day for blocked mechanical penetrations, all leakage rate acceptance criteria were satisfied. The upper confidence limit (UCL) of the leakage rate calculated at the 95% level, plus post test local leakage test results for blocked systems, was less than 0.75La (0.75 x 0.2%/day = 0.150%/day). Also, the Instrument Selection Guide (ISG) was less than 0.25 La (see Appendix G). When considering minimum penetration leakage values before repair to isolation valves, Type C results added to the Type A results give Mass Point leakage of 0.1195%/day and Total Time leakage of 0.1225%/day.

In order to verify the leakage rate measurement system, a 10.8 scfm leak was imposed. A 4.75 hour verification test was run from 0130 to 0615 on October 9. The Total Time calculated leakage rate was 0.287%/day, which satisfied the acceptance criterion of being in the range 0.233 to 0.333%/day. The Mass Point calculated leakage rate was 0.268%/day, which satisfied the acceptance criterion of being in the range of 0.235 to 0.335%/day.

Leakage rates were calculated during the entire 24 hour test period. SCE&G had petitioned the NRC for permission to perform a short duration test in accordance with BN-TOP-1. Permission was granted. Just prior to the test, SCE&G decided to perform a 24-hour test. Data would also be analyzed to show that a short duration test could be performed, demonstrating containment integrity while reducing outage duration for future tests. After 8 hours of testing, all acceptance criteria were satisfied. Results are reported in Appendix H.

A description of the computer program used to calculate the leakage rates is given in Appendix A. Test summary data, leakage rate reports, and plots are given in Appendices B through F. Local leakage rate test results are given in Appendix I.

3. TEST DATA SUMMARY

A. Plant Information

Owner:	South Carolina Electric and Gas Company
Plant:	Virgil C. Summer Nuclear Station Unit 1
Location:	Jenkinsville, SC
Containment Type:	Reinforced, Post Tensioned Concrete
Date Test Completed:	October 9, 1984
Docket Number:	50-395

B. Technical Data

1.	Containment Net Free Air Volume	1,840,000 cu. ft.
2.	Design Pressure	57 psig
3.	Calculated Peak Accident Pressure, Pa	47.1 psig
4.	Containment ILRT Average Temperature Limits	55-120°F

C. Test Results - Type A Test

1.	Test Method	Absolute
2.	Data Analysis Techniques	Total Time and Mass Point
3.	Test Pressure	47.1 psig + 3.0 - 0.0
4.	Maximum Allowable Leakage Rate, La	0.2%/day
5.	75% of La	0.150%/day

6. Integrated Leakage Rate Test Results

	Leakage Rate, %/day	
	From Regression Line (Lam)	At Upper 95% Confidence Level
Total Time Analysis	0.087	0.094
Mass Point Analysis	0.089	0.091

7.	Verification Test Imposed Leakage Rate, Li%/day	10.8 scfm 0.196%/day

8. Verification Test Results

	Leakage Rate, %/day
Total Time Analysis	0.287
Mass Point Analysis	0.268

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

	Total Time Analysis	Mass Point Analysis
(1) Upper Limit (Li + Lam + 0.25 La)	0.333	0.335
(2) Lower Limit (Li + Lam - 0.25 La)	0.233	0.235

10. Report Printouts

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

D. Local Leakage Rate Test Results - Type B and C Tests (see also Appendix I)

1. LLRT Results

LLRT Subtotal of Type B and C Tests: 0.0666%/day

0.6 La = 0.12%/day

Therefore, total type B and C leakage < 0.6 La

2. Leakage of penetrations not in post-LOCA lineup during ILRT:

Penetration	Description	As Left (%/day)
221	RCP Seal Water	0.000525
229	RCP Seal Water	0.000669
408	RCP Seal Water	0.000467
410	RCP Seal Water	0.000967
226	RHR 'B'	0.002983
227	RHR 'B'	0.002657
310	Service Air	0.001312
324	Breathing Air	0.000461
312	Component Cooling	0.003983
330	Component Cooling	0.004848
405	Sample System	0.000434

E. Integrated Leakage Rate Measurement System

The following instrument system was used:

No. Required	Description	Date	
1. Absolute Pressure			
2	Mensor Precision Pressure Gauge	Range:	0-100 psia
		Accuracy:	± 0.05% F.S.
		Resolution:	0.001 psia
		Repeatability:	0.001 psia
2. Drybulb Temperature			
24	100 Ohm Temperature Sensors	Range:	0-125°F
		Accuracy:	0.2°F
		Resolution:	0.001°F
		Repeatability:	0.01°F
3. Dewpoint Temperature			
5*	Chilled Mirror Dewpoint	Range:	0-120°F
		Accuracy:	0.1% FS
* 1 failed, 4 used during the test.		Resolution:	0.001
		Repeatability:	± 0.01°F
4. Flow			
1	Mass Flow Meter	Range:	0-12 scfm
		Accuracy:	± 1% F.S.
		Sensitivity:	NA
		Repeatability:	0.2% F.S.

5. Overall Instrumentation Selection Guide (ISG) Value (from ANSI/ANS 56.8-1981, Appendix G) based on ILRT instrumentation, and a 24-hour test duration = 0.0052%/day.
   8-hour ISG = 3x0.0052 = 0.0156%/day.

6. For Drybulb and Dewpoint Temperature Sensor Locations and Volume Fractions, see Table 1.

F. Information Retained at Plant

The following information is available for review at the Facility:

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

2. A listing of normal operations instrumentation used for the leakage rate test.

3. A system lineup (at time of test), showing required valve positions and status of piping systems.

4. A continuous, sequential log of events from initial survey of containment to restoration of all tested systems.

5. Documentation of instrumentation calibrations and standards, including an error analysis of instrumentation (Appendix G).

6. Data to verify temperature stabilization criteria as established by test procedure (Appendix B).

7. The working copy of test procedure that includes signature signoff of procedural steps.

8. The procedure and all data that would verify completion of penetrations and valve testing (Type B & C tests).

9. Computer printouts of Integrated Leakage Rate Test Data along with a summary description of the computer program (Appendix A).

10. The Quality Assurance audit plan or checkout that was used to monitor ILRT with proper signoffs.

11. A listing of all test exceptions instituted by licensee to conclude successful testing.

12. Descriptions of sensor malfunctions, repairs, and methods used to redistribute volume fractions to operating instrumentation (Table 1 and Appendix d).

13. A review of confidence limits of test results with accompanying computer printouts where applicable.

14. 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.

15. Plots presenting ILRT data obtained during the test (Appendix E).

16. The P&IDs of pertinent systems.

4. ANALYSIS AND INTERPRETATION

During the ILRT, 11 mechanical penetrations were not in post-LOCA lineup. The penetrations together with their post ILRT Type C leakage rates are given below:

Penetration	Post ILRT Leakage Rate	
	SCCM	%/day
RCP Seal Water (221)	799.9	0.000525
RCP Seal Water (229)	1018.8	0.000669
RCP Seal Water (408)	711.5	0.000467
RCP Seal Water (410)	1473.5	0.000967
RHR 'B' (226)	4546.8	0.002983*
RHR 'B' (227)	4050.00	0.002657*
Service Air (310)	6070.8	0.001312
Breathing Air (324)	7388.5	0.000461
Component Cooling (312)	660.9	0.003983
Component Cooling (330)	1999.7	0.004848
Sample System (405)	703.0	0.000434

* Leakage rates reported but not added to the ILRT Leakage Rate - see RHR Penetration discussion, Section 4.

The total leakage rate for the nine penetrations expressed in %/day of containment air mass is 0.014.

The calculated Mass Point leakage rate during the ILRT was 0.089 %/day. The calculated 95% upper confidence level was 0.091 %/day. The calculated Total Time leakage rate during the ILRT was 0.087%/day. The corresponding 95% upper confidence level was 0.094%/day. Adding the total Type C leakage for systems not in post-LOCA lineup during the test yields the corrected leakage rates as follows:

	Leakage Rate, %/day			
	Mass Point		Total Time	
	Leakage Rate	95% UCL	Leakage Rate	95% UCL
Calculated	0.089	0.091	0.087	0.094
Type C	0.014	0.014	0.014	0.014
Corrected	0.103	0.105	0.101	0.108

Since the corrected 95% upper confidence levels for the Mass Point and Total Time leakage rates are less than 0.75 La, the test results demonstrate that leakage through the primary reactor containment and systems and components penetrating primary containment do not exceed the allowable leakage rate specified in the V. C. Summer Nuclear Station Final Safety Analysis Report, Reference 1.

RHR Penetration

Train "B" was in operation during the ILRT in accordance with Technical Specifications. Difficulties were encountered while testing the Containment Isolation valves associated with penetrations 226 and 227.

Penetration 226

This penetration serves the train "B" RHR hot leg suction. This penetration has two motor-operated valves inside containment, with the valve farthest from the RCS and outside the primary shield wall being the Containment Isolation valve. Actuator problems on the containment isolation valve (XVG-87013-RH) prevented a successful local leak rate test. The as found leakage rate was greater than the capacity of the test equipment (> 20 l/m). The motor operator was replaced and the subsequent leakage test indicated a leakage rate of 1080 cc/min or 0.002983%/day.

Penetration 227

This penetration serves the low head cold leg injection piping from RHR. Relief request has been submitted to NRR from Type C testing. The as found leakage was 12,650 cc/min. After valve repair, the leakage was reduced to 962 cc/min or 0.002657%/day.

The leakage rates of these two penetrations (226 and 227) are hereby reported to the Commission in accordance with 10CFR50, Appendix J, Section III.A.1.(d), but are not included in the overall Type "A" leakage rate.

5. REFERENCES

1. V. C. Summer Nuclear Station Final Safety Analysis Report

2. V. C. Summer Nuclear Station Surveillance Test Procedure STP-206.001 Integrated Leak Rate Test.

3. 10CFR50, Appendix J, Reactor Containment Leakage Test 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.

TABLE 1

DRYBULB AND DEWPOINT TEMPERATURE SENSOR LOCATIONS

Sensor Number	Elevation (ft)	Azimuth (degrees)	Chanel Number	Volume Fractions/ Sensor
7307A	569	248	11	0.1005
7307B	569	63	12	0.1005
7307C	533	17	13	0.1413
7307D	533	191	14	0.1413
7307E	412	293	15	0.0200
7307F	514	352	16	0.0345
7307G	514	166	17	0.0346
7307H	463	133	18	0.0345
7307I	463	307	19	0.0346
7307J	463	40	20	0.0345
7307K	463	48	21	0.0346
7307L	463	193	22	0.0345
7307M	463	200	23	0.0345
7307N	436	290	24	0.0200
7307O	436	302	25	0.0200
7307P	436	38	26	0.0200
7307Q	436	73	27	0.0200
7307R	436	160	28	0.0200
7307S	436	207	29	0.0200
7307T	412	298	30	0.0200
7307U	412	45	31	0.0200
7307V	412	68	32	0.0200
7307W	412	156	33	0.0200
7307X	412	200	34	0.0200
				1.0000
7306A	552	17	1	0.4837
*7306B	514	352	2	0.0000
7306C	463	133	3	0.2582
7306D	463	207	4	0.1291
7306E	412	298	5	0.1290
				1.0000

* Dewcell B failed early in the test. It's volume fraction was added to dewcell C for the test calculations.

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. Brief descriptions of progrm 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

   f. Maximum allowable leakage rate at test pressure.

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

   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 tests, 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:

$$P_1V_1 = W_1RT_1 \quad (1)$$

$$P_iV_i = W_iRT_i \quad (2)$$

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

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

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

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 1^{st} 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.

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

$$L_i = \frac{-2400}{\Delta t_i}\left(\frac{\Delta W_i}{W_1}\right)$$

where:

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

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

$$\Delta P_i = P_i - P_1$$

$$\Delta V_i = V_i - V_1$$

$$\Delta T_i = T_i - T_1$$

b. Calculated leakage rate from regression analysis:

$$\bar{L} = a + b\,\Delta t_N$$

where:

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

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

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

N = Number of data points

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

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

$$\bar{L}_{95} = a + b\,\Delta t_N + S_{\bar{L}}$$

where:

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

For $\Delta t_N \geq 24$

$$S_{\bar{L}} = t_{0.025;N-2}[(\Sigma L_i^2 - a\Sigma L_i - b\Sigma L_i \Delta t_i)/(N-2)]^{1/2} \times$$

$$[1 + \frac{1}{N} + (\Delta t_N - \overline{\Delta t})^2 / (\Sigma \Delta t_i^2 - (\Sigma \Delta t_i)^2/N)]^{1/2} \quad (9a)$$

where:

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

For $\Delta t_N < 24$

$$S_{\bar{L}} = t_{0.025;N-2}[(\Sigma L_i^2 - a\Sigma L_i - b\Sigma L_i \Delta t_i)/(N-2)]^{1/2} \times$$

$$[\frac{1}{N} + (\Delta t_N - \overline{\Delta t})^2 / (\Sigma \Delta t_i^2 - (\Sigma \Delta t_i)^2/N)]^{1/2} \quad (9b)$$

where:

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

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

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, $W = a + b\ t$:

$$\overline{L} = -2400\ \frac{b}{a} \tag{11}$$

where:

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

$$a = (\Sigma W_i - b\Sigma\Delta t_i)/N \tag{12}$$

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

Δt_i = Total elapsed time at time 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)

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

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

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

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

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

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

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

where:

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

$$S_b = t_{0}.025;N-2 \; \frac{SN^{1/2}}{[N\Sigma\Delta t_i^{\,2} - (\Sigma\Delta t_i)^2\,]^{1/2}} \qquad (15)$$

where, $t_{0}.025;N-2 = \dfrac{1.6449(N-2)^2 + 3.5283(N-2)^2 + 0.85602}{(N-2)^2 + 1.2209(N-2) - 1.5162}$

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

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

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 descripton 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 requested 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.
PLOT	Enables user to plot summary data, individual sensor data, air mass or leakage rate versus time.
DELETE	Enables user to delete a data point.
INSERT	Enables user to reinstate a previously deleted data point.
VOLFRA	Enables user to change volume fractions.
TIME	Enables the user to specify the time interval for a report or plot.
VERF	Enables the user to input imposed leakage rate and calculated ILRT leakage rates at start of verification test.

Appendix B

STABILIZATION SUMMARY DATA

V. C. SUMMER ILRT
TEMPERATURE STABILIZATION

FROM A STARTING TIME AND DATE OF: 1730 1007 1984

TIME (HOURS)	TEMP (R)	AVE ΔT (4HRS)	ANSI AVE ΔT (1HR)	DIFF	BN-TOP-1 AVE ΔT (2HRS)
.00	552.62				
.25	552.60				
.50	552.58				
.75	552.55				
1.00	552.53				
1.25	552.50				
1.50	552.48				
1.75	552.45				
2.00	552.42				-.103*
2.25	552.38				-.110*
2.50	552.36				-.109*
2.75	552.33				-.108*
3.00	552.30				-.111*
3.25	552.28				-.111*
3.50	552.26				-.111*
3.75	552.24				-.105*
4.00	552.21	-.103	-.093	-.01*	-.051*

* INDICATES TEMPERATURE STABILIZATION HAS BEEN SATISFIED

Appendix C

ILRT TREND REPORT

V. C. SUMMER ILRT
TREND REPORT

TIME AND DATE AT START OF TEST: 2145 1007 1984

NO. PTS	END TIME	TOTAL TIME ANALYSIS MEAS.	CALCULATED	UCL	MASS POINT ANALYSIS CALCULATED	UCL
4	2230	-.030	-.022	.152	-.025	.207
5	2245	.016	-.029	.271	-.016	.092
6	2300	.143	.047	.436	.083	.219
7	2315	.047	.038	.332	.062	.157
8	2330	.090	.053	.303	.077	.147
9	2345	.108	.071	.293	.095	.151
10	0	.068	.067	.263	.085	.130
11	15	.099	.075	.255	.093	.130
12	30	.049	.066	.231	.077	.112
13	45	.075	.066	.220	.076	.106
14	100	.064	.064	.207	.072	.097
15	115	.053	.059	.194	.065	.088
16	130	.055	.056	.184	.060	.081
17	145	.056	.054	.175	.058	.076
18	200	.053	.051	.168	.055	.071
19	215	.071	.053	.165	.058	.073
20	230	.063	.053	.161	.058	.072
21	245	.071	.055	.159	.061	.073
22	300	.079	.058	.159	.064	.076
23	315	.079	.060	.159	.067	.078
24	330	.054	.058	.154	.064	.075
25	345	.061	.057	.151	.063	.073
26	400	.078	.059	.150	.066	.075
27	415	.080	.061	.151	.069	.078
28	430	.060	.060	.148	.067	.075
29	445	.063	.060	.145	.066	.074
30	500	.064	.060	.143	.065	.073
31	515	.072	.061	.142	.066	.074
32	530	.070	.061	.141	.067	.074
33	545	.065	.061	.139	.066	.073
34	600	.073	.062	.139	.068	.073
35	615	.079	.063	.139	.069	.075
36	630	.071	.063	.138	.070	.075
37	645	.072	.064	.137	.070	.075
38	700	.065	.064	.136	.069	.074
39	715	.072	.064	.135	.070	.074
40	730	.067	.064	.134	.069	.074
41	745	.060	.063	.132	.068	.073
42	800	.067	.063	.131	.068	.072
43	815	.077	.064	.131	.069	.073
44	830	.072	.065	.131	.069	.074
45	845	.085	.066	.132	.071	.076
46	900	.082	.067	.132	.073	.077
47	915	.085	.069	.133	.075	.079
48	930	.073	.069	.132	.075	.079
49	945	.076	.069	.132	.075	.079

V. C. SUMMER ILRT
TREND REPORT

TIME AND DATE AT START OF TEST: 2145 1007 1984

NO. PTS	END TIME	TOTAL TIME ANALYSIS MEAS.	CALCULATED	UCL	MASS POINT ANALYSIS CALCULATED	UCL
50	1000	.082	.070	.132	.076	.080
51	1015	.070	.070	.132	.076	.080
52	1030	.073	.070	.131	.076	.079
53	1045	.076	.071	.131	.076	.079
54	1100	.081	.071	.131	.077	.080
55	1115	.080	.072	.131	.077	.081
56	1130	.084	.073	.131	.078	.082
57	1145	.083	.073	.131	.079	.082
58	1200	.079	.074	.131	.079	.083
59	1215	.083	.075	.131	.080	.083
60	1230	.082	.075	.131	.080	.084
61	1245	.079	.075	.131	.081	.084
62	1300	.084	.076	.131	.081	.084
63	1315	.078	.076	.131	.081	.084
64	1330	.083	.077	.131	.082	.085
65	1345	.082	.077	.131	.082	.085
66	1400	.084	.078	.131	.082	.085
67	1415	.080	.078	.131	.083	.085
68	1430	.088	.079	.131	.083	.086
69	1445	.081	.079	.131	.083	.086
70	1500	.086	.079	.131	.084	.087
71	1515	.088	.080	.131	.085	.087
72	1530	.087	.080	.131	.085	.088
73	1545	.083	.081	.131	.085	.088
74	1600	.091	.081	.132	.086	.089
75	1615	.087	.082	.132	.086	.089
76	1630	.089	.082	.132	.087	.089
77	1645	.088	.083	.132	.087	.090
78	1700	.084	.083	.132	.087	.090
79	1715	.082	.083	.132	.087	.090
80	1730	.081	.083	.132	.087	.090
81	1745	.087	.084	.132	.088	.090
82	1800	.084	.084	.131	.088	.090
83	1815	.084	.084	.131	.088	.090
84	1830	.083	.084	.131	.088	.090
85	1845	.086	.084	.131	.088	.090
86	1900	.088	.085	.131	.088	.090
87	1915	.083	.085	.131	.088	.090
88	1930	.088	.085	.131	.088	.090
89	1945	.085	.085	.131	.088	.090
90	2000	.085	.086	.131	.088	.090
91	2015	.090	.086	.131	.089	.091
92	2030	.089	.086	.131	.089	.091
93	2045	.090	.087	.131	.089	.091
94	2100	.083	.087	.131	.089	.091
95	2115	.085	.087	.131	.089	.091
96	2130	.083	.087	.130	.089	.091
97	2145	.082	.087	.094	.089	.091

Appendix D

ILRT SUMMARY DATA, MASS POINT AND TOTAL TIME REPORTS

V. C. SUMMER ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 1840000.
VRATET = .287 VRATEM = .289

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
2145	1007	552.195	62.9479	.3756	1840000.
2200	1007	552.169	62.9437	.3768	1840000.
2215	1007	552.152	62.9417	.3768	1840000.
2230	1007	552.128	62.9409	.3751	1840000.
2245	1007	552.117	62.9386	.3754	1840000.
2300	1007	552.108	62.9333	.3787	1840000.
2315	1007	552.083	62.9333	.3762	1840000.
2330	1007	552.071	62.9297	.3773	1840000.
2345	1007	552.059	62.9268	.3792	1840000.
0	1008	552.042	62.9264	.3771	1840000.
15	1008	552.022	62.9217	.3798	1840000.
30	1008	552.012	62.9235	.3765	1840000.
45	1008	551.999	62.9196	.3784	1840000.
100	1008	551.985	62.9186	.3784	1840000.
115	1008	551.977	62.9182	.3768	1840000.
130	1008	551.955	62.9152	.3778	1840000.
145	1008	551.946	62.9136	.3769	1840000.
200	1008	551.932	62.9120	.3770	1840000.
215	1008	551.927	62.9090	.3790	1840000.
230	1008	551.914	62.9080	.3780	1840000.
245	1008	551.899	62.9048	.3792	1840000.
300	1008	551.887	62.9020	.3810	1840000.
315	1008	551.872	62.8997	.3803	1840000.
330	1008	551.862	62.9018	.3772	1840000.
345	1008	551.859	62.9000	.3770	1840000.
400	1008	551.843	62.8951	.3804	1840000.
415	1008	551.835	62.8932	.3803	1840000.
430	1008	551.823	62.8949	.3781	1840000.
445	1008	551.818	62.8933	.3787	1840000.
500	1008	551.802	62.8910	.3790	1840000.
515	1008	551.785	62.8871	.3809	1840000.
530	1008	551.782	62.8867	.3803	1840000.
545	1008	551.772	62.8861	.3789	1840000.
600	1008	551.768	62.8834	.3796	1840000.
615	1008	551.762	62.8811	.3809	1840000.
630	1008	551.745	62.8804	.3801	1840000.
645	1008	551.743	62.8795	.3795	1840000.
700	1008	551.735	62.8797	.3783	1840000.
715	1008	551.725	62.8764	.3807	1840000.
730	1008	551.724	62.8772	.3788	1840000.
745	1008	551.705	62.8763	.3787	1840000.
800	1008	551.697	62.8731	.3809	1840000.
815	1008	551.701	62.8705	.3815	1840000.
830	1008	551.698	62.8710	.3795	1840000.
845	1008	551.699	62.8669	.3821	1840000.
900	1008	551.697	62.8669	.3811	1840000.
915	1008	551.690	62.8647	.3823	1840000.
930	1008	551.681	62.8669	.3786	1840000.
945	1008	551.672	62.8642	.3798	1840000.

V. C. SUMMER ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 1840000.
VRATET = .287 VRATEM = .289

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
1000	1008	551.660	62.8604	.3826	1840000.
1015	1008	551.651	62.8631	.3789	1840000.
1030	1008	551.651	62.8616	.3794	1840000.
1045	1008	551.646	62.8595	.3800	1840000.
1100	1008	551.638	62.8564	.3821	1840000.
1115	1008	551.640	62.8564	.3811	1840000.
1130	1008	551.659	62.8563	.3807	1840000.
1145	1008	551.651	62.8555	.3805	1840000.
1200	1008	551.634	62.8546	.3809	1840000.
1215	1008	551.632	62.8520	.3820	1840000.
1230	1008	551.625	62.8512	.3818	1840000.
1245	1008	551.626	62.8519	.3801	1840000.
1300	1008	551.617	62.8485	.3830	1840000.
1315	1008	551.611	62.8494	.3811	1840000.
1330	1008	551.601	62.8458	.3837	1840000.
1345	1008	551.606	62.8465	.3825	1840000.
1400	1008	551.597	62.8442	.3833	1840000.
1415	1008	551.589	62.8442	.3818	1840000.
1430	1008	551.609	62.8427	.3833	1840000.
1445	1008	551.594	62.8435	.3815	1840000.
1500	1008	551.616	62.8428	.3817	1840000.
1515	1008	551.608	62.8408	.3827	1840000.
1530	1008	551.607	62.8404	.3821	1840000.
1545	1008	551.598	62.8408	.3807	1840000.
1600	1008	551.599	62.8366	.3839	1840000.
1615	1008	551.588	62.8365	.3830	1840000.
1630	1008	551.590	62.8352	.3833	1840000.
1645	1008	551.579	62.8337	.3838	1840000.
1700	1008	551.576	62.8350	.3815	1840000.
1715	1008	551.573	62.8351	.3804	1840000.
1730	1008	551.571	62.8347	.3808	1840000.
1745	1008	551.574	62.8314	.3831	1840000.
1800	1008	551.571	62.8320	.3815	1840000.
1815	1008	551.566	62.8311	.3814	1840000.
1830	1008	551.568	62.8313	.3812	1840000.
1845	1008	551.557	62.8280	.3835	1840000.
1900	1008	551.557	62.8265	.3841	1840000.
1915	1008	551.558	62.8285	.3810	1840000.
1930	1008	551.559	62.8252	.3833	1840000.
1945	1008	551.559	62.8263	.3812	1840000.
2000	1008	551.545	62.8243	.3827	1840000.
2015	1008	551.549	62.8214	.3846	1840000.
2030	1008	551.549	62.8209	.3841	1840000.
2045	1008	551.539	62.8191	.3849	1840000.
2100	1008	551.531	62.8215	.3815	1840000.
2115	1008	551.534	62.8203	.3817	1840000.
2130	1008	551.519	62.8190	.3820	1840000.
2145	1008	551.510	62.8183	.3822	1840000.

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
2145	552.195	62.9479	566155.		
2200	552.169	62.9437	566143.	11.5	46.2
2215	552.152	62.9417	566143.	.9	24.8
2230	552.128	62.9409	566160.	-17.6	-7.0
2245	552.117	62.9386	566151.	9.0	3.8
2300	552.108	62.9333	566113.	38.5	33.8
2315	552.083	62.9333	566138.	-25.6	11.1
2330	552.071	62.9297	566118.	20.4	21.2
2345	552.059	62.9268	566104.	13.8	25.5
0	552.042	62.9264	566119.	-14.9	16.0
15	552.022	62.9217	566097.	22.3	23.3
30	552.012	62.9235	566123.	-26.2	11.7
45	551.999	62.9196	566102.	20.9	17.7
100	551.985	62.9186	566106.	-3.9	15.1
115	551.977	62.9182	566111.	-5.4	12.5
130	551.955	62.9152	566106.	4.9	13.0
145	551.946	62.9136	566102.	4.5	13.3
200	551.932	62.9120	566102.	-.5	12.4
215	551.927	62.9090	566080.	22.8	16.8
230	551.914	62.9080	566084.	-4.4	15.0
245	551.899	62.9048	566071.	12.7	16.8
300	551.887	62.9020	566058.	13.5	18.5
315	551.872	62.8997	566053.	4.6	18.5
330	551.862	62.9018	566081.	-28.2	12.8
345	551.859	62.9000	566069.	12.6	14.4
400	551.843	62.8951	566041.	28.1	18.3
415	551.835	62.8932	566032.	8.6	18.9
430	551.823	62.8949	566059.	-27.3	14.2
445	551.818	62.8933	566051.	8.4	14.9
500	551.802	62.8910	566046.	5.0	15.0
515	551.785	62.8871	566027.	18.6	17.0
530	551.782	62.8867	566027.	.4	16.5
545	551.772	62.8861	566033.	-5.9	15.3
600	551.768	62.8834	566012.	20.5	17.3
615	551.762	62.8811	565998.	15.0	18.5
630	551.745	62.8804	566009.	-11.8	16.6
645	551.743	62.8795	566003.	6.3	16.9
700	551.735	62.8797	566013.	-10.2	15.3
715	551.725	62.8764	565993.	20.2	17.0
730	551.724	62.8772	566002.	-8.7	15.7
745	551.705	62.8763	566013.	-11.2	14.2

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
800	551.697	62.8731	565993.	19.6	15.8
815	551.701	62.8705	565965.	28.1	18.1
830	551.698	62.8710	565972.	-6.5	17.0
845	551.699	62.8669	565935.	36.4	20.0
900	551.697	62.8669	565937.	-1.4	19.4
915	551.690	62.8647	565923.	13.3	20.1
930	551.681	62.8669	565954.	-30.1	17.1
945	551.672	62.8642	565930.	15.1	18.0
1000	551.660	62.8604	565917.	21.6	19.4
1015	551.651	62.8631	565950.	-32.8	16.4
1030	551.651	62.8616	565937.	12.8	17.1
1045	551.646	62.8595	565922.	15.1	18.0
1100	551.638	62.8564	565903.	19.1	19.1
1115	551.640	62.8564	565900.	2.3	18.9
1130	551.659	62.8563	565881.	19.3	19.3
1145	551.651	62.8555	565881.	-.2	19.6
1200	551.634	62.8546	565891.	-9.8	18.5
1215	551.632	62.8520	565870.	21.0	19.7
1230	551.625	62.8512	565869.	.8	19.4
1245	551.626	62.8519	565875.	-6.0	18.7
1300	551.617	62.8485	565853.	22.2	19.8
1315	551.611	62.8494	565868.	-15.1	18.5
1330	551.601	62.8458	565845.	23.1	19.7
1345	551.606	62.8465	565846.	-1.6	19.3
1400	551.597	62.8442	565834.	12.0	19.7
1415	551.589	62.8442	565843.	-8.5	18.9
1430	551.609	62.8427	565809.	33.8	20.6
1445	551.594	62.8435	565831.	-22.3	19.0
1500	551.616	62.8428	565803.	28.1	20.4
1515	551.608	62.8408	565793.	10.1	20.7
1530	551.607	62.8404	565790.	2.8	20.5
1545	551.598	62.8408	565804.	-13.5	19.5
1600	551.599	62.8366	565764.	39.6	21.4
1615	551.588	62.8365	565775.	-10.5	20.6
1630	551.590	62.8352	565762.	12.8	21.0
1645	551.579	62.8337	565759.	3.0	20.8
1700	551.576	62.8350	565774.	-15.0	19.8
1715	551.573	62.8351	565778.	-3.9	19.3
1730	551.571	62.8347	565776.	1.9	19.2
1745	551.574	62.8314	565744.	32.1	20.6
1800	551.571	62.8320	565752.	-8.6	19.9

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
1815	551.566	62.8311	565749.	3.1	19.8
1830	551.568	62.8313	565749.	.7	19.6
1845	551.557	62.8280	565730.	19.0	20.3
1900	551.557	62.8265	565716.	13.9	20.7
1915	551.558	62.8285	565734.	-17.8	19.6
1930	551.559	62.8252	565702.	31.5	20.8
1945	551.559	62.8263	565713.	-10.7	20.1
2000	551.545	62.8243	565710.	3.2	20.0
2015	551.549	62.8214	565678.	31.2	21.2
2030	551.549	62.8209	565675.	3.4	21.1
2045	551.539	62.8191	565668.	6.8	21.2
2100	551.531	62.8215	565698.	-29.7	19.7
2115	551.534	62.8203	565684.	14.0	20.0
2130	551.519	62.8190	565688.	-3.8	19.7
2145	551.510	62.8183	565691.	-3.2	19.3

FREE AIR VOLUME USED (CU. FT.)	=1840000.
REGRESSION LINE	
INTERCEPT (LBM)	= 566178.
SLOPE (LBM/HR)	= -21.0
MAXIMUM ALLOWABLE LEAKAGE RATE	= .200
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	= .150
THE UPPER 95% CONFIDENCE LIMIT	= .091
THE CALCULATED LEAKAGE RATE	= .089

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
2145	552.195	62.9479	
2200	552.169	62.9437	.196
2215	552.152	62.9417	.105
2230	552.128	62.9409	-.030
2245	552.117	62.9386	.016
2300	552.106	62.9333	.143
2315	552.083	62.9333	.047
2330	552.071	62.9297	.090
2345	552.059	62.9268	.108
0	552.042	62.9264	.068
15	552.022	62.9217	.099
30	552.012	62.9235	.049
45	551.999	62.9196	.075
100	551.985	62.9186	.064
115	551.977	62.9182	.053
130	551.955	62.9152	.055
145	551.946	62.9136	.056
200	551.932	62.9120	.053
215	551.927	62.9090	.071
230	551.914	62.9080	.063
245	551.899	62.9048	.071
300	551.887	62.9020	.079
315	551.872	62.8997	.079
330	551.862	62.9018	.054
345	551.859	62.9000	.061
400	551.843	62.8951	.078
415	551.835	62.8932	.080
430	551.823	62.8949	.060
445	551.818	62.8933	.063
500	551.802	62.8910	.064
515	551.785	62.8871	.072
530	551.782	62.8867	.070
545	551.772	62.8861	.065
600	551.768	62.8834	.073
615	551.762	62.8811	.079
630	551.745	62.8804	.071
645	551.743	62.8795	.072
700	551.735	62.8797	.065
715	551.725	62.8764	.072
730	551.724	62.8772	.067
745	551.705	62.8763	.060
800	551.697	62.8731	.067

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
815	551.701	62.8705	.077
830	551.698	62.8710	.072
845	551.699	62.8669	.085
900	551.697	62.8669	.082
915	551.690	62.8647	.085
930	551.681	62.8669	.073
945	551.672	62.8642	.076
1000	551.660	62.8604	.082
1015	551.651	62.8631	.070
1030	551.651	62.8616	.073
1045	551.646	62.8595	.076
1100	551.638	62.8564	.081
1115	551.640	62.8564	.080
1130	551.659	62.8563	.084
1145	551.651	62.8555	.083
1200	551.634	62.8546	.079
1215	551.632	62.8520	.083
1230	551.625	62.8512	.082
1245	551.626	62.8519	.079
1300	551.617	62.8485	.084
1315	551.611	62.8494	.078
1330	551.601	62.8458	.083
1345	551.606	62.8465	.082
1400	551.597	62.8442	.084
1415	551.589	62.8442	.080
1430	551.609	62.8427	.088
1445	551.594	62.8435	.081
1500	551.616	62.8428	.086
1515	551.608	62.8408	.088
1530	551.607	62.8404	.087
1545	551.598	62.8408	.083
1600	551.599	62.8366	.091
1615	551.588	62.8365	.087
1630	551.590	62.8352	.089
1645	551.579	62.8337	.088
1700	551.576	62.8350	.084
1715	551.573	62.8351	.082
1730	551.571	62.8347	.081
1745	551.574	62.8314	.087
1800	551.571	62.8320	.084
1815	551.566	62.8311	.084
1830	551.568	62.8313	.083

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 24.00 HOURS

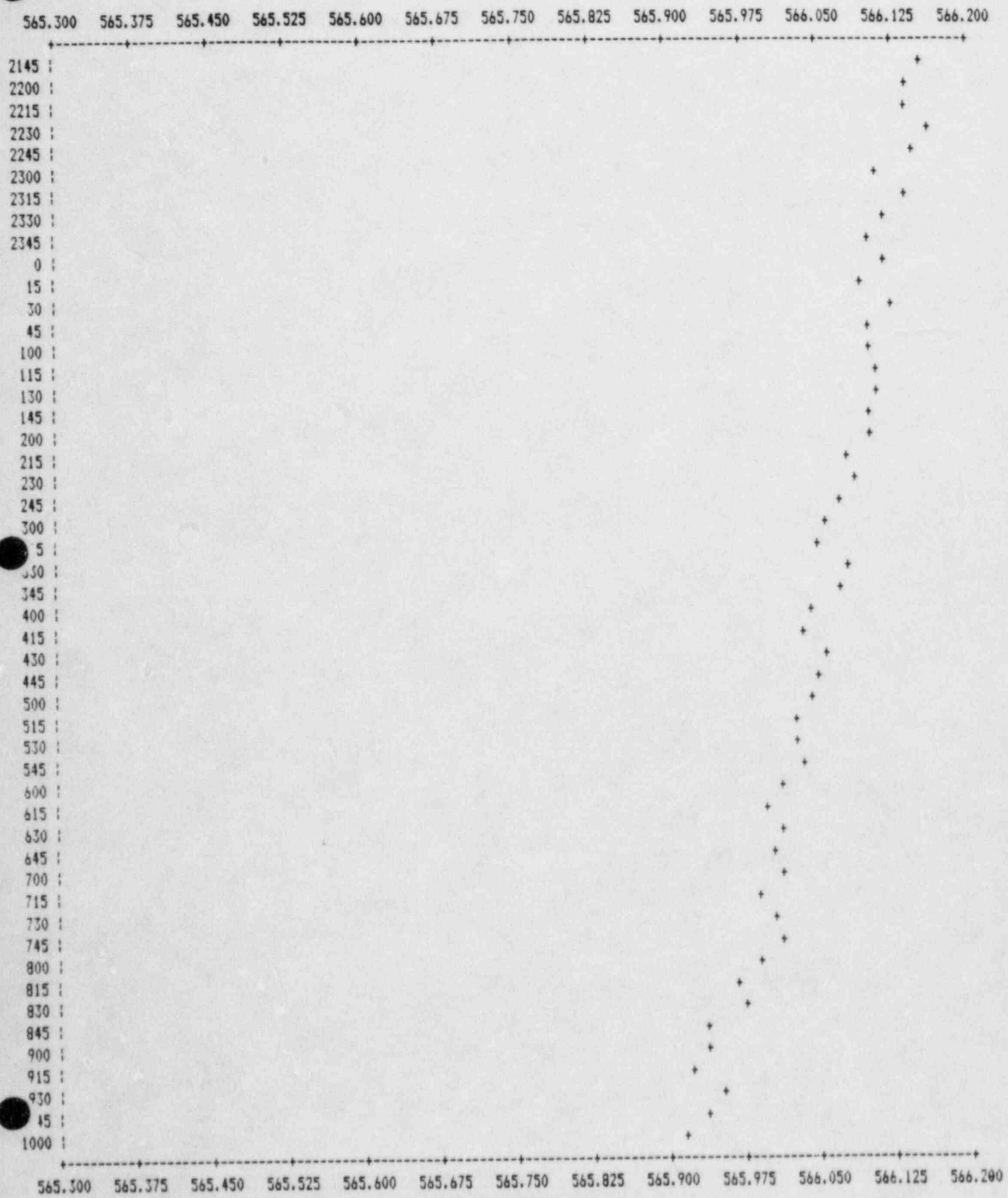
TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
1845	551.557	62.8280	.086
1900	551.557	62.8265	.088
1915	551.558	62.8285	.083
1930	551.559	62.8252	.088
1945	551.559	62.8263	.085
2000	551.545	62.8243	.085
2015	551.549	62.8214	.090
2030	551.549	62.8209	.089
2045	551.539	62.8191	.090
2100	551.531	62.8215	.083
2115	551.534	62.8203	.085
2130	551.519	62.8190	.083
2145	551.510	62.8183	.082

MEAN OF THE MEASURED LEAKAGE RATES	=	.078
MAXIMUM ALLOWABLE LEAKAGE RATE	=	.200
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	=	.150
THE UPPER 95% CONFIDENCE LIMIT	=	.094
THE CALCULATED LEAKAGE RATE	=	.087

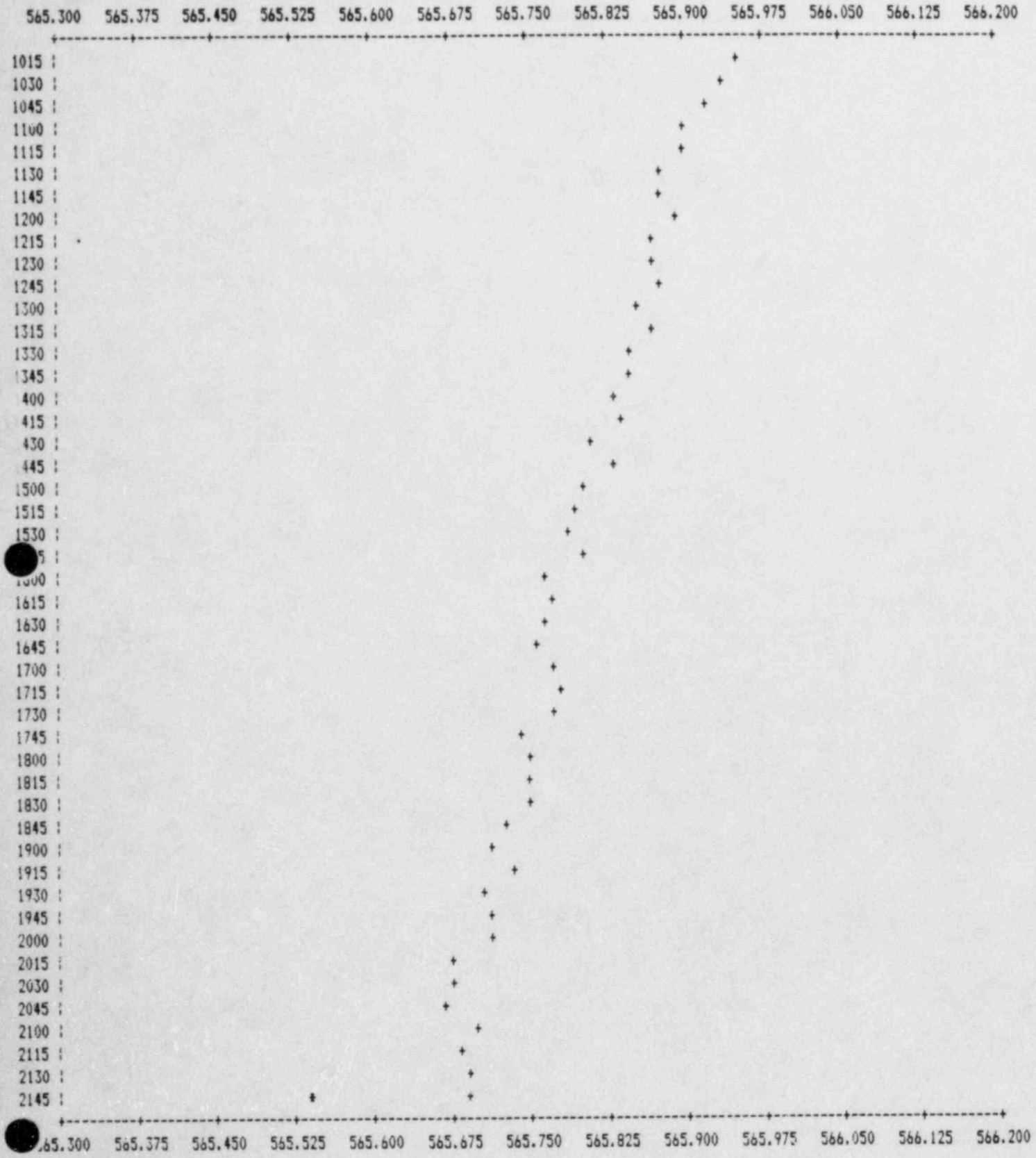
Appendix E

ILRT AND VERIFICATION PLOTS, AIRMASS, TEMPERATURE, PRESSURE, VAPOR PRESSURE, AND LEAKAGE RATE

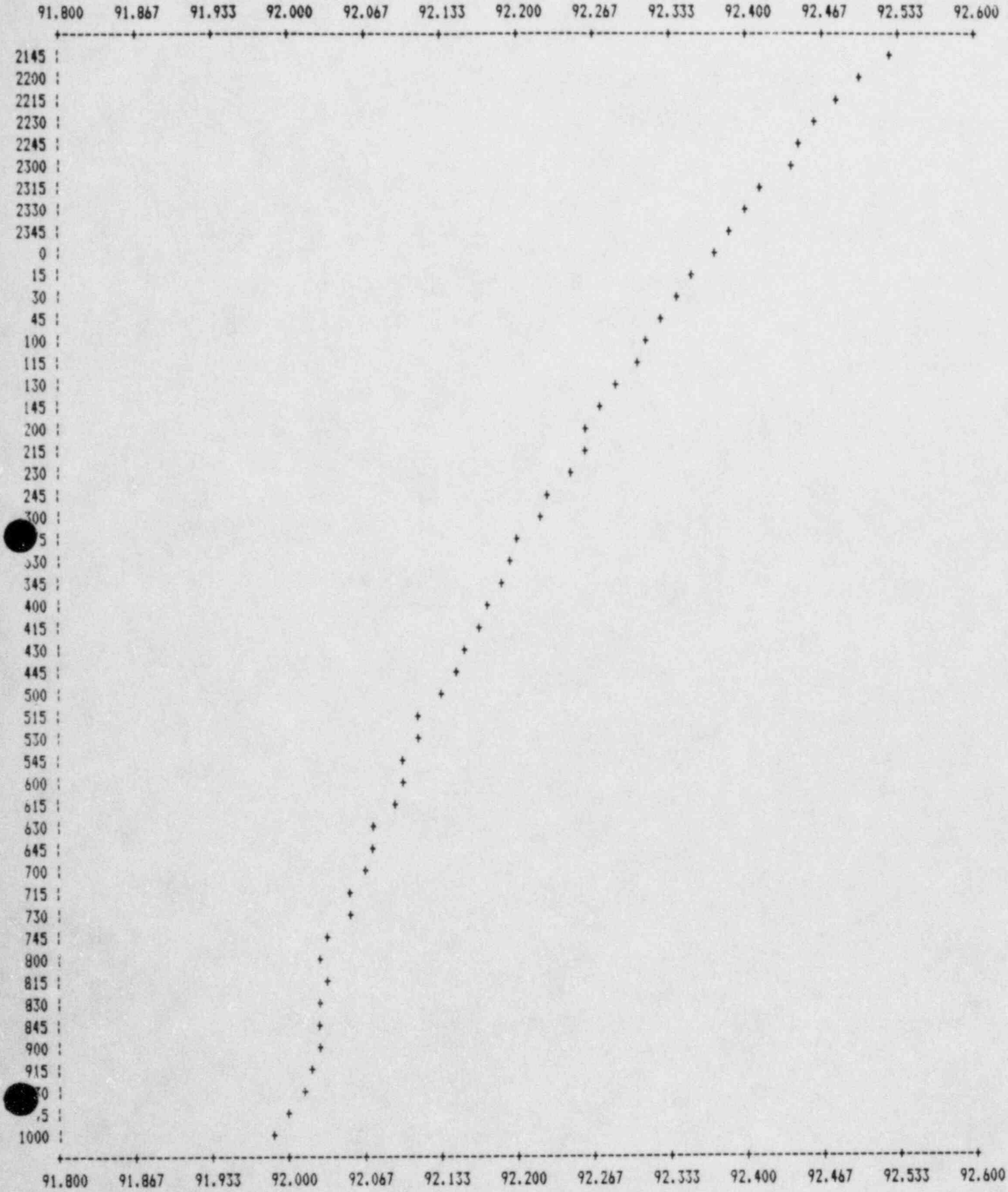
V. C. SUMMER ILRT
AIRMASS LBM X 1000



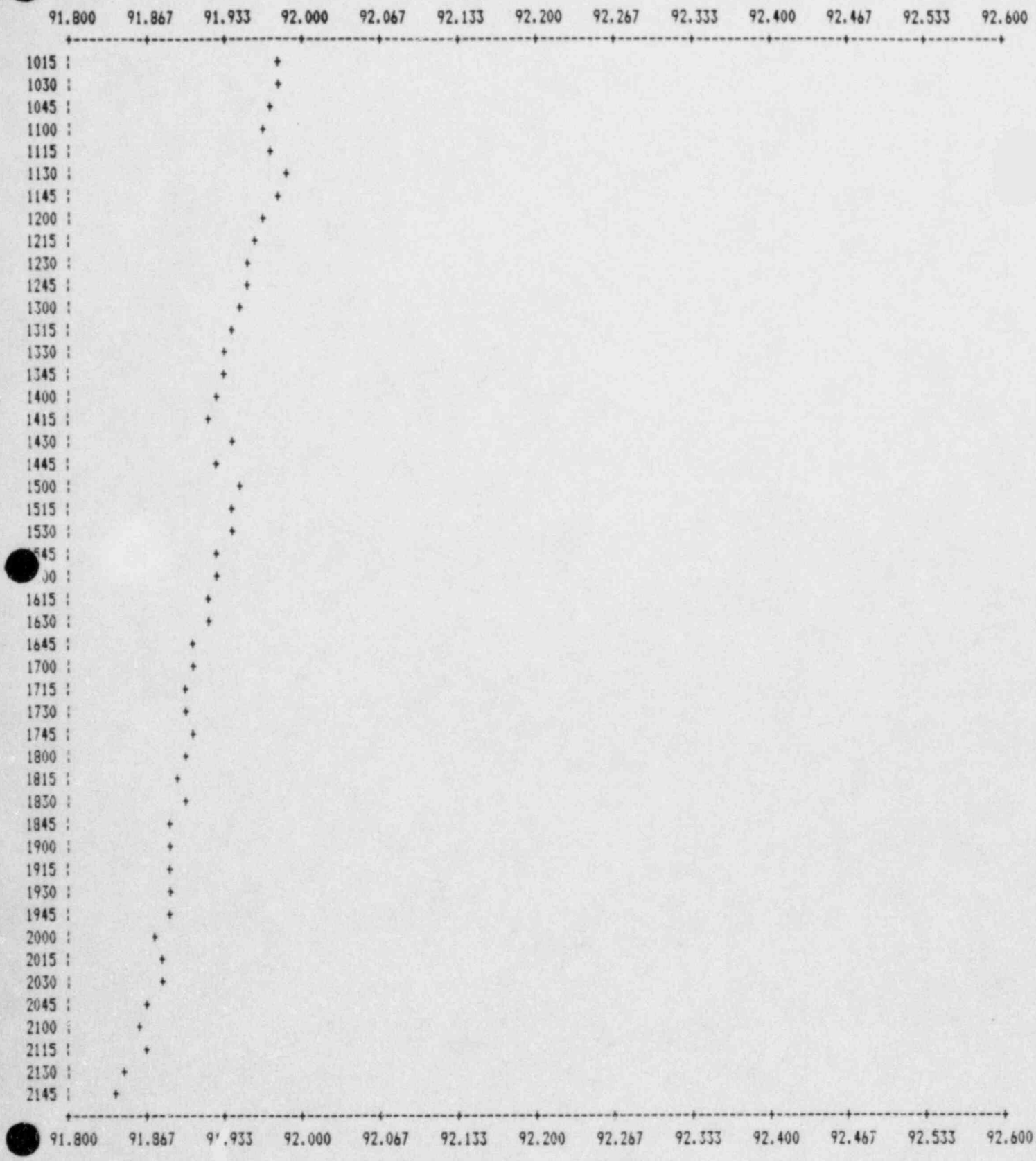
V. C. SUMMER ILRT
AIRMASS LBM X 1000



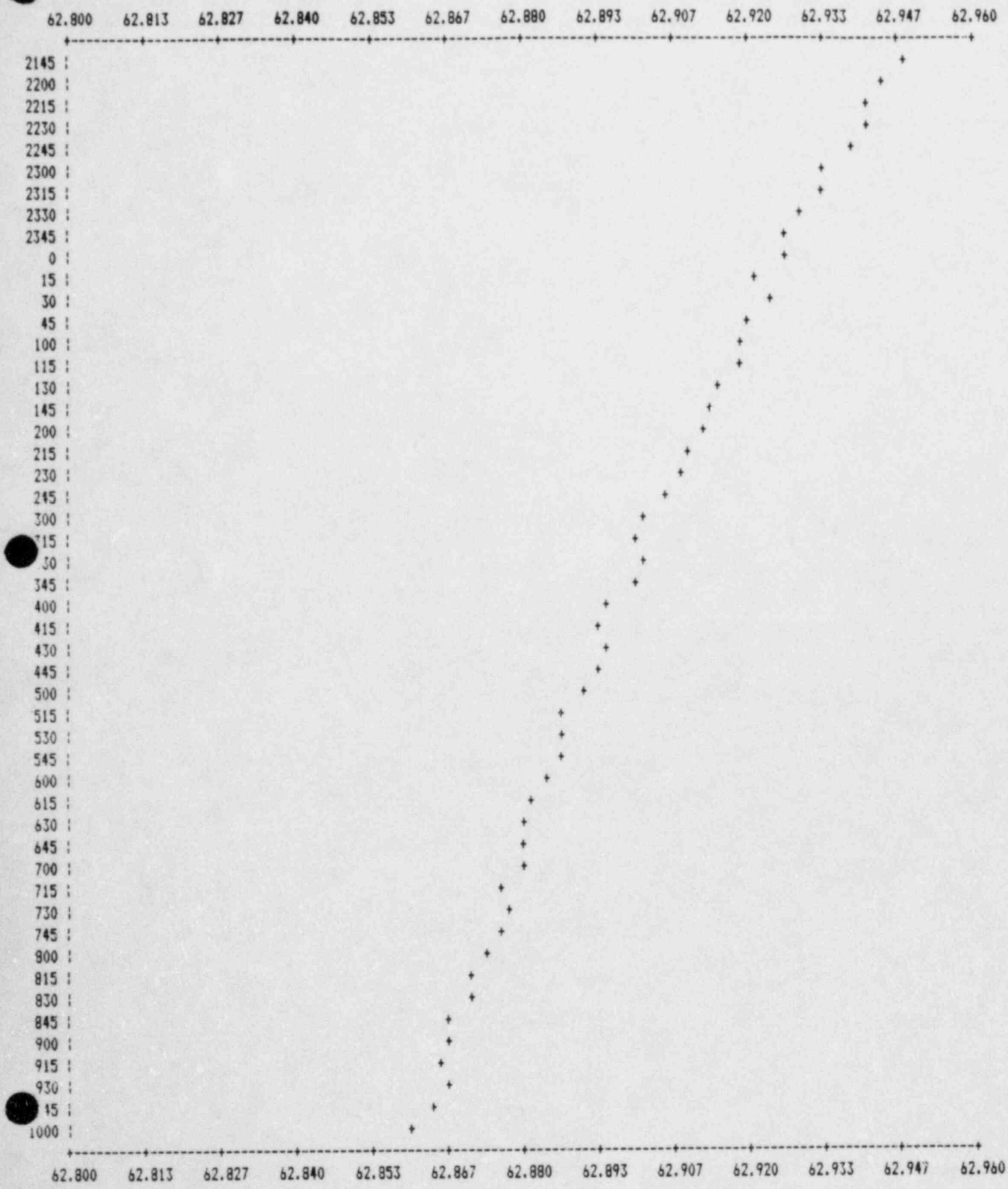
V. C. SUMMER ILRT
TEMPERATURE DEGREES F



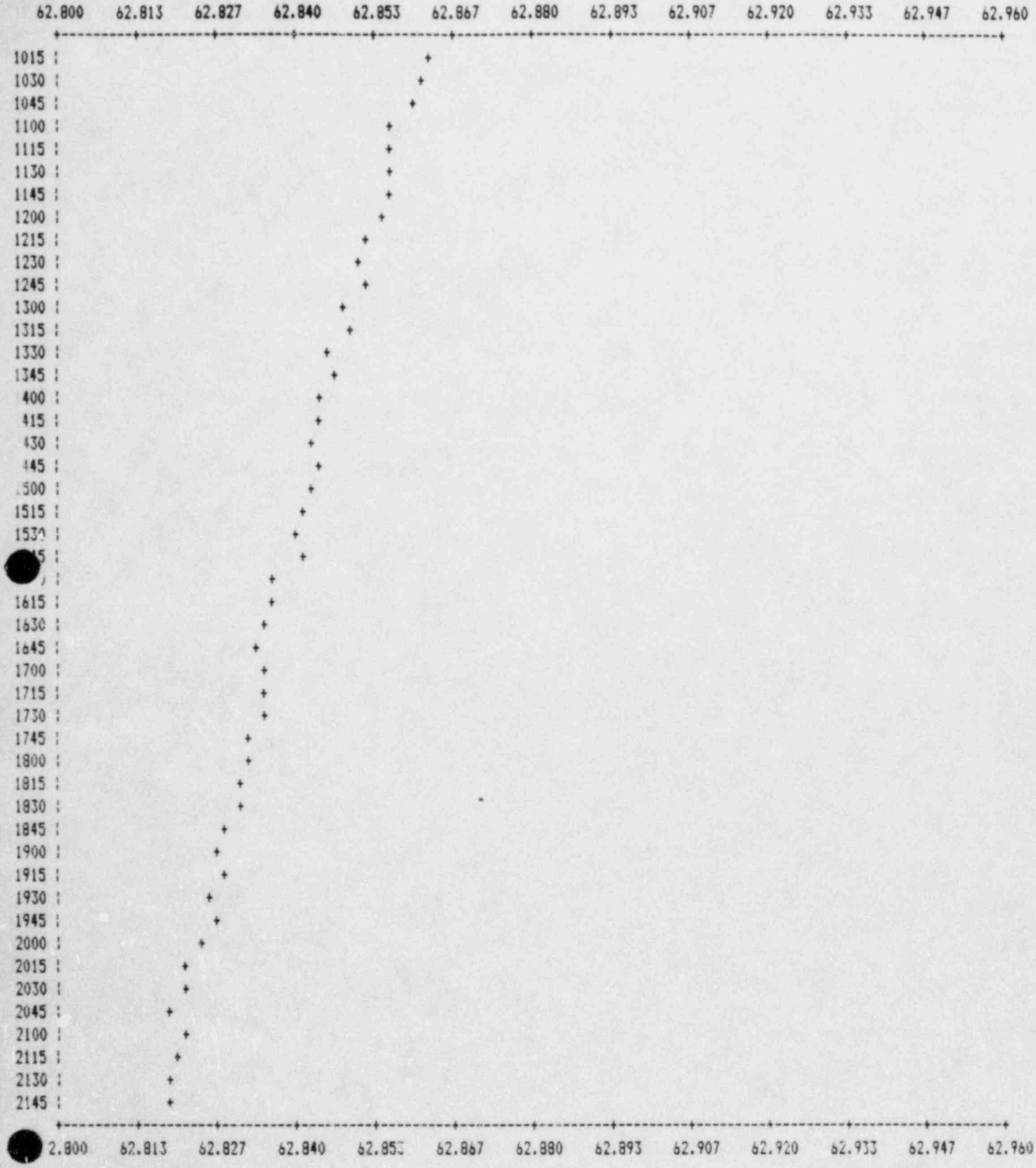
V. C. SUMMER ILRT
TEMPERATURE DEGREES F



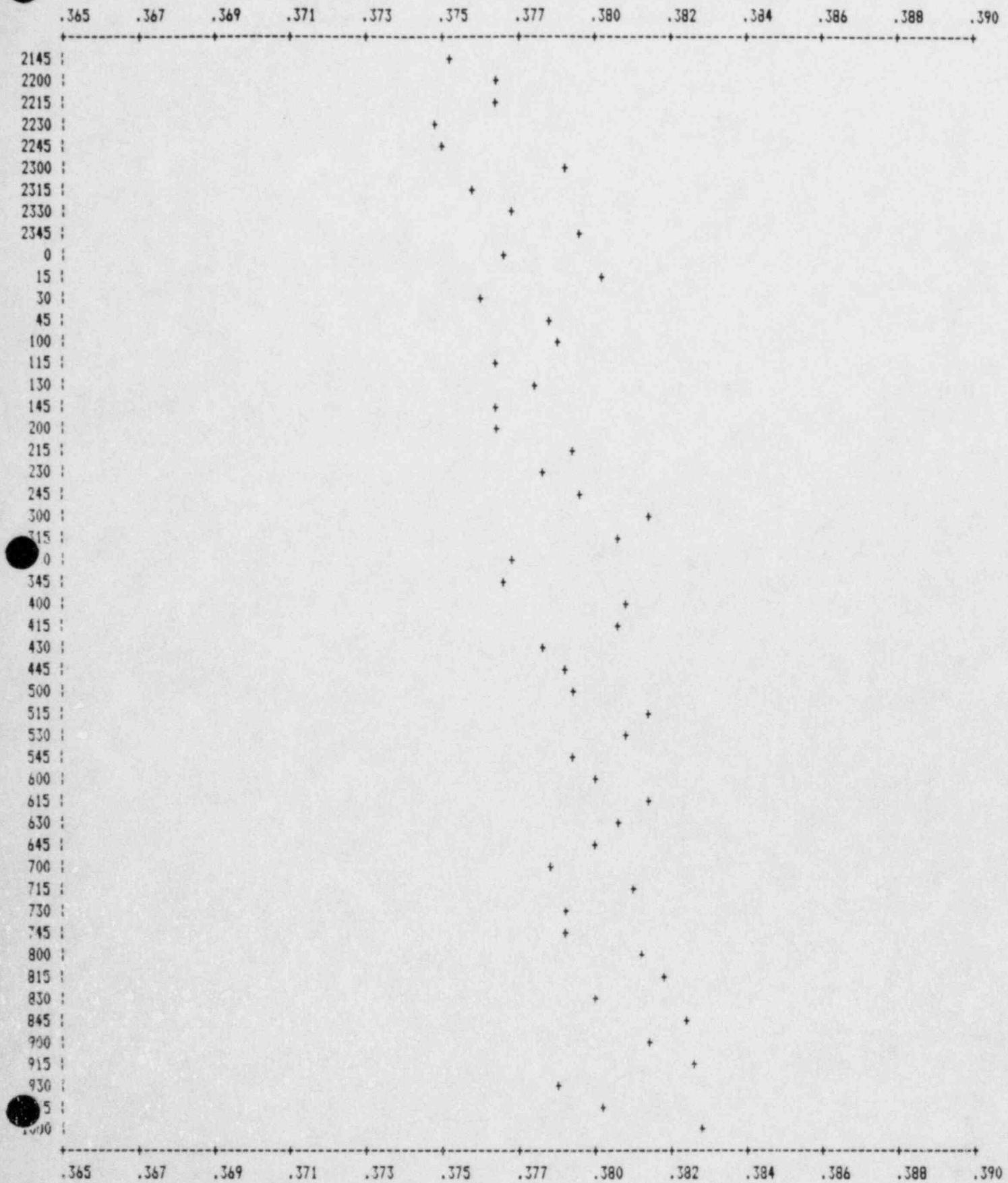
V. C. SUMMER ILRT
PRESSURE PSIA



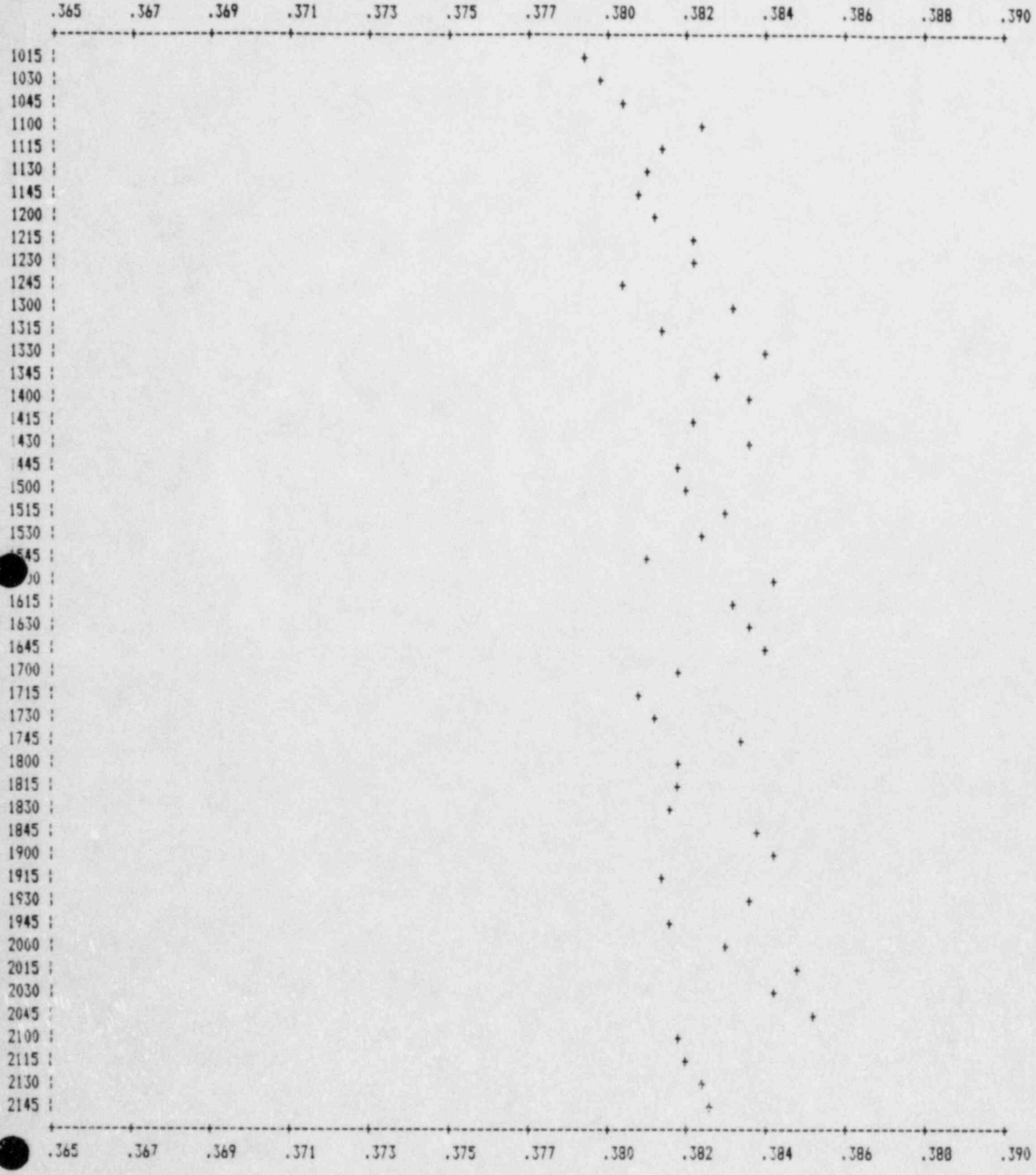
V. C. SUMMER ILRT
PRESSURE PSIA



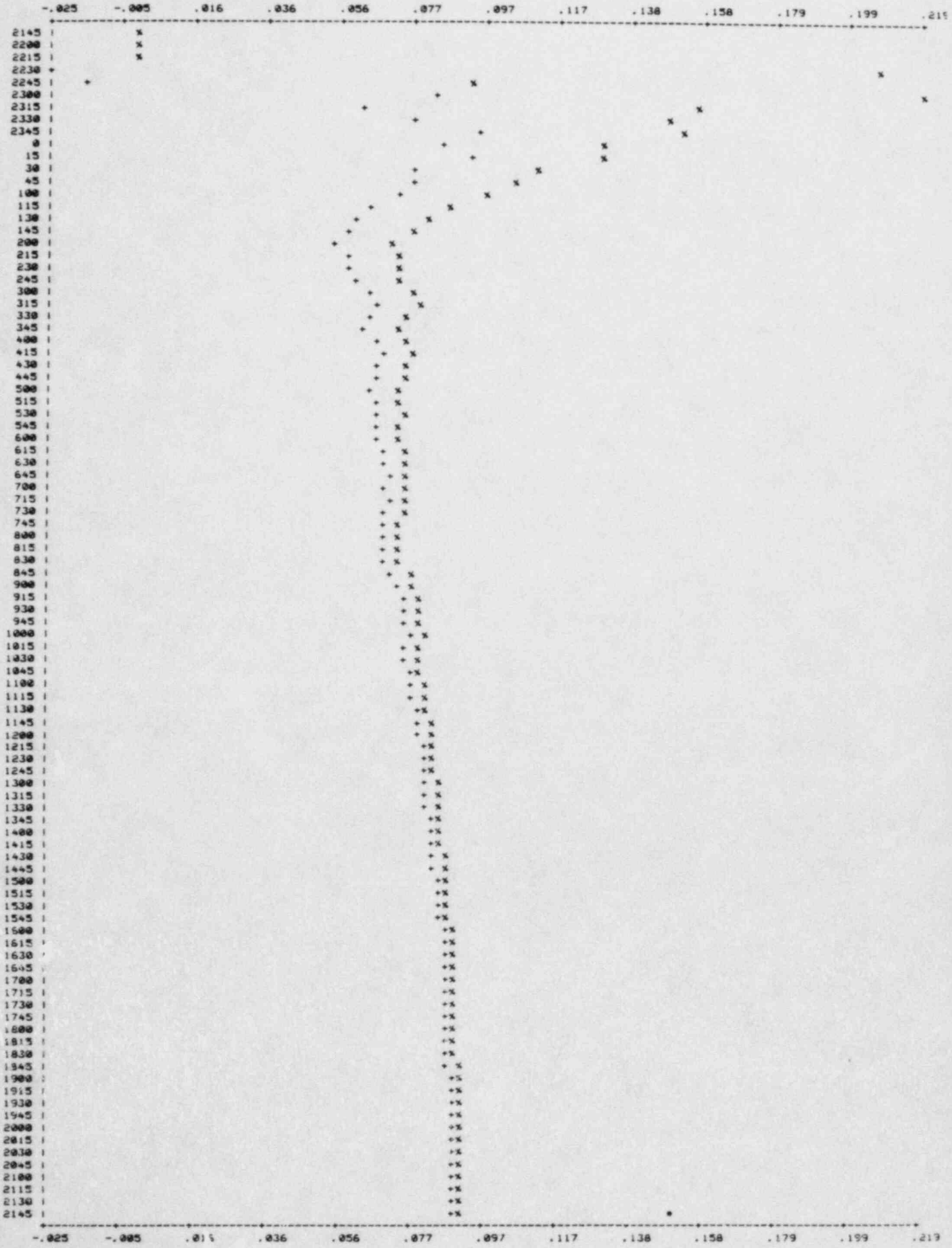
V. C. SUMMER ILRT
VAPOR PRESSURE PSIA

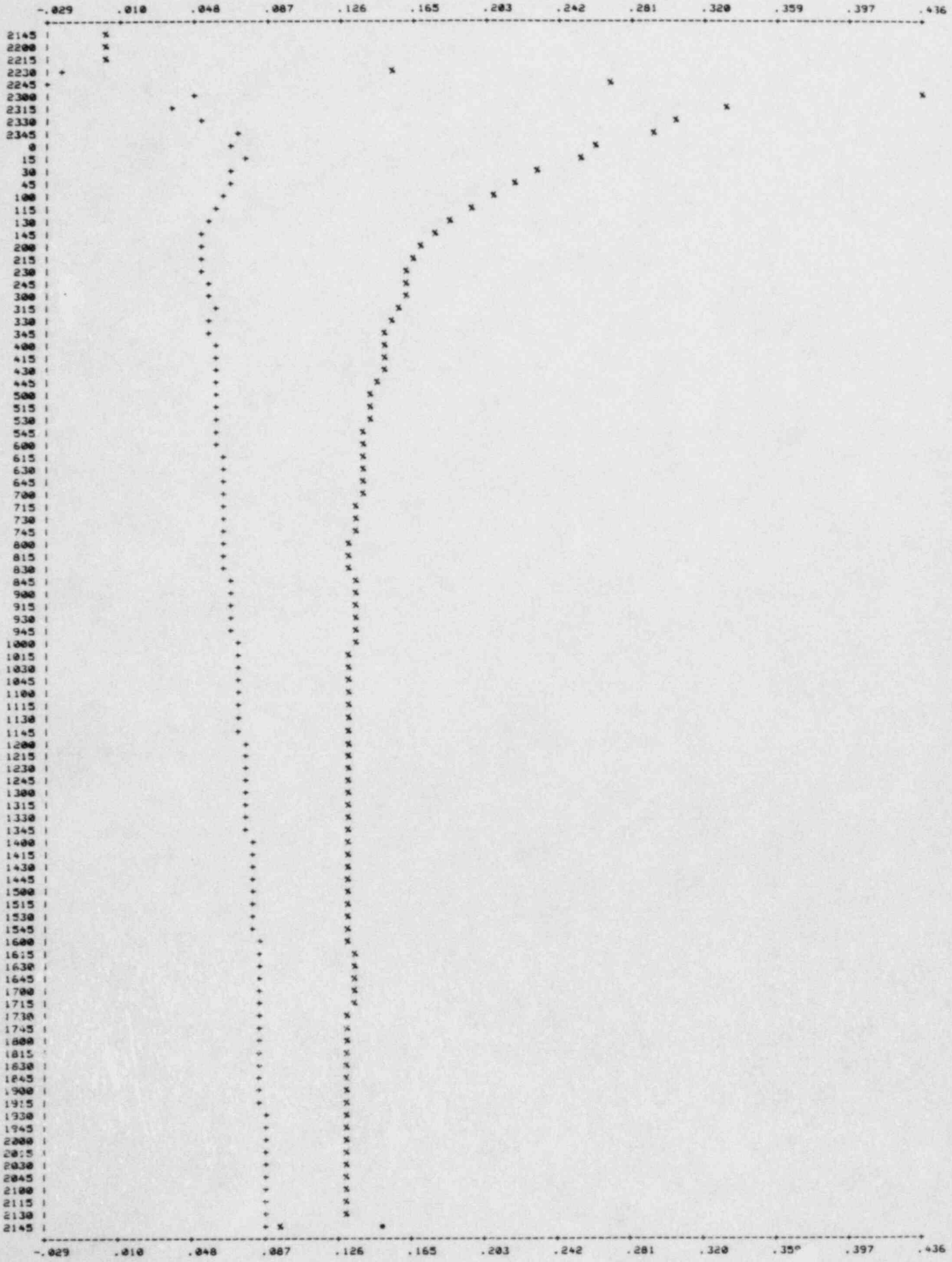


V. C. SUMMER ILRT
VAPOR PRESSURE PSIA

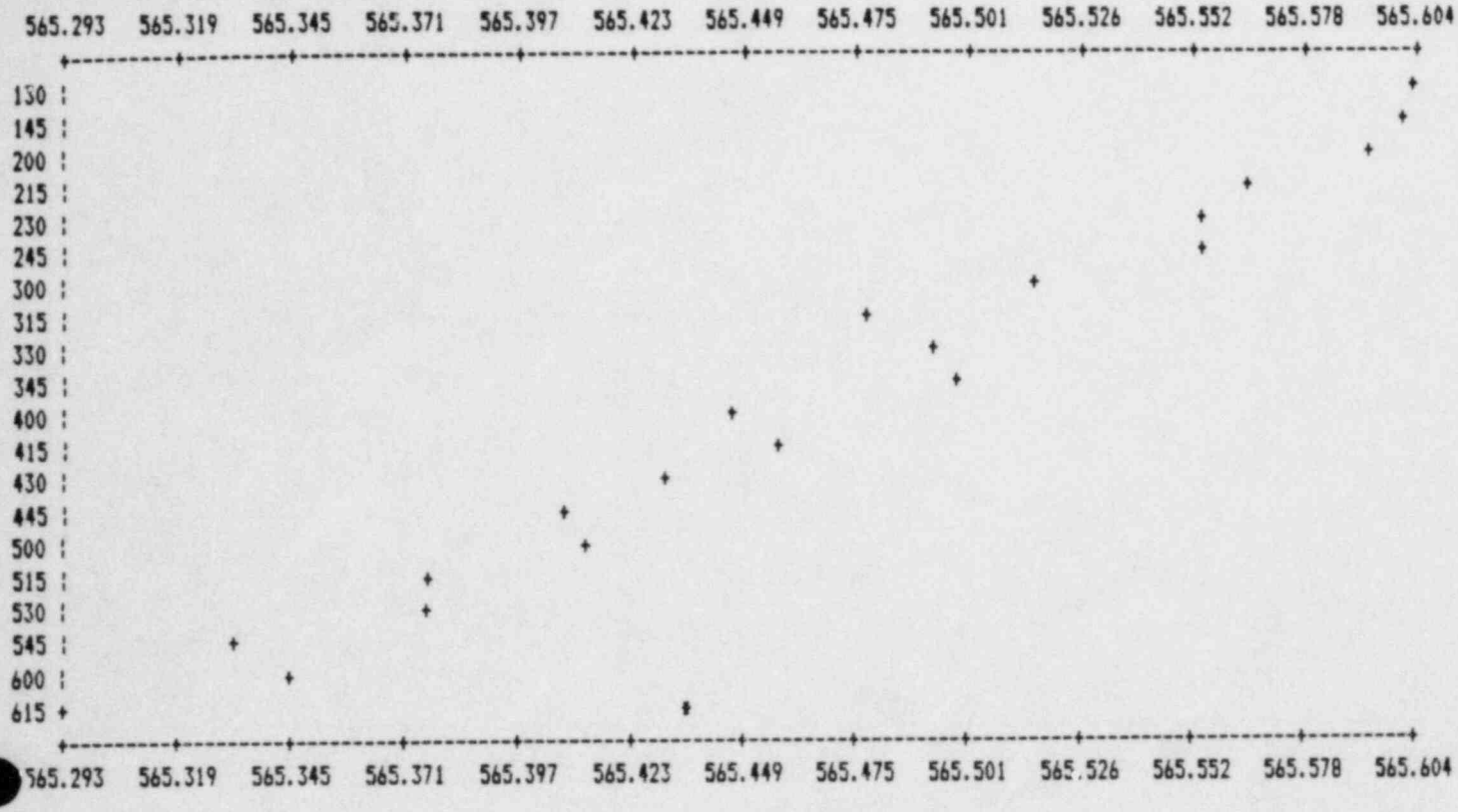


V. C. SUMMER ILRT
MASS POINT LEAKAGE RATE(+) AND UCL(%)

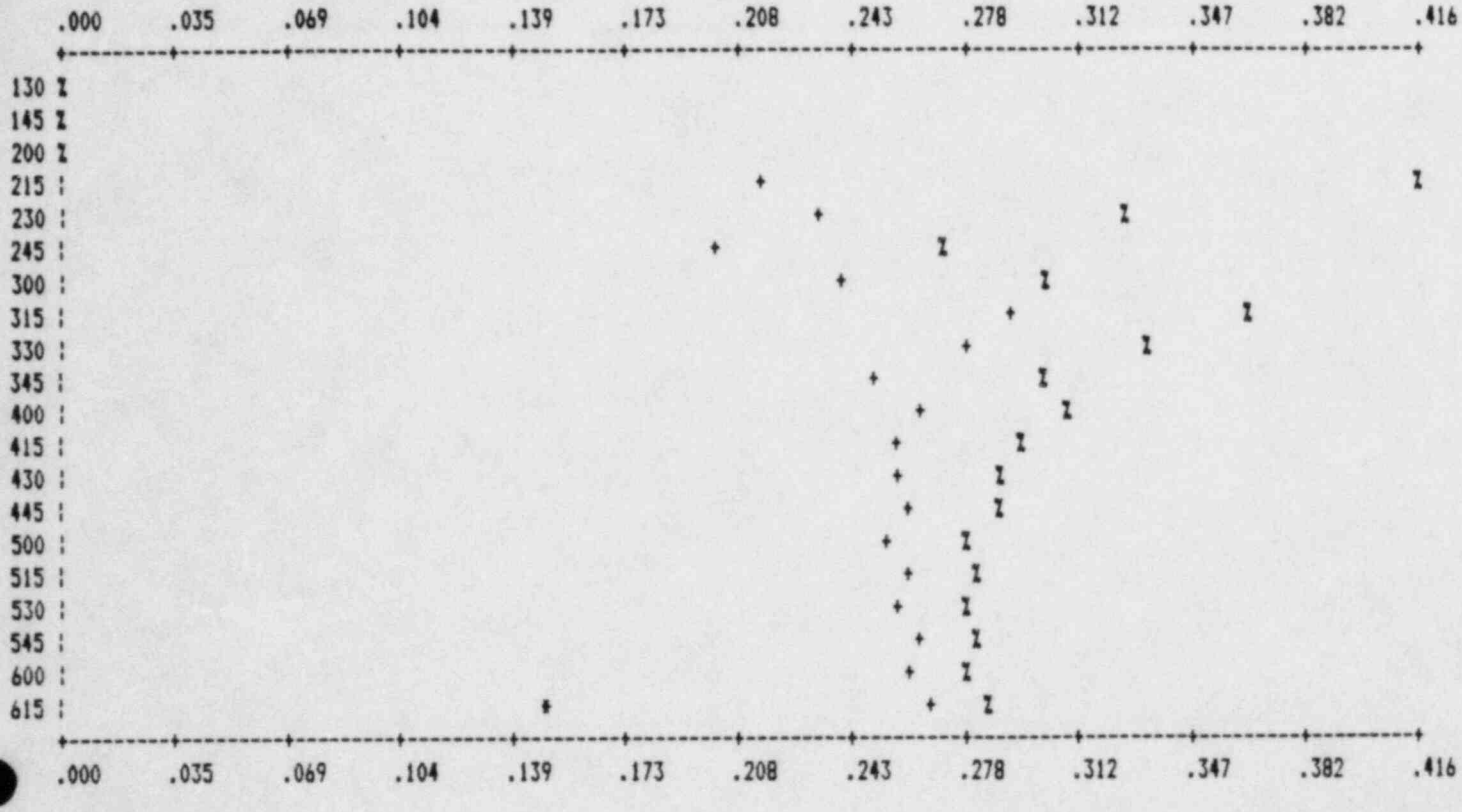



V. C. SUMMER ILRT
TOTAL TIME LEAKAGE RATE(+) AND UCL(X)
-.029
.010
.048
.087
.126
.165
.203
.242
.281
.320
.359
.397
.436
2145
2200
2215
2230
2245
2300
2315
2330
2345
0
15
30
45
100
115
130
145
200
215
230
245
300
315
330
345
400
415
430
445
500
515
530
545
600
615
630
645
700
715
730
745
800
815
830
845
900
915
930
945
1000
1015
1030
1045
1100
1115
1130
1145
1200
1215
1230
1245
1300
1315
1330
1345
1400
1415
1430
1445
1500
1515
1530
1545
1600
1615
1630
1645
1700
1715
1730
1745
1800
1815
1830
1845
1900
1915
1930
1945
2000
2015
2030
2045
2100
2115
2130
2145

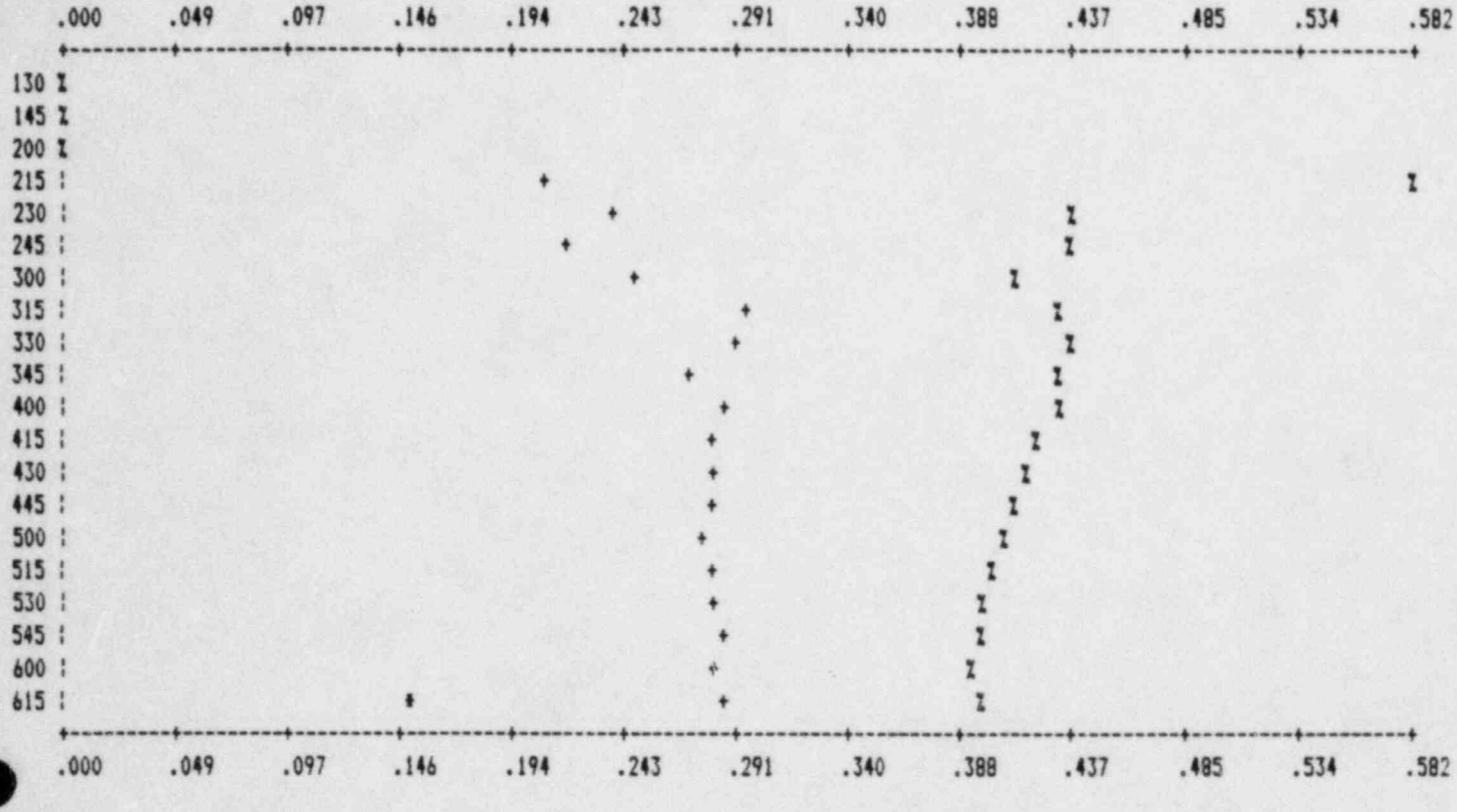
V. C. SUMMER ILRT
AIRMASS LBM X 1000



V. C. SUMMER ILRT
MASS POINT LEAKAGE RATE(+) AND UCL(%)



V. C. SUMMER ILRT
TOTAL TIME LEAKAGE RATE(+) AND UCL(%)



Appendix F

VERIFICATION FLOW SUMMARY DATA, MASS POINT AND TOTAL TIME REPORTS

V. C. SUMMER ILRT
SUMMARY DATA

ALMAX = .200 VOLUME = 1840000.
VRATET = .283 VRATEM = .285

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME
130	1009	551.441	62.8008	.3867	1840000.
145	1009	551.444	62.8007	.3853	1840000.
200	1009	551.439	62.7993	.3847	1840000.
215	1009	551.432	62.7954	.3861	1840000.
230	1009	551.427	62.7937	.3853	1840000.
245	1009	551.424	62.7934	.3836	1840000.
300	1009	551.425	62.7892	.3858	1840000.
315	1009	551.432	62.7856	.3874	1840000.
330	1009	551.434	62.7876	.3834	1840000.
345	1009	551.418	62.7864	.3836	1840000.
400	1009	551.422	62.7810	.3870	1840000.
415	1009	551.425	62.7825	.3835	1840000.
430	1009	551.417	62.7789	.3851	1840000.
445	1009	551.413	62.7759	.3856	1840000.
500	1009	551.406	62.7756	.3844	1840000.
515	1009	551.401	62.7708	.3867	1840000.
530	1009	551.397	62.7705	.3860	1840000.
545	1009	551.402	62.7662	.3873	1840000.
600	1009	551.384	62.7655	.3860	1840000.
615	1009	551.403	62.7619	.3876	1840000.

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 130 1009 1984
TEST DURATION: 4.75 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
130	551.441	62.8008	565604.		
145	551.444	62.8007	565601.	3.7	14.8
200	551.439	62.7993	565593.	7.6	22.6
215	551.432	62.7954	565565.	28.2	52.7
230	551.427	62.7937	565554.	10.7	50.2
245	551.424	62.7934	565555.	-.7	39.6
300	551.425	62.7892	565516.	38.4	58.6
315	551.432	62.7856	565477.	39.3	72.7
330	551.434	62.7876	565493.	-15.9	55.7
345	551.418	62.7864	565498.	-5.2	47.2
400	551.422	62.7810	565446.	52.4	63.4
415	551.425	62.7825	565456.	-10.1	54.0
430	551.417	62.7789	565431.	24.5	57.7
445	551.413	62.7759	565408.	22.9	60.3
500	551.406	62.7756	565413.	-5.0	54.5
515	551.401	62.7708	565375.	38.0	61.0
530	551.397	62.7705	565376.	-.7	57.0
545	551.402	62.7662	565332.	43.6	64.0
600	551.384	62.7655	565344.	-12.0	57.7
615	551.403	62.7619	565293.	50.9	65.4

FREE AIR VOLUME USED (CU. FT.) =1840000.
REGRESSION LINE
INTERCEPT (LBM) = 565617.
SLOPE (LBM/HR) = -63.2
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT = .335
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT = .235
THE CALCULATED LEAKAGE RATE = .268

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 130 1009 1984
TEST DURATION: 4.75 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
130	551.441	62.8008	
145	551.444	62.8007	.063
200	551.439	62.7993	.096
215	551.432	62.7954	.224
230	551.427	62.7937	.213
245	551.424	62.7934	.168
300	551.425	62.7892	.249
315	551.432	62.7856	.309
330	551.434	62.7876	.236
345	551.418	62.7864	.200
400	551.422	62.7810	.269
415	551.425	62.7825	.229
430	551.417	62.7789	.245
445	551.413	62.7759	.256
500	551.406	62.7756	.231
515	551.401	62.7708	.259
530	551.397	62.7705	.242
545	551.402	62.7662	.271
600	551.384	62.7655	.245
615	551.403	62.7619	.278

MEAN OF THE MEASURED LEAKAGE RATES	=	.225
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT	=	.333
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT	=	.233
THE CALCULATED LEAKAGE RATE	=	.287

Appendix G

ISG CALCULATIONS

ISG CALCULATION

24 HOUR TEST

La = 0.2%/day

P = 63.15 psia

T = 551.4

Vap Pres = 0.3875 psia, @70°F, Δ1°F = 0.0125 psia change VPRS

t = 24 hours

Pressure $e_p = \frac{0.003}{\sqrt{2}} = 0.002121$

Vapor Pressure $C_{v_p} = \frac{(0.01)\ (0.0125)}{\sqrt{4}} = 0.0000625$

Temperature $C_T = \frac{0.04}{\sqrt{24}} = 0.0081648$

$$ISG = \frac{2400}{24}\left[2\left(\frac{0.002121}{63.15}\right)^2 + 2\left(\frac{0.0000625}{63.15}\right)^2 + 2\left(\frac{0.0081649}{551.4}\right)^2\right]^{1/2}$$

ISG = 0.0052

Appendix H

8-HOUR TEST RESULTS

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 8.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	MEASURED LEAKAGE RATE
2145	552.195	62.9479	
2200	552.169	62.9437	.196
2215	552.152	62.9417	.105
2230	552.128	62.9409	-.030
2245	552.117	62.9386	.016
2300	552.108	62.9333	.143
2315	552.083	62.9333	.047
2330	552.071	62.9297	.090
2345	552.059	62.9268	.108
0	552.042	62.9264	.068
15	552.022	62.9217	.099
30	552.012	62.9235	.049
45	551.999	62.9196	.075
100	551.985	62.9186	.064
115	551.977	62.9182	.053
130	551.955	62.9152	.055
145	551.946	62.9136	.056
200	551.932	62.9120	.053
215	551.927	62.9090	.071
230	551.914	62.9080	.063
245	551.899	62.9048	.071
300	551.887	62.9020	.079
315	551.872	62.8997	.079
330	551.862	62.9018	.054
345	551.859	62.9000	.061
400	551.843	62.8951	.078
415	551.835	62.8932	.080
430	551.823	62.8949	.060
445	551.818	62.8933	.063
500	551.802	62.8910	.064
515	551.785	62.8871	.072
530	551.782	62.8867	.070
545	551.772	62.8861	.065

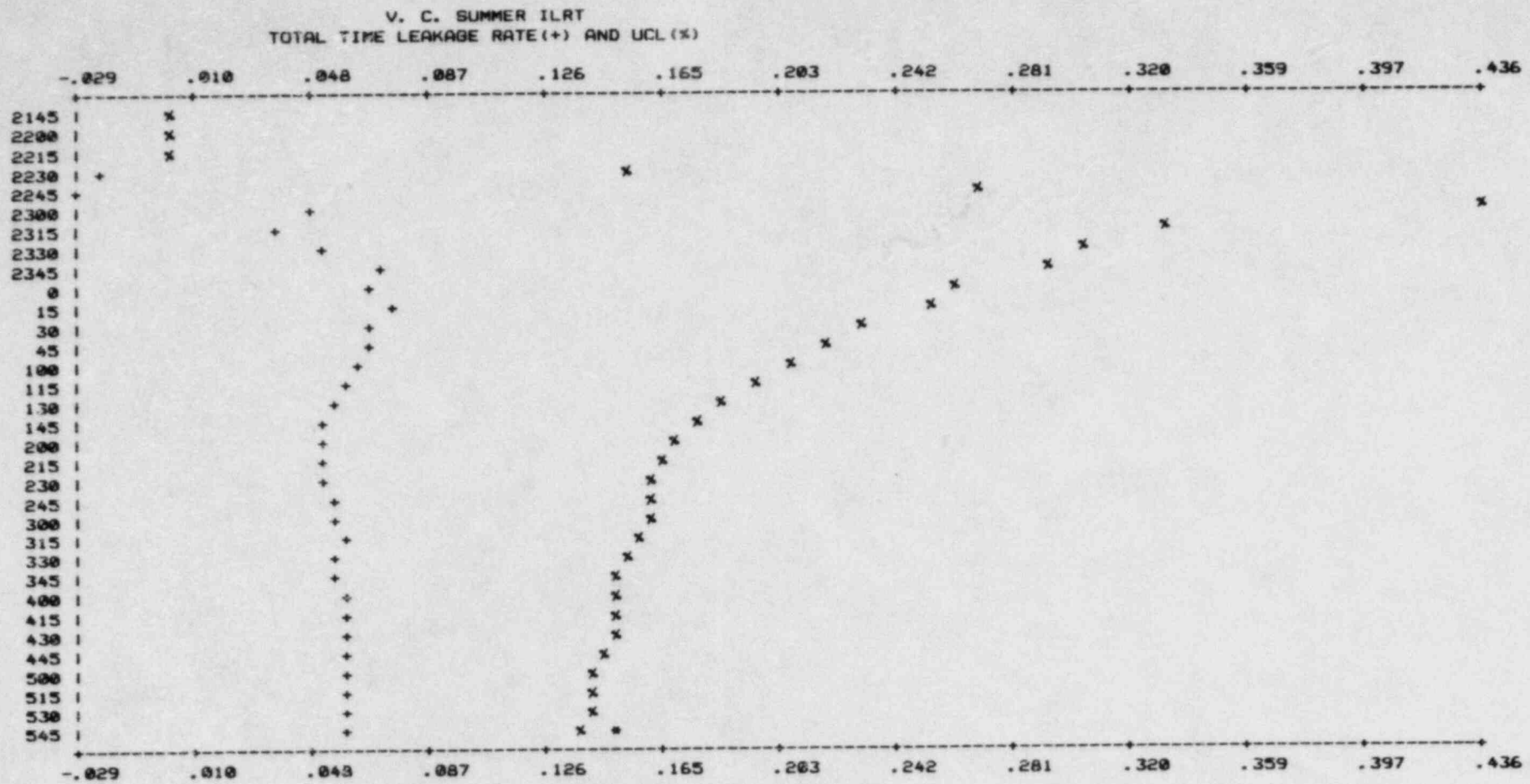
MEAN OF THE MEASURED LEAKAGE RATES	=	.071
MAXIMUM ALLOWABLE LEAKAGE RATE	=	.200
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	=	.150
THE UPPER 95% CONFIDENCE LIMIT	=	.139
THE CALCULATED LEAKAGE RATE	=	.061

V. C. SUMMER ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

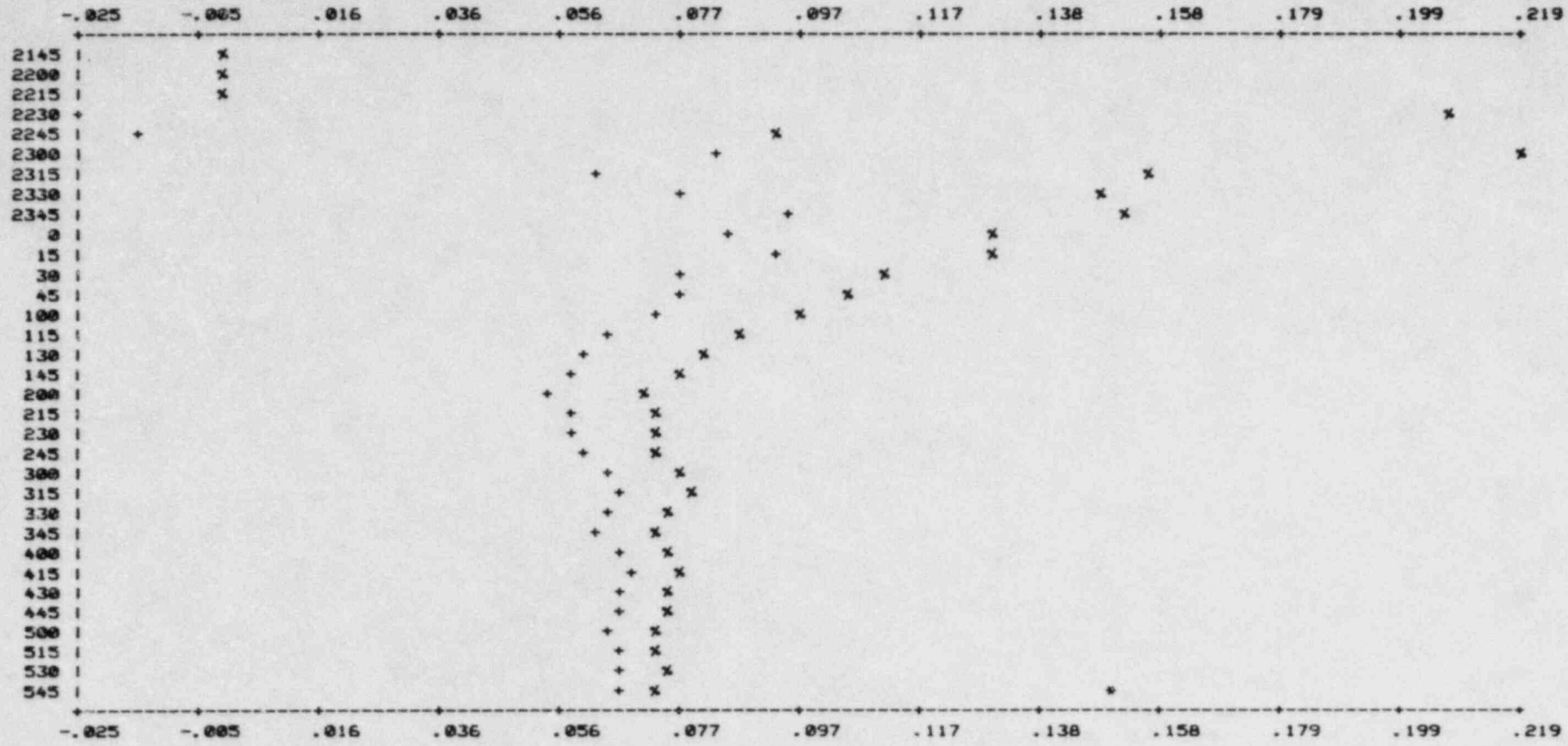
TIME AND DATE AT START OF TEST: 2145 1007 1984
TEST DURATION: 8.00 HOURS

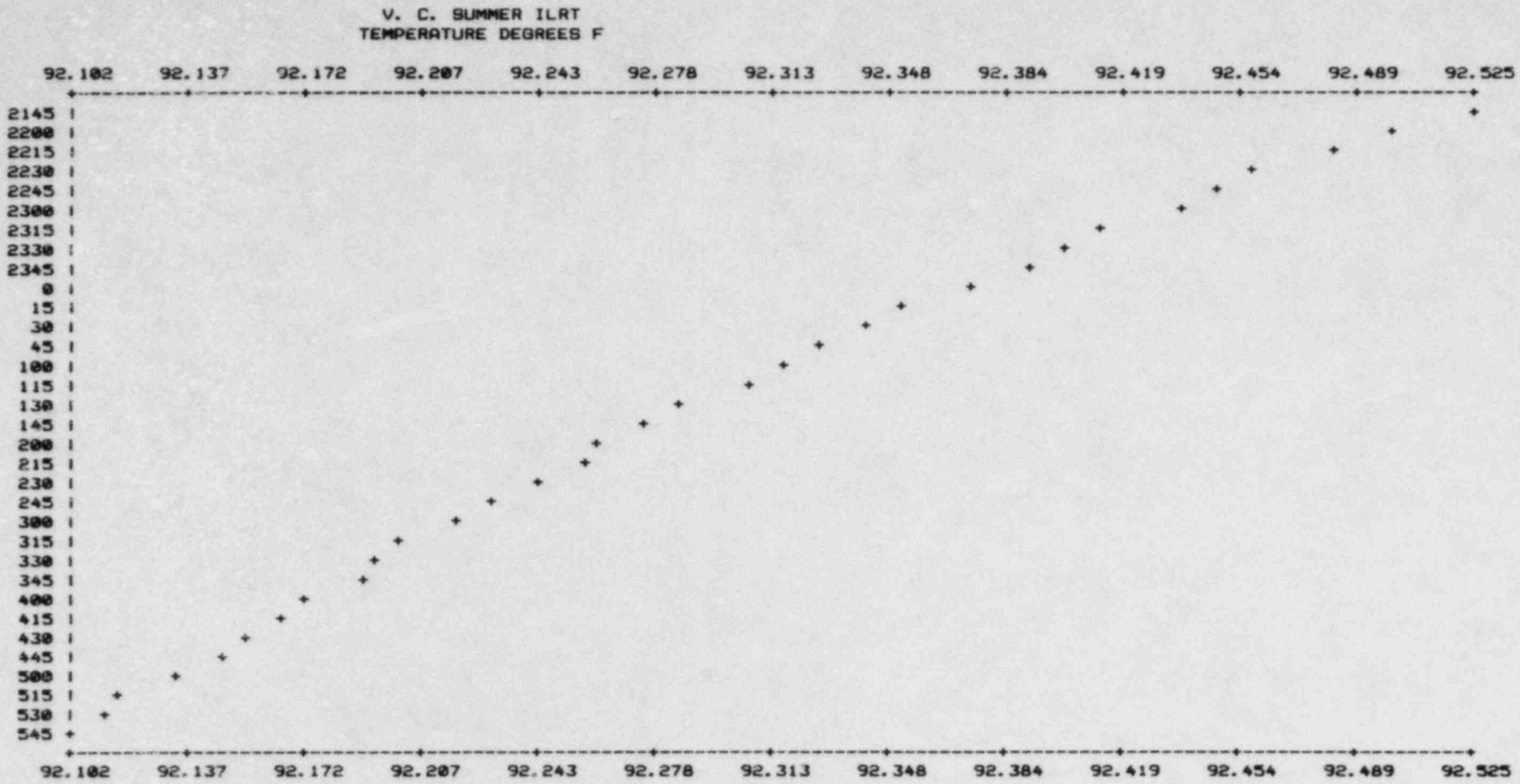
TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
2145	552.195	62.9479	566155.		
2200	552.169	62.9437	566143.	11.5	46.2
2215	552.152	62.9417	566143.	.9	24.8
2230	552.128	62.9409	566160.	-17.6	-7.0
2245	552.117	62.9386	566151.	9.0	3.8
2300	552.108	62.9333	566113.	38.5	33.8
2315	552.083	62.9333	566138.	-25.6	11.1
2330	552.071	62.9297	566118.	20.4	21.2
2345	552.059	62.9268	566104.	13.8	25.5
0	552.042	62.9264	566119.	-14.9	16.0
15	552.022	62.9217	566097.	22.3	23.3
30	552.012	62.9235	566123.	-26.2	11.7
45	551.999	62.9196	566102.	20.9	17.7
100	551.985	62.9186	566106.	-3.9	15.1
115	551.977	62.9182	566111.	-5.4	12.5
130	551.955	62.9152	566106.	4.9	13.0
145	551.946	62.9136	566102.	4.5	13.3
200	551.932	62.9120	566102.	-.5	12.4
215	551.927	62.9090	566080.	22.8	16.8
230	551.914	62.9080	566084.	-4.4	15.0
245	551.899	62.9048	566071.	12.7	16.8
300	551.887	62.9020	566058.	13.5	18.5
315	551.872	62.8997	566053.	4.6	18.5
330	551.862	62.9018	566081.	-28.2	12.8
345	551.859	62.9000	566069.	12.6	14.4
400	551.843	62.8951	566041.	28.1	18.3
415	551.835	62.8932	566032.	8.6	18.9
430	551.823	62.8949	566059.	-27.3	14.2
445	551.818	62.8933	566051.	8.4	14.9
500	551.802	62.8910	566046.	5.0	15.0
515	551.785	62.8871	566027.	18.6	17.0
530	551.782	62.8867	566027.	.4	16.5
545	551.772	62.8861	566033.	-5.9	15.3

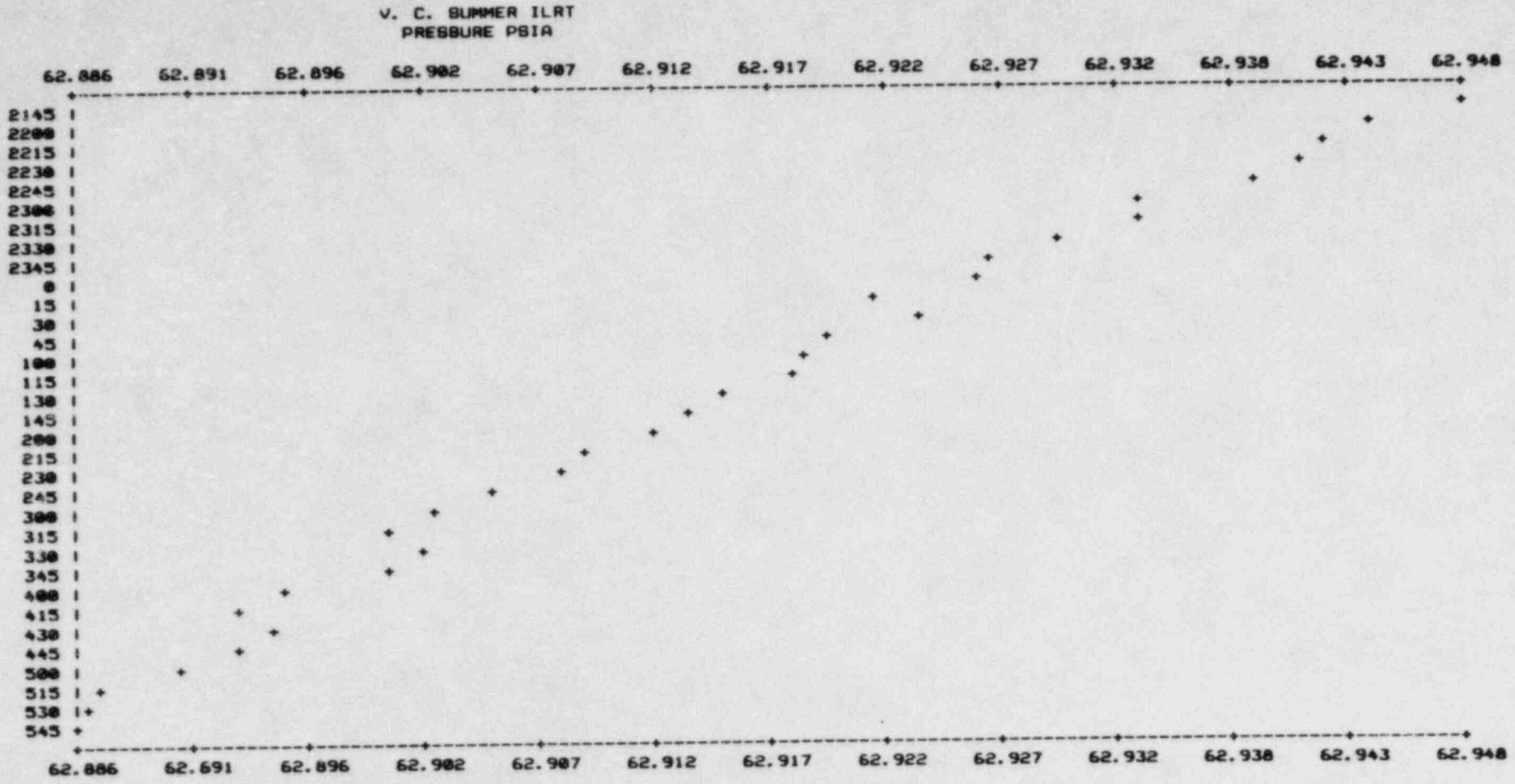
FREE AIR VOLUME USED (CU. FT.)	=1840000.
REGRESSION LINE	
INTERCEPT (LBM)	= 566154.
SLOPE (LBM/HR)	= -15.7
MAXIMUM ALLOWABLE LEAKAGE RATE	= .200
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	= .150
THE UPPER 95% CONFIDENCE LIMIT	= .073
THE CALCULATED LEAKAGE RATE	= .066

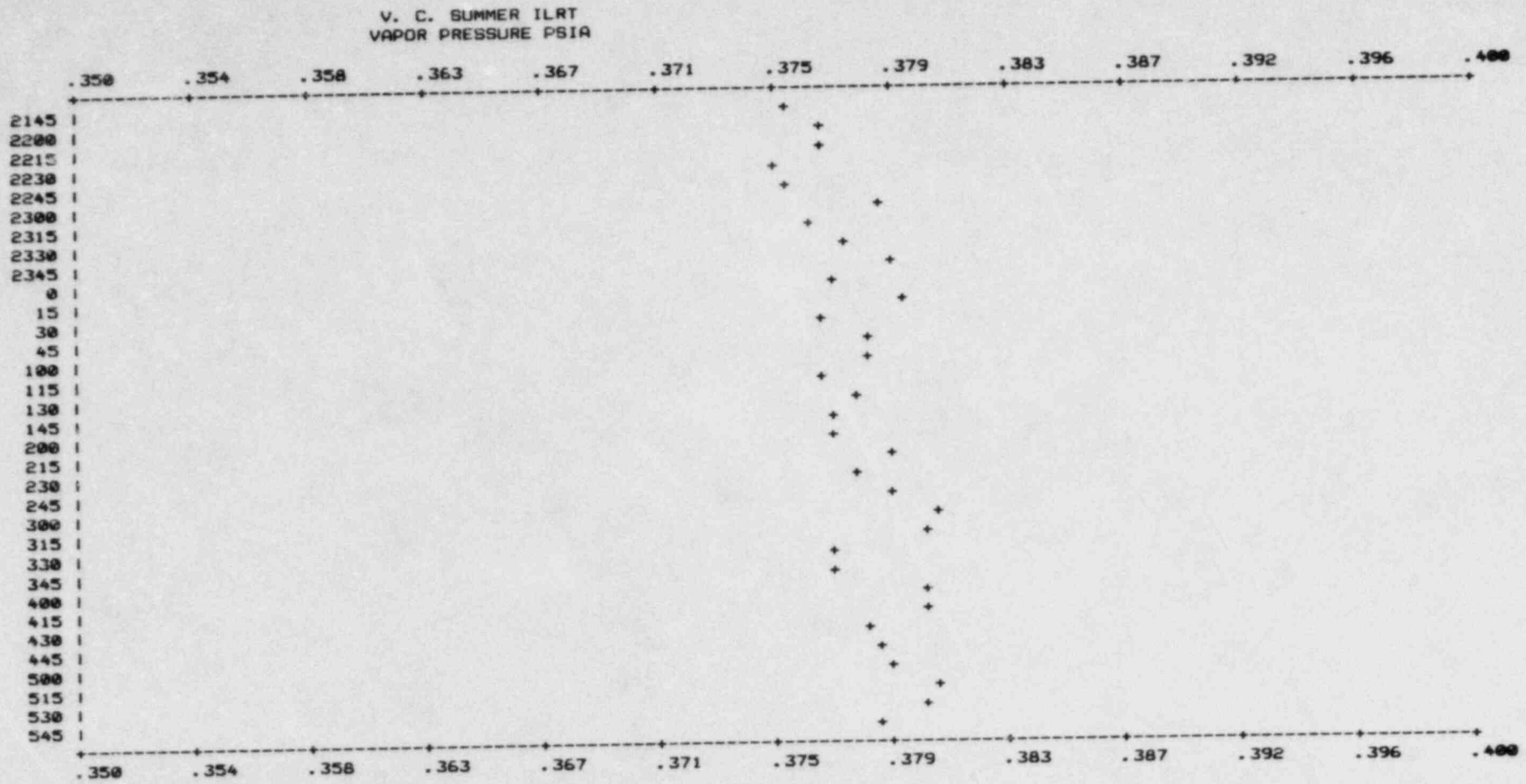

V. C. SUMMER ILRT
TOTAL TIME LEAKAGE RATE(+) AND UCL(x)
-.029
.010
.048
.087
.126
.165
.203
.242
.281
.320
.359
.397
.436
2145
2200
2215
2230
2245
2300
2315
2330
2345
0
15
30
45
100
115
130
145
200
215
230
245
300
315
330
345
400
415
430
445
500
515
530
545

V. C. SUMMER ILRT
MASS POINT LEAKAGE RATE(+) AND UCL(x)

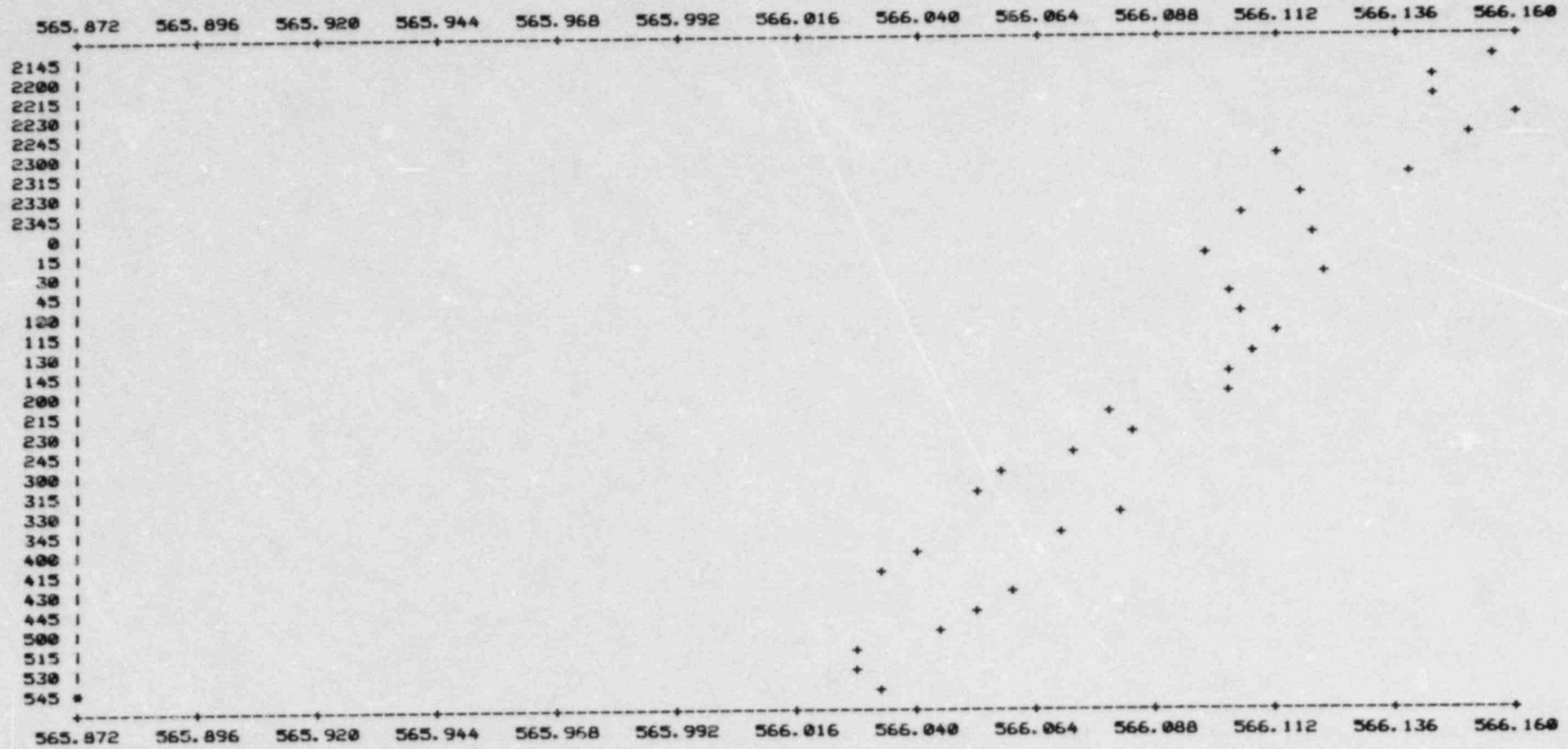



V. C. SUMMER ILRT
TEMPERATURE DEGREES F
92.102
92.137
92.172
92.207
92.243
92.278
92.313
92.348
92.384
92.419
92.454
92.489
92.525
2145
2200
2215
2230
2245
2300
2315
2330
2345
0
15
30
45
100
115
130
145
200
215
230
245
300
315
330
345
400
415
430
445
500
515
530
545


V. C. SUMMER ILRT
PRESSURE PSIA
62.886
62.891
62.896
62.902
62.907
62.912
62.917
62.922
62.927
62.932
62.938
62.943
62.948
2145
2200
2215
2230
2245
2300
2315
2330
2345
0
15
30
45
100
115
130
145
200
215
230
245
300
315
330
345
400
415
430
445
500
515
530
545


V. C. SUMMER ILRT
VAPOR PRESSURE PSIA
.350
.354
.358
.363
.367
.371
.375
.379
.383
.387
.392
.396
.400
2145
2200
2215
2230
2245
2300
2315
2330
2345
0
15
30
45
100
115
130
145
200
215
230
245
300
315
330
345
400
415
430
445
500
515
530
545

V. C. SUMMER ILRT
AIRMASS LBM X 1000



Appendix I

LOCAL LEAKAGE RATE TEST RESULTS

LLRT (TYPE B & C) TEST SUMMARY

1. TYPE B TEST

Pene #	Description	cc/min. As Left Leak Rate
107	Fuel Transfer Tube	0
201	L.R. System Blind Flanges (2)	0
210	L.R. System Blind Flanges (2)	0
211	L.R. System Blind Flanges (2)	0
212	L.R. System Blind Flanges (2)	0
216	L.R. System Blind Flanges (2)	0
327	SP Sys. Mini-Containment (valve enclosure)	0
328	SP Sys. Mini-Containment (valve enclosure)	0
329	RH Sys. Mini-Containment (valve enclosure)	0
425	RH Sys. Mini-Containment (valve enclosure)	0
501	PT 951	0
502	Elect. Pene.	0
503	Elect. Pene.	0
504	Elect. Pene.	0
505	Spare Pene.	
600	Elect. Pene.	0
601	Elect. Pene.	0
602	Elect. Pene.	0
603	Elect. Pene.	0
604	Elect. Pene.	0
605	Elect. Pene.	0
606	Elect. Pene.	0
607	Elect. Pene.	0
700	Elect. Pene.	0
701	Elect. Pene.	0
702	Elect. Pene.	0
703	PT 950	0
704	Elect. Pene.	0
705	Elect. Pene.	0
706	Elect. Pene.	0
707	Elect. Pene.	0
708	Elect. Pene.	0
709	Elect. Pene.	0
710	Elect. Pene.	0
711	Elect. Pene.	0
712	Elect. Pene.	0
713	Spare Pene.	
714	Elect. Pene.	0
715	Elect. Pene.	0
716	Elect. Pene.	0
717	Elect. Pene.	0
718	Elect. Pene.	

LLRT (TYPE B & C) TEST SUMMARY

1. TYPE B TEST

Pene #	Description	cc/min. As Left Leak Rate
719	Spare Pene.	
720	Elect. Pene.	0
721	Elect. Pene.	0
722	Elect. Pene.	0
723	Elect. Pene.	0
724	Spare Pene.	
725	Elect. Pene.	0
726	Elect. Pene.	0
727	Elect. Pene.	0
728	Elect. Pene.	0
800	Elect. Pene.	0
801	Spare Pene.	
802	Elect. Pene.	0
803	Elect. Pene.	0
804	Elect. Pene.	0
805	Elect. Pene.	0
806	Elect. Pene.	0
807	Spare Pene.	
808	Elect. Pene.	0
809	Elect. Pene.	0
810	Elect. Pene.	0
811	Spare Pene.	
812	Spare Pene.	
813	Elect. Pene.	0
814	Elect. Pene.	0
815	Elect. Pene.	0
	Personnel Air Lock	0
	Emergency Air Lock	370
	Equipment Hatch	80

LLRT (TYPE B & C) TEST SUMMARY

2. TYPE C TEST

Pene#	Description	cc/min. As Left Leak Rate
101	R.B. Purge Exhaust	1160
102	R.B. Cool Unit "B" Return	985
103	Post Acc. H_2 Purge Line	970
104	Spare	
105A	H_2 Analyzer Supply	2
105B	H_2 Analyzer Return	2
106	Spare	
108	Spare	
204	C.C.W. to Reactor Cool Pumps	245
208	To CRDM CLR 150L	76
209	From CRDM CLR 150L	32.8
214	Spare	
215	Spare	
217	PT 953	
218	Spare	
221	Seal Inj. to RCP-C	190
222	Hi.Hd. S.I. to RCS	30
223	Sample from RCS-C	140
226	RHR Suction from RCS-C	1080
227	Lo. Hd. S.I. to RCS	962
228	Spare Pene.	
229	Seal Inj. to RCP-B	242
230	Spare Pene.	
231	Demin. Water	3.5
232	Spare Pene.	
301A	H_2 Analyzer Supply	41.8
301B	H_2 Analyzer Return	1
302	Purge Press. Blower Suction	738
303	R.B. Spray Nozzles - Train "B"	350
304	S.W. to R.B. Cool Unit "A"	562
305	S.W. from R.B. Cool Unit "A"	0
307	Spare Pene.	
309	R.B. Hi Range Area Monitor Support	
310	R.B. Station Air	475
311	R.B. Instrument Air	85.8
312	CCW to RCP Bearings	1442
313	N_2 to F.W. Lines	510
314	Sample from RCS-B	168
315	Spare Pene.	
316	RHR Pump Suction RCS-A	395
317	Fill Line to Accumulator	311
318	RCS Letdown Heat Exchanger	700
319	R.B. Instrument Air Comp. Suction	144.3
320	N_2 to Accumulator	500
321	Accumulator Test Line	430
322	Lo. Hd. S.I. to RCS - Hot Legs	0

LLRT (TYPE B & C) TEST SUMMARY

2. TYPE C TEST

Pene#	Description	cc/min. As Left Leak Rate
323	Accumulator Sample	250
324	Breathing Air	167
325	Lo. Hd. S.I. to RCS - Hot Legs	620
327	Spray Pump "A" Suction From R.B. Sump	96.7
328	Spray Pump "B" Suction From R.B. Sump	1000
329	S.I. Pp. A Suction From R.B. Sump	300
330	CCW From RCP Bearings	1755
401	Supply to RB Spray Nozzle - Train "A"	97.5
402	R.B. Cooling Supply	1015
403	R.B. Cooling Unit B Supply	551
404	Fire Service Hose Reel Supply	4
405	Sample Line from Prez.	157
406A	Dead Weight Tester	0
407A	Radiation Monitor Supply	330
407B	Radiation Monitor Return	399
408	Seal Inj. to RCP-A	169
409	Charging to Regen. Heat XR	55
410	RCP Seal Water Return	350
412	Hi. Hd. S.I. to RCS	570
413	Spare Pene.	
414	Spare Pene.	
415	Hi. Hd. S.I. to RCS	377
416	Spare Pene.	
417D	Nuclear Sample	168
418	RCDT to Vent Hdr. & H_2	141
419	Refuel Cavity Dr. Line	24
420	Prez. Relief Tk.	1
421	Refuel Cavity Fill Line	404
422	PRT Makeup	745
423	RCDT	129
424	R.B. Sump Dr.	5.5
425	S.I. Pp "B" From R.B. Sump	421
426	Boron Inj. to RCS	100
427	Fire Service Deluge	298

The total local leakage rate for both Type B & C Tests is:

24123.9 cc/min
or .333 La

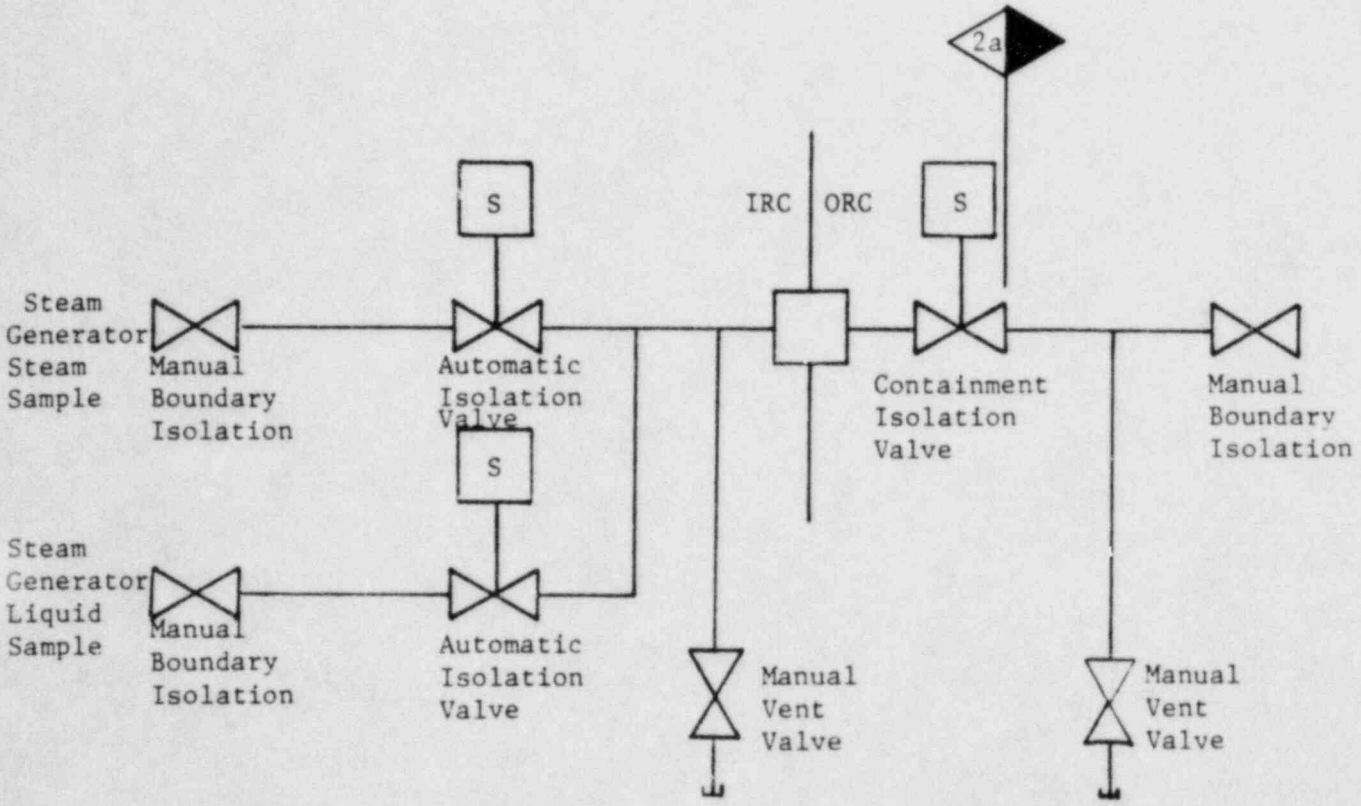
Appendix J

TYPICAL STEAM GENERATOR SAMPLE LINE DRAWING

APPENDIX J

STEAM GENERATOR SAMPLE

(Typical of all 3
penetrations: 220, 225, 411)



Appendix K

PRESSURIZED VESSEL LEAKAGE CALCULATION

Analysis of Pressurized Sources in Containment

Initial Conditions

Accumulator level (minimum or worst case) = 57% or 7416.12 gals.
Accumulator pressure (maximum or w.c.) = 555 lbs.

"A" Accumulator Temperature = 89.7
"B" Accumulator Temperature = 89.1
"C" Accumulator Temperature = 90.2
} Using appropriate ILRT temperature sensors

Accumulator Gas(N_2) Volume = 1450 ft.^{3} (Total) - (7416.12 gals.)(.1337 ft.^{3}/gal.)

or

458.46 ft.^{3} gas space per Accumulator

Minimum Leak to mask an actual failed test 0.15%/day - 0.1%/day = 0.05%/day
= .002083%/hr

Mass Leak/Hr = .002083%/hr x 566154.9 lbm. (Actual Mass)
= 11.79 lbm./hr

$\Delta P/hr$ per Accumulator assuming leak of 11.79 lbm./hr

Use R=55.2 for nitrogen

Accumulator

$$A\ \Delta P/hr = \frac{(\Delta M/hr.)\ RT}{Volume} = \frac{(11.79)(55.2)(460 + 89.7)}{458.46} = 780.33 \text{ psf/hr} = 5.42 \text{ psi/hr}$$

$$B\ \Delta P/hr = \frac{(11.79)(55.2)(460 + 89.1)}{458.46} = 779.48 \text{ psf/hr} = 5.41 \text{ psi/hr}$$

$$C\ \Delta P/hr = \frac{(11.79)(55.2)(460 + 90.2)}{458.46} = 781.04 \text{ psf/hr} = 5.42 \text{ psi/hr}$$

Accumulator pressures were observed for a period of 12 hrs. during the 24 hour test period with no change in pressure.

Worst case (min.) pressure change in any one accumulator:

5.41 psi/hr x 12hr = 64.92 psi

Worst case pressure change if all accumulators are leaking:

64.92 psi ÷ 3 = 21.64 psi

Indicators for Accumulator pressure are in 20 psi increments. A change of 21.64 psi is well within the range of detectable pressure change for accumulator pressure channels.

N_2 Reservoir for Pressurizer PORV (PCV-444B)

N_2 Reservoir Volume = 16 ft^3 N_2 Reservoir Pressure = 82.0 psi

N_2 Reservoir Temperature = 92.8 ^oF

$$\Delta P/hr = \frac{(\Delta M/hr)(R)(T)}{V} = \frac{(14.39)(55.2)(460 + 92.8)}{16} = 27444 \text{ psf/hr} = 190.58 \text{ psi/hr}$$

Since the reservoir pressure was only 82 psi, any significant leakage would have been detectable. Indicator scale for PI 8090 is in 10 psi increments.