DUKE POWER COMPANY
POWER BUILDING
422 SOUTH CHURCH STREET, CHARLOTTE, N. C. 28242

WILLIAM O. PARKER, JR.
VICE PRESIDENT
STEAM PRODUCTION

TELEPHONE: AREA 704
373-4083

October 6, 1977

RECEIVED
OCT 25 1977
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. J. P. O'Reilly, Director
U. S. Nuclear Regulatory Commission
Suite 1217
230 Peachtree Street, Northwest
Atlanta, Georgia 30303

RE: Oconee Unit 2
Docket No. 50-270

Dear Mr. O'Reilly:

Pursuant to the Oconee Nuclear Station Technical Specification 4.4.1.1.7, please find attached a report documenting the successful completion of the Oconee Unit 2 Reactor Building Integrated Leak Rate Report.

Very truly yours,

William O. Parker, Jr. By

William O. Parker, Jr.

RLG:ge

Attachment

cc: Mr. E. G. Case (40)

772980164

D U K E   P O W E R   C O M P A N Y

OCONEE NUCLEAR STATION

UNIT 2

INTEGRATED LEAK RATE TEST

OF THE

REACTOR CONTAINMENT BUILDING

Prepared By: Terrel E. Cribbe

Terrel E. Cribbe
Test Coordinator

Approved By: Graham Davenport

B.G. Davenport
Test Engineer

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1.0 INTRODUCTION

The periodic Integrated Leak Rate Test (ILRT) of the Oconee Nuclear Station Unit 2 Reactor Building was satisfactorily completed on August 1, 1977. The testing was conducted in accordance with the requirements of FSAR Section 5.6.2.1, Technical Specification 4.4, BN-TOP-1 (Bechtel Testing Criteria for ILR Testing), ANSI N45.4-1972 and 10 CFR Part 50, Appendix J. The absolute method of testing was employed with containment temperatures measured at 24 locations and containment dewpoint temperatures at two locations. Leakage was measured at half the design basis accident pressure of ∿ 29.5 psig. A measured induced leak was used to verify the results. Interpretation and final analysis of the test data, show results well within the specified limits for this containment, which has a maximum allowable leak rate of .176% per day. The leakage rate for Oconee Unit 2 Containment Building was found to be .0969% per day. The mean of the leakage rate over the 10 hour test period was .07499% per day.

2.0 SUMMARY AND CONCLUSIONS

2.1 Synopsis

The successful ILRT was performed in accordance with periodic test procedure PT/0/A/150/03 as approved for use on July 8, 1977. This procedure is similar to that used for the pre-operational ILRT.

Pressurization for the ILRT began at 0512 hours on 7/29/77 with both air compressors. Pressurization was stopped at 10 psig and the building was entered and inspected for indications of leakage. The only indication of leakage was around the gasket of the inner door of the personnel hatch. The outer door was shut per the procedure and the compressors were restarted. At approximately 2100 hours with the building pressure at 12 psig a leak was noted around the gasket of the outer door of the personnel hatch. Since the hatch pressure was only .1 psig it was decided to pressurize the hatch externally to see if the outer door would seat. At 2330 hours the hatch was pressurized and the outer door seated at 1.8 psig. The air supply to the hatch was secured and the RB pressurization continued. The compressors were secured at 0715 on 7/30/77 with the containment at approximately 30 psig. It was noted at that time that the personnel hatch was at the containment pressure (The hatch had equalized with the containment).

The 10 hour test period started at 1300 hours on 7/30/77. At 2315 hours on 7/30/77 inspection of data and calculations indicated that the test was satisfactory and data aquisition was terminated.

At 0220 hours on 7/31/77 a known leak note of approximately .177% was induced for purposes of verifying the capability to measure a leakage rate. This induced leak rate test gave favorable results. The personnel hatch was depressurized and it was noted that the inner door was not leaking at the full test pressure. Depressurization of the containment building was begun at 1135 on 7/31/77 and completed at 0500 on 8/1/77.

Instrumentation consisted of one (1) precision pressure sensor, twenty four (24) temperature sensors and two (2) dewpoint sensors which were used to measure containment atmospheric conditions during the ILRT.

The gasket on the inner door of the personnel hatch was repaired on 8/4/77. The hatch was locally tested on 8/8/77 with satisfactory results.

2.2 Test Organization

The Performance section at Oconee Nuclear Station had overall responsibility for this periodic ILRT. The testing activities were supervised by the test coordinator. See Figure 2.2-1 for organization chart. The test personnel were as follows:

A.	Test coordinator (and one alternate) Responsible for all ILRT Activities	- -	T. E. Cribbe H. V. Pham
B.	Data Engineers (one per shift) Responsible for Testing Activities on their assigned shifts	- - -	R. P. Rogers W. G. Newman R. R. Carpenter
C.	Data Takers (one per shift) Responsible for reading and recording all test data	- - -	J. H. Rowe W. M. Matthews D. J. Vito
D.	Computer Operators (one per shift)	- - -	T. E. Evans D. W. DeNard G. F. Long
E.	Operators (normal shift)		

2.3 Test Criteria

Pressure:	29.5 psig
Leak Rate:	.176% Limiting Condition for Operation .132% Test Acceptance
Temperature:	60^{o}-100^{o}
Volume:	1,910,000 cu. ft.

2.4 Test Results

As shown in the computer printouts and graphs in Section 4.2 of this report, the calculated leak rate, the mean of the calculated leak rates and the mean of the measured leak rates are all well below the allowable leakage rate limit. The leakage rate test results are tabulated below:

Test	Maximum Allowable Leak Rate (%/day)	Calculated Leak Rate	Upper Limit Of 95% Confidence Limit
29.5 psig	.176	.097%	.132

For reporting purposes, a leak rate of .097% shall be used for this test. This leak rate was obtained by using a least squares linear fit of the 15 min. leak rate data taken during the ILRT. These calculations are based on the total time method as described in ANSI N45.4-1972.

The verification test consisted of imposing a known leak rate on the containment at the end of the ILRT. Results from this supplemental test are acceptable provided the difference between the supplemental test data and the type A test data is within .25 L_t. A summary of the verification test data is given below.

29.5 psig ILRT	%/day
Leak Rate calc. during ILRT, L_{tm}	.097
Imposed verification leak rate, L_t	.177
Total	.274
Upper verification limit = .274 + .25 L_t	.318
Leak rate calc. during verification test	.278
Lower verification limit = .274 − .25L_t	.230

2.5 ERROR ANALYSIS

The leakage rate in weight percent per day is computed using the absolute method by the formula:

$$LR = \frac{2400}{H}\left[1 - \frac{To\ P}{T\ Po}\right] \qquad (1)$$

Where:

Po = Initial Reactor Building absolute pressure corrected for water vapor pressure.

P = Final Reactor Building absolute pressure corrected for water vapor pressure.

To = Initial Reactor Building mean absolute temperature.

T = Final Reactor Building mean absolute temperature.

H = Number of hours held at test pressure.

The change or uncertainty interval in LR due to uncertainties in the measured variables is given by:

$$\sigma LR = \left[\left(\frac{dLR}{dP}\cdot\sigma_P\right)^2 + \left(\frac{dLR}{dPO}\cdot\sigma_{Po}\right)^2 + \left(\frac{dLR}{dTo}\cdot\sigma_{To}\right)^2 + \left(\frac{dLR}{dT}\cdot\sigma_T\right)^2\right]^{\frac{1}{2}} \qquad (2)$$

Where σ is the standard error for each variable.

The error in LR after differentiating is:

$$eLR = \frac{2400}{H}\left[\left(\frac{-To}{TPo}\cdot e_P\right)^2 + \left(\frac{To\ P}{T\ Po^2}\cdot e_{Po}\right)^2 + \left(\frac{-P}{TPo}\cdot e_{To}\right)^2 + \left(\frac{To\ P}{T^2Po}\cdot e_T\right)^2\right]^{\frac{1}{2}} \qquad (3)$$

Where: $e_P = \sigma_P$ $\qquad e_{Po} = \sigma_{Po}$

$e_{To} = \sigma_{To}$ $\qquad e_T = \sigma_T$

The analysis technique, based on equation (3) above, was verified by K. Horoschek and E. Weipport in "Tigntness Investigations on Reactor Safety Pressure Vessels," Vol, 13, No. 3, March 1961.

For small values of LR:

$T \cong To$, $P \cong Po$ and

$e_P \doteq e_{Po}$, $e_T \doteq e_{To}$

Therefore, the equation then simplifies to:

$$eLR = \frac{2400}{H} \left[\left(\frac{-e_P}{P}\right)^2 + \left(\frac{e_P}{P}\right)^2 + \left(\frac{-e_T}{T}\right)^2 + \left(\frac{e_T}{T}\right)^2 \right]^{1/2}$$

or

$$eLR = \frac{2400}{H} \left[2\left(\frac{e_P}{P}\right)^2 + 2\left(\frac{e_T}{T}\right)^2 \right]^{1/2} \qquad (4)$$

Where e_P = error in pressure which accounts for the error in the absolute pressure measurement instrument (e_{PT}) and the water vapor measurement system (e_{Pv}) and where e_T = error in temperature.

$$e_P = \left[(e_{PT})^2 + (e_{Pv})^2 \right]^{1/2} \qquad (5)$$

e_{PT} = Absolute Pressure Instrument Accuracy Error

$$e_{Pv} = \frac{\text{Dew Point Sensor Accuracy Error}}{(\text{Number of Sensors})^{1/2}} \left(\frac{dP_v}{dT_D}\right)$$

$$e_T = \frac{\text{RTD Accuracy Error}}{(\text{Number of RTD's})^{1/2}}$$

To develop a numerical value for e_{LR} it will be assumed that:

H = 10 hours
RB mean absolute pressure = 29.5 psig
RB mean absolute temperature = 529.7°R (70°F)

RB mean dewpoint temperature = 68°F

Substituting the instrument accuracy values given in Section 3.2.1 into the above equations yields:

e_{PT} = ±0.0005 percent full scale *

*Value of full scale repeatability used. This number is more significant for the error analysis than the absolute accuracy.

$$e_{Pv} = \pm \frac{0.5^\circ F}{\sqrt{2}} = \pm 0.353^\circ F$$

From the ASME Steam Tables at 68°F:

e_{Pv} = 0.00414 psi

$$e_P = \sqrt{(0.0005\ psi)^2 + (0.00414\ psi)^2}$$

$$e_P = \pm\ 0.00417\ psi$$

$$e_T = \pm\ \frac{0.07°F}{(24)^{1/2}}\ *$$

* Value of full scale repeatability used. This number is more significant for the error analysis than the absolute accuracy.

$$e_T = \pm\ 0.0143$$

Substitution into equation (4) yields:

$$eLR = \pm \left[2 \left(\frac{0.00417}{44.645} \right)^2 + 2 \left(\frac{0.0143}{530.00} \right)^2 \right]^{1/2} \quad \frac{2400}{10}$$

$$= \pm\ 0.0330\%\ \text{per day}$$

REACTOR BUILDING INTEGRATED
LEAK RATE TEST ORGANIZATION

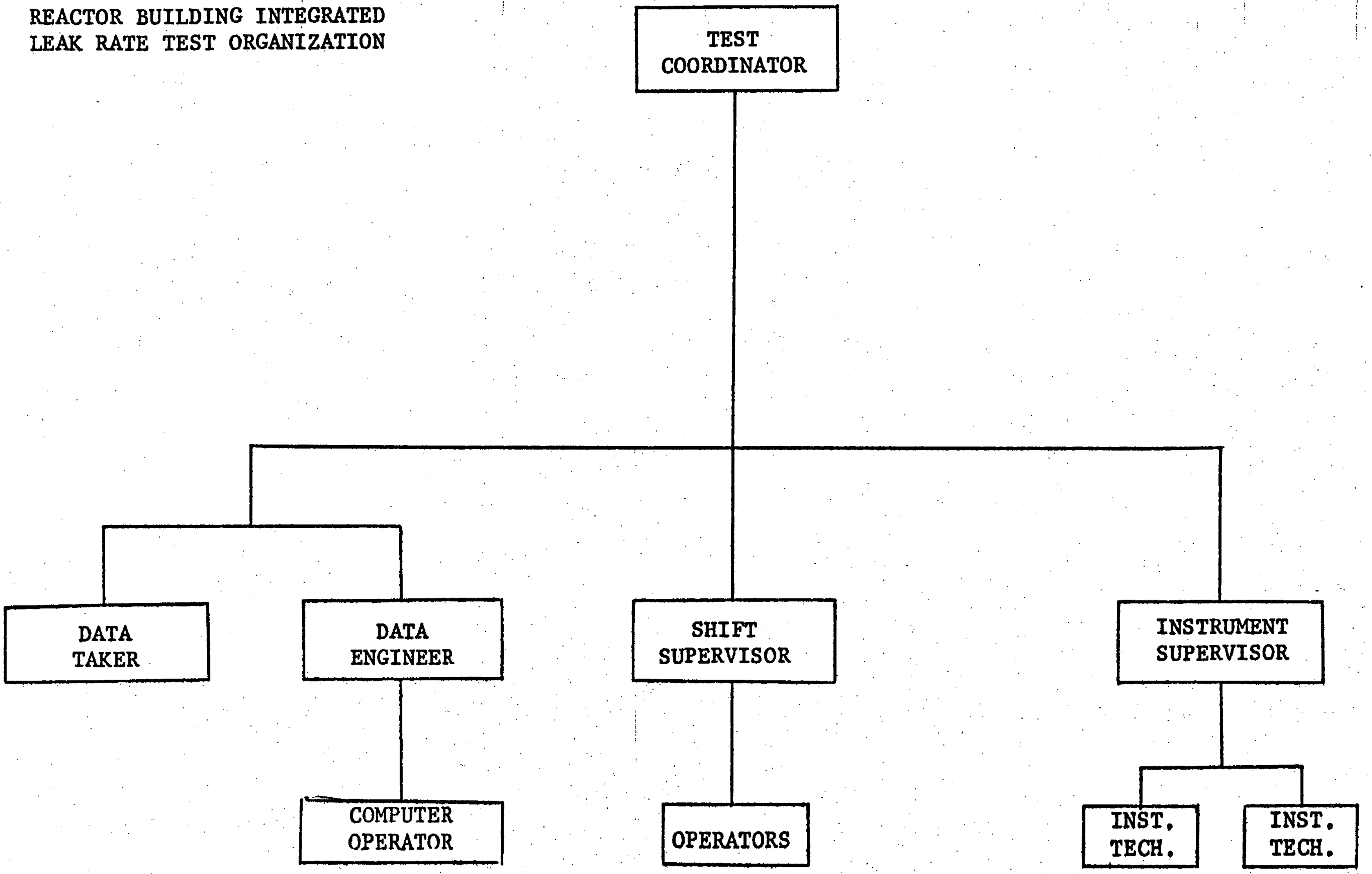


Figure 2.2-1

3.0 DESIGN INFORMATION

3.1 REACTOR BUILDING

The reactor building is a reinforced and post-tensioned concrete structure designed to contain any accidental release of radioactivity from the reactor coolant system as defined in the Final Safety Analysis Report (Reference 1).

The structure consists of a post-tensioned reinforced concrete cylinder and dome connected to and supported by a massive reinforced concrete foundation slab as shown in Figure 3.1-1. The entire interior surface of the structure is lined with a 1/4 inch thick welded ASTM A36 steel plate to assure a high degree of leak tightness. Numerous mechanical and electrical systems penetrate the reactor building wall through welded steel penetrations.

Principal dimensions are as follows:

Inside Diameter	116 ft.
Inside Height (Including Dome)	208-1/2 ft.
Vertical Wall Thickness	3-3/4 ft.
Dome Thickness	3-1/4 ft.
Foundation Slab Thickness	8-1/2 ft.
Liner Plate Thickness	1/4 inch
Internal Free Volume	1,910,000 Cu. ft.

3.2 MEASUREMENT SYSTEMS

Instrumentation used for the Oconee Unit 2 ILRT is similar to that used on previous tests conducted by Bechtel. The leak rate test measurement system is shown schematically in Figure 3.2-1.

Reactor Building pressure was measured by a Texas Instrument precision pressure gage. The unit was factory calibrated before the test.

Reactor Building temperature was measured by twenty-four (24) calibrated RTD's and read on a Leeds and Northrup Numatron digital readout device. Each RTD was assumed to be representative of a fraction of the total containment volume. In addition to the twenty-four (24) RTD's used for the calculation of Reactor Building temperature, four (4) additional RTD's were used to measure the liner plate temperature.

Reactor Building dewpoint temperature was measured by two (2) Cambridge Dewpoint Hygrometers.
Air samples for the two (2) dewpoint sensors came from two (2) of the auxiliary fans which continually circulated air in the Reactor Building during the leak rate test. The relative location of the humidity sensors is shown in Figure 3.4-1. A 0-10.45 scfm Brooks rotometer was used in establishing a known leak rate.

3.2.1 INSTRUMENT LIST

Specifications for the instrumentation used for the Oconee Unit 2 ILRT are listed in Table 3.2-1.

3.2.2 TEMPERATURE SENSOR LOCATIONS

The locations of temperature sensors within the Reactor Building are shown in Figures 3.2-2 through 3.2-6.

3.2.3 RTD AND DEWPOINT VOLUME FRACTIONS

Volume fractions were used for calculating the average temperature and the average dewpoint temperature in the containment. These fractions were determined using an equivalent volume for each sensor. The free volume of the containment was divided into "cells" with a sensor center in each. Volume fractions are given in Table 3.2-2

3.3 PRESSURIZATION SYSTEM

Reactor Building pressurization was accomplished by two (2) electric motor driven air compressors operating in parallel. These compressors, purchased for pressurization of the Oconee Reactor Building, also include aftercoolers as integral equipment. The discharge from the compressors passes through a single air dryer which reduces the moisture content in the air prior to its entry into the Reactor Building. The specifications for these components are as follows:

A. Two (2) electric driven Joy Turbo-Air (20V2) centrifigual type air compressors with a capacity of 2300 scfm @ 80 psig.

B. Two (2) Basco size 22048 aftercoolers (Integral to Compressors), type "ES" Fixed Tubesheet, with a capacity of 2100 scfm @ 14.4 psia and with a design pressure of 150 psig.

C. One (1) Hankison (Model H-15) refrigerator type air dryer with inertial impingement separator, and a capacity of 3750 scfm (100^{o}F Sat. inlet) @ 100 psig.

Three valves, 3LRT-15, 3LRT-16, and 3LRT-17 are used to control pressurization and depressurization of the Reactor Building. The controls for these valves are located in the test panel. The pressurization system is shown schematically in Figure 3.3-1.

3.4 RECIRCULATION SYSTEM

The Reactor Building Air Recirculation System consists of four (4) auxiliary fans and three (3) Reactor Building cooling fans. The auxiliary fans take suction through ducts in the upper region of the Reactor Building and circulate it downward. The Reactor Building cooling fans take air from midheight in the Reactor Building and exhaust it through duct work down to the lower levels of the Reactor Building. This is shown schematically in Figure 3.4-1.

3.5 COMPUTER PROGRAMS

All calculations, summaries, and reports were performed using the Duke Power Company ILRT computer program.

3.5.1 DUKE COMPUTER PROGRAM

The Integrated Leak Rate Program calculates the leak rate for a nuclear reactor containment vessel. The program computes the leak rate at a given time from input values of pressure, temperature and vapor pressure. The leak rate, as a function of time, is determined by elementary linear least-square methods.

The Integrated Leak Rate Program is designed to allow the user to evaluate containment leak rate test results at the jobsite during containment leak rate testing. Interim leak rate test reports may be obtained at any time during the testing period. Each interim report consists of two printouts. The first printout, called the total-time computation, uses the initial and latest input data to compute leak rate. Each computed leak rate is statistically averaged using a linear least-squares fit. Early in the test this method of computation gives indication as to whether or not the leak rate is acceptable.

A second printout, called the point-to-point computation, is also provided. The point-to-point method uses the data at a given hour and the data from the previous reading to compute leak rate. Each individually computed leak rate is then statistically averaged using a linear least-squares fit.

The results of the two methods used indicate that either method is a satisfactory method for computing containment integrated leak rates. Both methods of computing the containment leak rate are presented in ANSI N45.4-1972. However, the total-time method is recommended by Appendix J to 10 CFR 50.

3.5.1.1 Explanation of Program

3.5.1.1.1 Purpose

(a) Process raw data for use in leak rate calculation.
(b) Calculate leak rate on a point-to-point or total time basis.
(c) Calculate a statistical point-to-point or total time leak rate by a linear least squares fit of the data.
(d) Output data.

3.5.1.1.2 Process Raw Data

(a) Temperature

(a.1) Unit - ^oF.
(a.2) Number - 28 (Includes 4 on liner plate).
(a.3) Input to computer will be in ^oF. The computer will apply necessary calibration corrections to the temperature.
(a.4) Each temperature (28) will be weighted by a volume fraction. The calculation for the average building temperature is:

$$T = \Sigma T_n \cdot V_n$$

Where: T = Average Building Temperature, ^{o}F
T_n = Temperature at each point, n + 1-28, ^{o}F
V_n = Volume fraction for each point. The volume represented divided by the total volume. Volume fractions must add to 1.

The Average Temperature must be converted to ^{o}R by adding 459.7.

(a.5) The temperature on the liner plate will be available for output.

(b) Pressure

(b.1) Unit - psia.
(b.2) Number - 1.
(b.3) Input is in psia. The computer will apply necessary calibration correction to the pressure.
(b.4) The pressure will be weighted by a volume fraction. The calculation for the average building pressure is:

$$P = W_1 P_t$$

Where: P = Average Building Pressure, psia
P_t = Pressure by Texas instrument, psia
W_1 = Volume fraction (must equal 1)

(c) Barometer

(c.1) Unit - Inches of Hg @ $32^{o}F$.
(c.2) Number - 1.
(c.3) Input is not used by calculations, but will be available for output.

(d) Dewpoint Temperature

(d.1) Unit - ^{o}F.
(d.2) Number - 2.
(d.3) Input to computer will be in ^{o}F. A calibration curve will be as-
sociated with each sensor and the input will be corrected.
(d.4) Each Dewpoint Temperature is weighted by a volume fraction. The calculation for the average is:

$$T_v = W_3 T_{v1} + W_4 T_{v2}$$

Where: T_v = Dewpoint Temperature, ^{o}F
T_{v1} = First Sensor Dewpoint Temperature, ^{o}F
T_{v2} = Second Sensor Dewpoint Temperature, ^{o}F
W = Volume Fraction ($W_3 + W_4 = 1$)

(d.5) From the Dewpoint Temperature (Saturation Temperature) the Vapor
Pressure (Saturation Pressure) is determined from the steam tables.
The range required is 40 to $120^{o}F$ from the steam tables.

$$P_v = f\ (T_v)$$

3.5.1.1.3 Leak Rate Calculations

(a) Leak Rate on Hourly Basis

Leak rate will be calculated on a point-to-point basis from data obtained at the previous point readings (data subscript 1) and data obtained at the present point readings (data subscript 2).

(a.1) Absolute Method

$$La = \frac{2400}{\Delta t}\left[1 - \frac{T1\ (P_2 - P_{v2})}{T_2\ (P_1 - P_{v1})}\right]$$

Where in (a.1) above

L = Percent leak rate per hour (La or Lx)
T1 = Average absolute temperature of Reactor Building air at start of each test period, °F
T2 = Average absolute temperature of Reactor Building air at end of each test period, °F
P1 = Absolute pressure of Reactor Building at start of each test period, psia
P2 = Absolute pressure of Reactor Building at end of each test period, psia
Pv1 = Vapor pressure of Reactor Building at start of each test period, psia
Pv2 = Vapor Pressure of Reactor Building at end of each test period, psia
Δt = Time interval between start and end of test period, hours

(b) Statistical Point-to-Point Leak Rate

Linear least square fitting is used to calculate a statistical point-to-point leak rate for the Absolute Method.

$Li = a + bti$

Where: $$a = \frac{\Sigma \ell i\ \Sigma(ti^2) - \Sigma ti\ \Sigma \ell iti}{N\ \Sigma(ti^2) - (\Sigma ti)^2}$$

$$b = \frac{N\Sigma \ell iti - \Sigma \ell i\ \Sigma ti}{N\Sigma\ (ti^2) - (\Sigma\ ti)^2}$$

Li = Statistical leak rate
ℓi = Calculated leak rate
ti = Time between data sets
N = Number of points to be fit (number of data sets)

(c) Leak Rate From Initial Data Set

Leak rate from the initial data set to each successive data set is calculated by the following equation:

(c.1) Absolute Method

$$Laa = \frac{2400}{TI} \left[1 - \frac{Ti\ (Pt - Pvt)}{Tt\ (Pi - Pvi)}\right]$$

Where:

i = Indicates data from initial set
t = Indicates data from each successive set
TI = Time from initial data set

(d) Statistical Leak Rate From Initial Data Set

The leak rate is calculated by a linear least squares fit over a period from the initial data set to each successive data set.

(d.1) The equations are the same as in 3.5.2.1.3(b).
(d.2) The data used is obtained from 3.5.2.1.3(c).

(e) 95 Percent Confidence Limits

$CLi = Li \pm T\ \sigma i$

Where:

CLi = Confidence limits at time ti
Li = Statistical leak rate at time ti
σi = Standard deviation
T = Tabulated constant

$$T = 1.95996 + \frac{2.37226}{(N-2)} + \frac{2.8225}{(N-2)^2}$$

Where: N = Number of data points

$$\sigma i = \left[\text{Variance} \left[1 + \frac{1}{N} + \frac{(to - \bar{t})^2}{\Sigma(ti-\bar{t})^2}\right]\right]^{1/2}$$

Where: $to = 0$
$\bar{t} = \frac{1}{N} \Sigma\ ti$

$$\text{Variance} = \left[\Sigma(\ell i - a - bti)^2\right] \div [N-2]$$

INSTRUMENT SPECIFICATIONS

Pressure Digital Readout

Serial No.	10132 2646
Mfg.	Texas Instrument
Model	145
Type	Precision pressure gage
Range	0-100 psia or 100,000 counts full scale
Stability	± .001 psi
Repeatability	± .0005 psi
Resolution	± .001 psi
Accuracy	± .015% of reading

Pressure Gauge

Mfg.	Heise
Range	0-100 psig
Accuracy	0.1 psi
Repeatability	0.1 psi

Temperature Elements

Mfg.	Leeds & Northrup
Model	8197
Type	RTD, Copper, 100 ohms
Range	0-150°F
Repeatability and hysterisis	± .02°F
Accuracy	± 0.12°F

Temperature Indications for Temperature Elements

Mfg.	Leeds & Northrup
Model	245 Numatron
Range	0-150°F
Reproductivity	± .07°F from 60°F to 120°F
Accuracy	± .12 from 60°F to 120°F and ± .48 Below 60°F

Dewpoint Temperature

Mfg.	Cambridge
Model	992-C1
Range	-100°F to +200°F
Accuracy	± 0.5°F
Serial No.	332 and 333

Table 3.2-1

Flow Indicator

Mfg.	Brooks
Type	Rotometer
Model	1110-24
Range	0 to 10.45 scfm
Accuracy	$\pm$ 1% of instantaneous reading
Repeatability	Better than 1/4% of instrument reading
Serial No.	7004-39848

Table 3.2-1 (Cont'd)

VOLUME FRACTIONS

Volume Fractions for RTD's

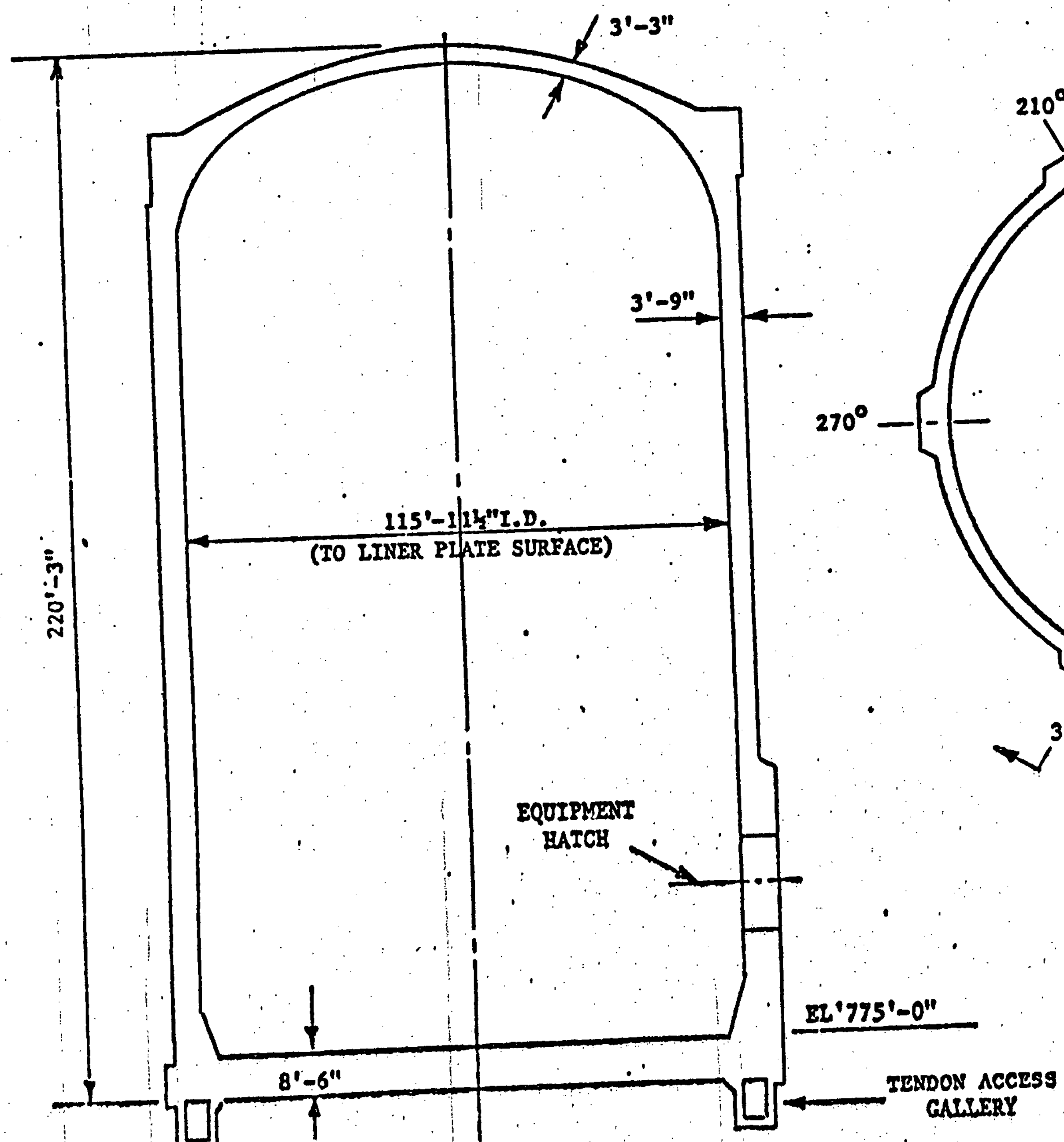
RTD #	Volume Fraction
1	.03
2	.02
3	.02
4	.05
5	.02
6	.03
7	.01
8	.08
9	.05
10	.05
11	.02
12	.02
13	.01
14	.02
15	.02
16	.01
17	.05
18	.09
19	.11
20	.01
21	.01
22	.09
23	.11
24	.07
	Total 1.00

Dew Point Sensors Volume Fraction

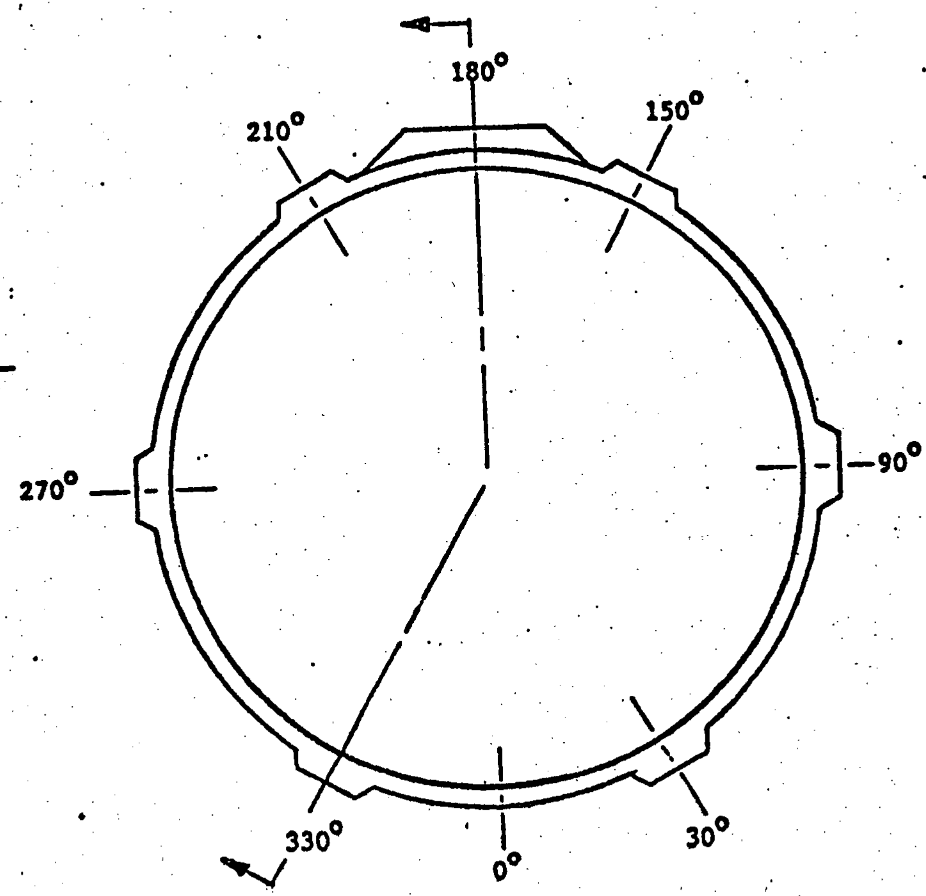
Dew Point Sensor #	Volume Fraction
1 (Azimuth 100° Elevation 850')	0.4
2 (Azimuth 260° Elevation 850')	0.6
	Total 1.0

Table 3.2-2

REACTOR BUILDING



SECTION A-A



HORIZONTAL SECTION THROUGH
REACTOR BUILDING

Figure 3.1-1

LEAK RATE MEASUREMENT SYSTEM

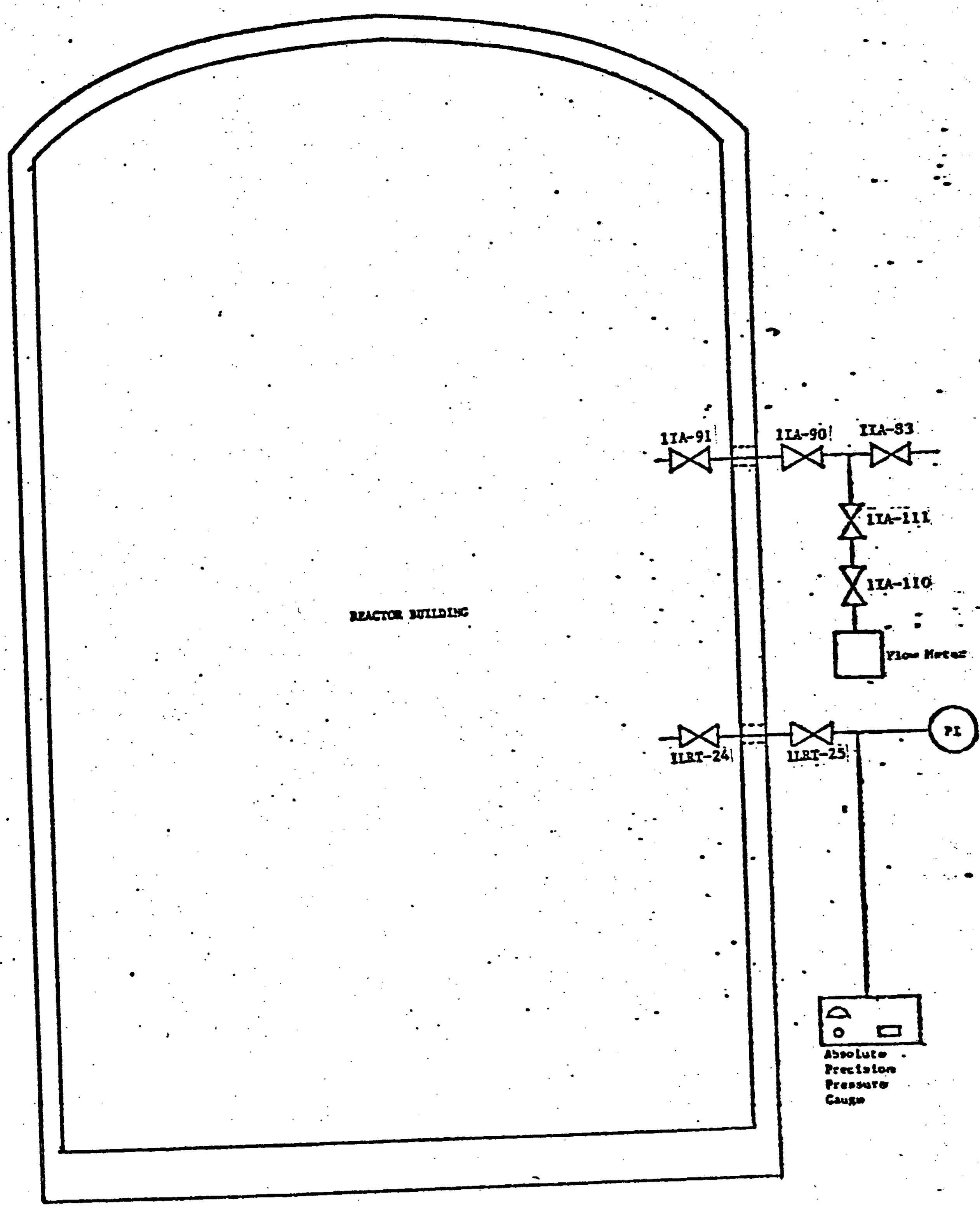


Figure 3.2-1

REACTOR BUILDING

BASEMENT FLOOR

ELEVATION 787'

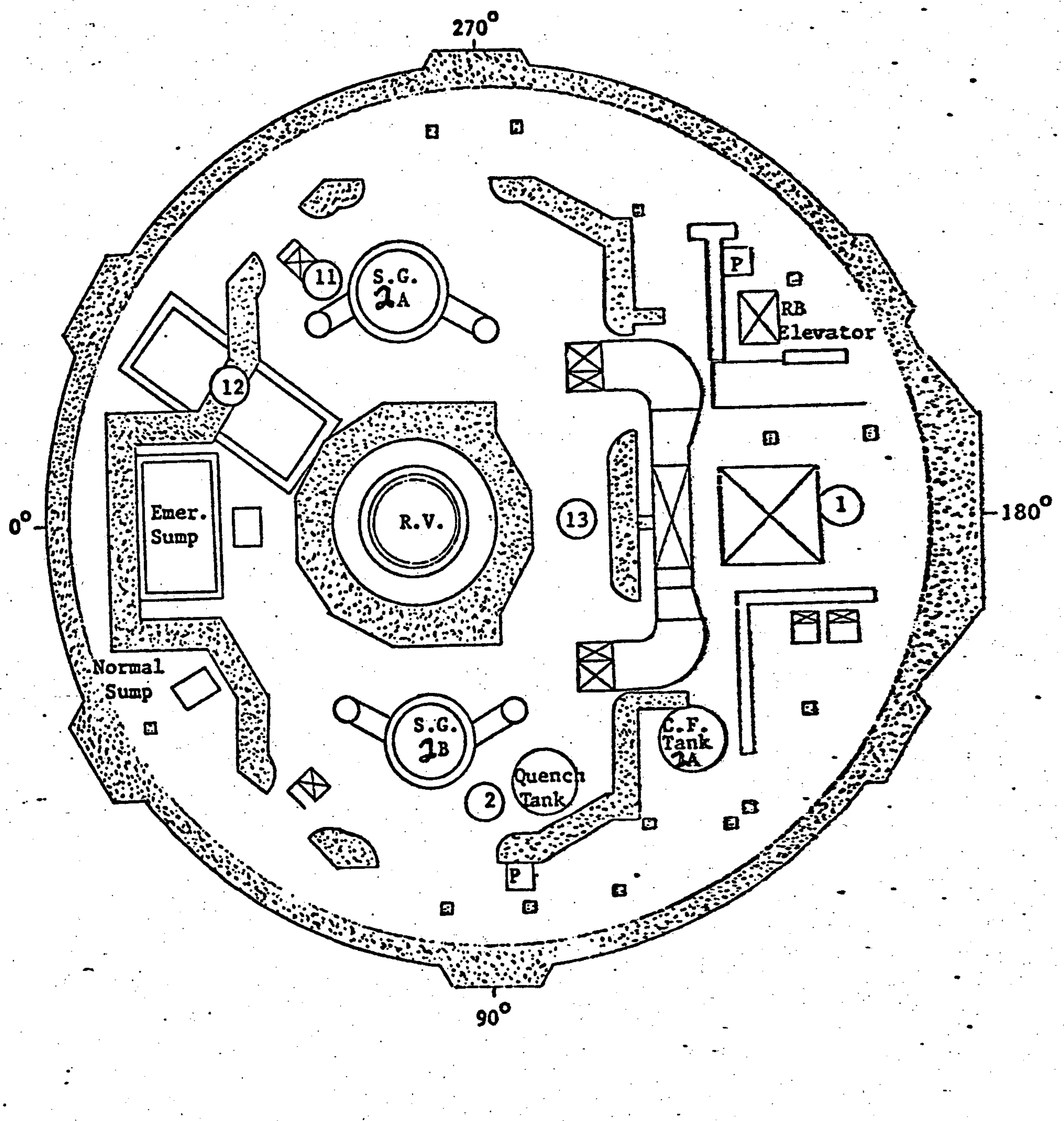


Figure 3.2-2

REACTOR BUILDING

INTERMEDIATE FLOOR

ELEVATION 830'

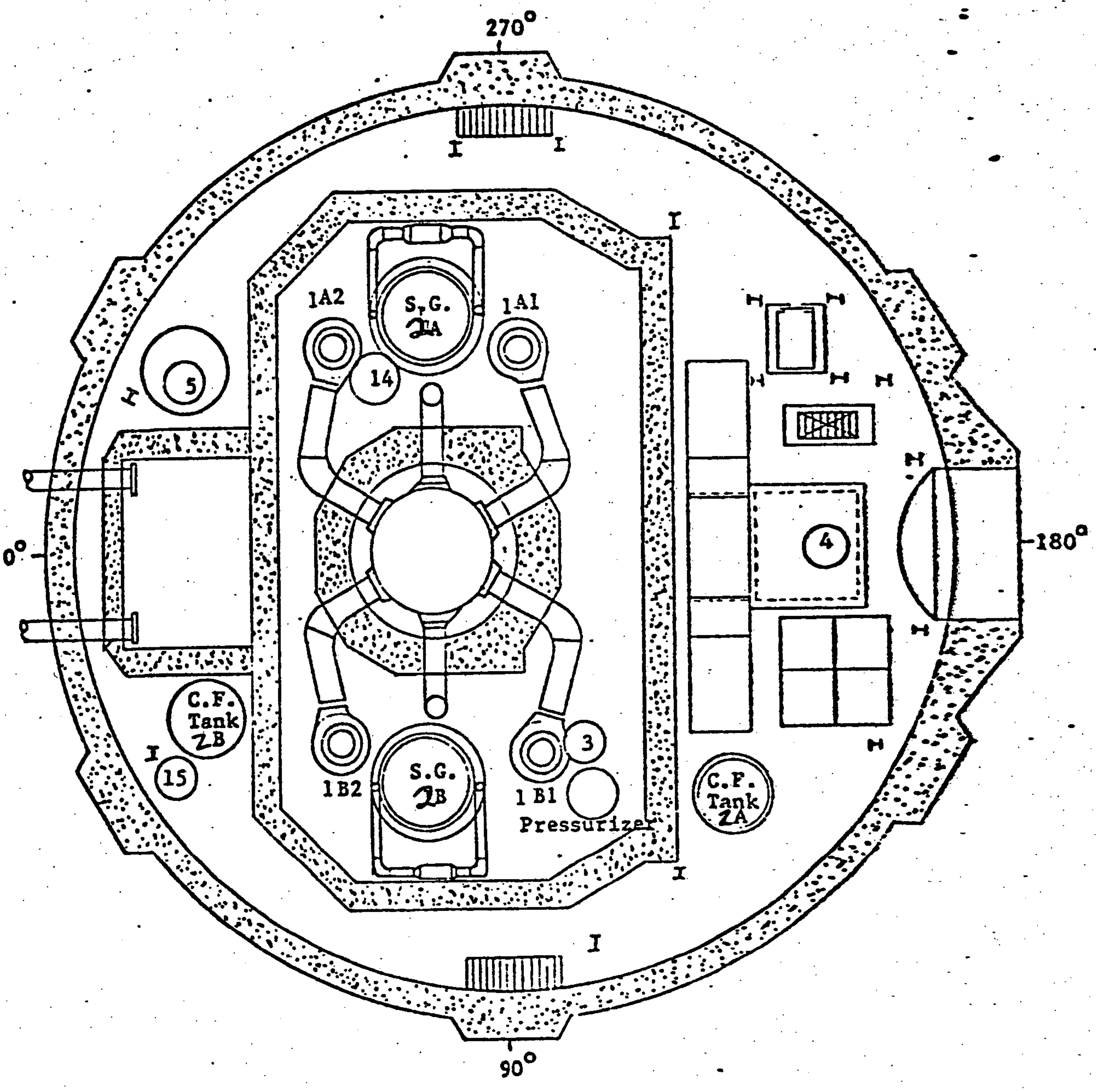


Figure 3.2-3

REACTOR BUILDING
OPERATING FLOOR
ELEVATION 850'

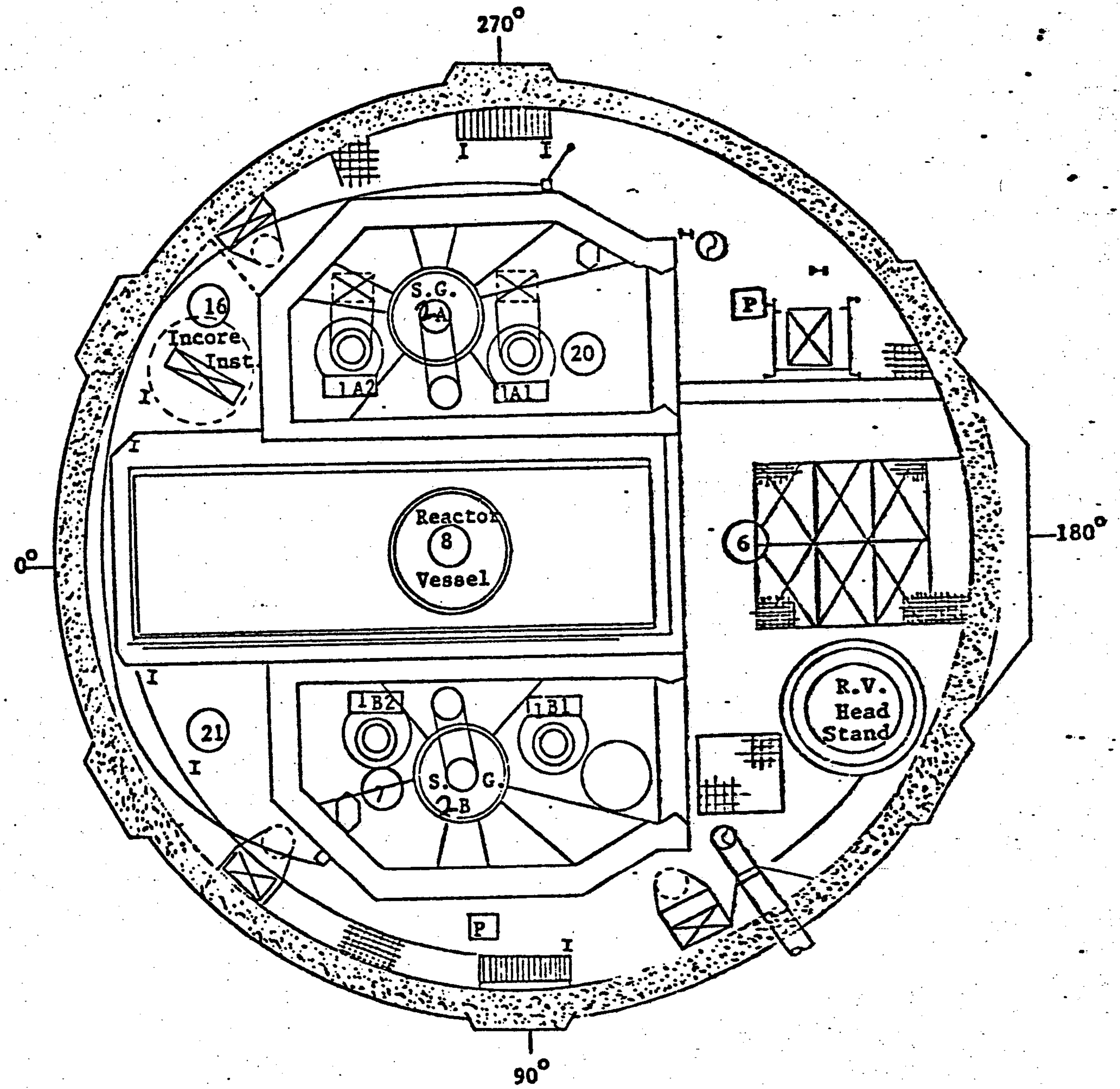


Figure 3.2-4

REACTOR BUILDING

SHIELDING FLOOR

ELEVATION 866'

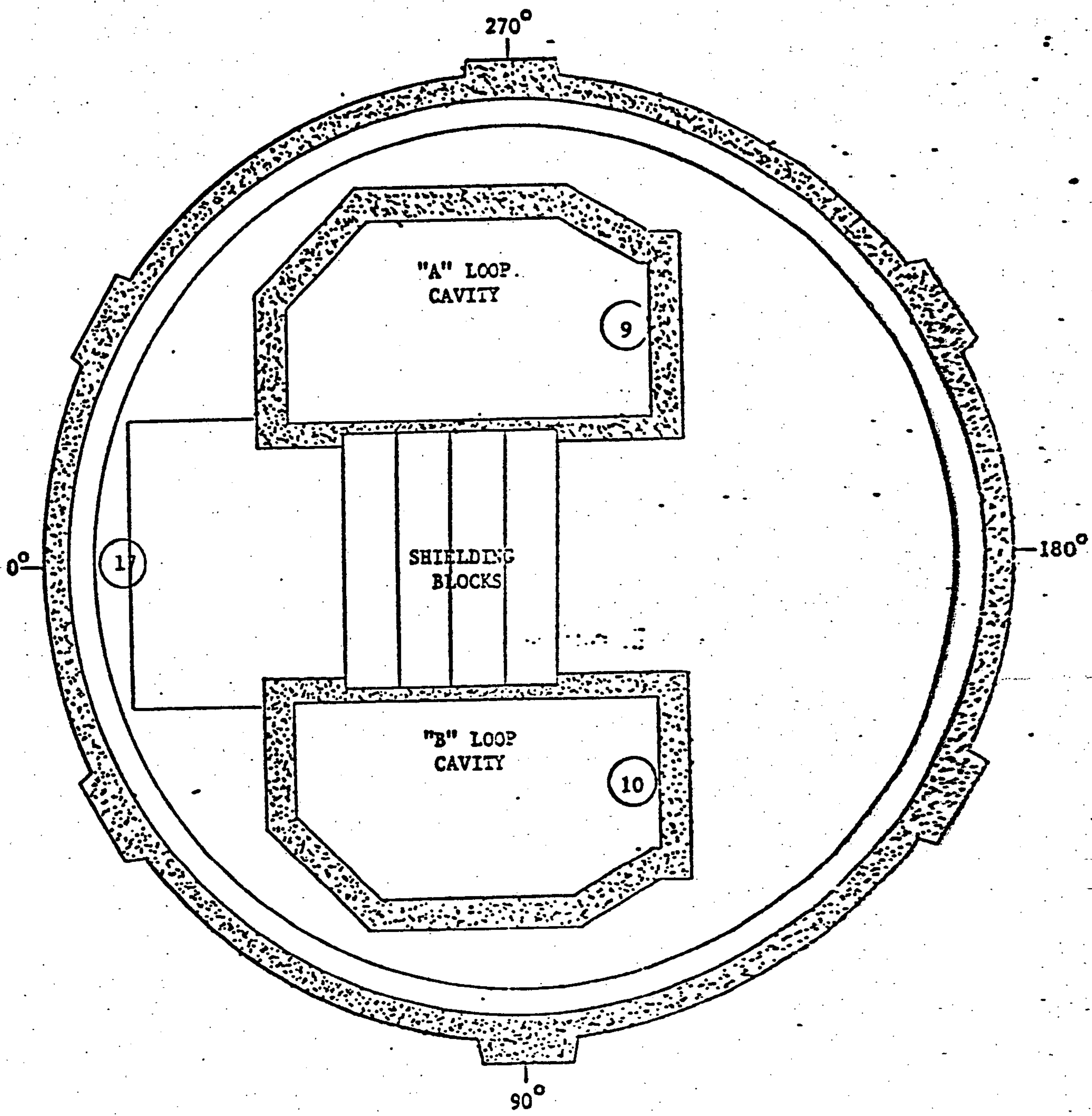
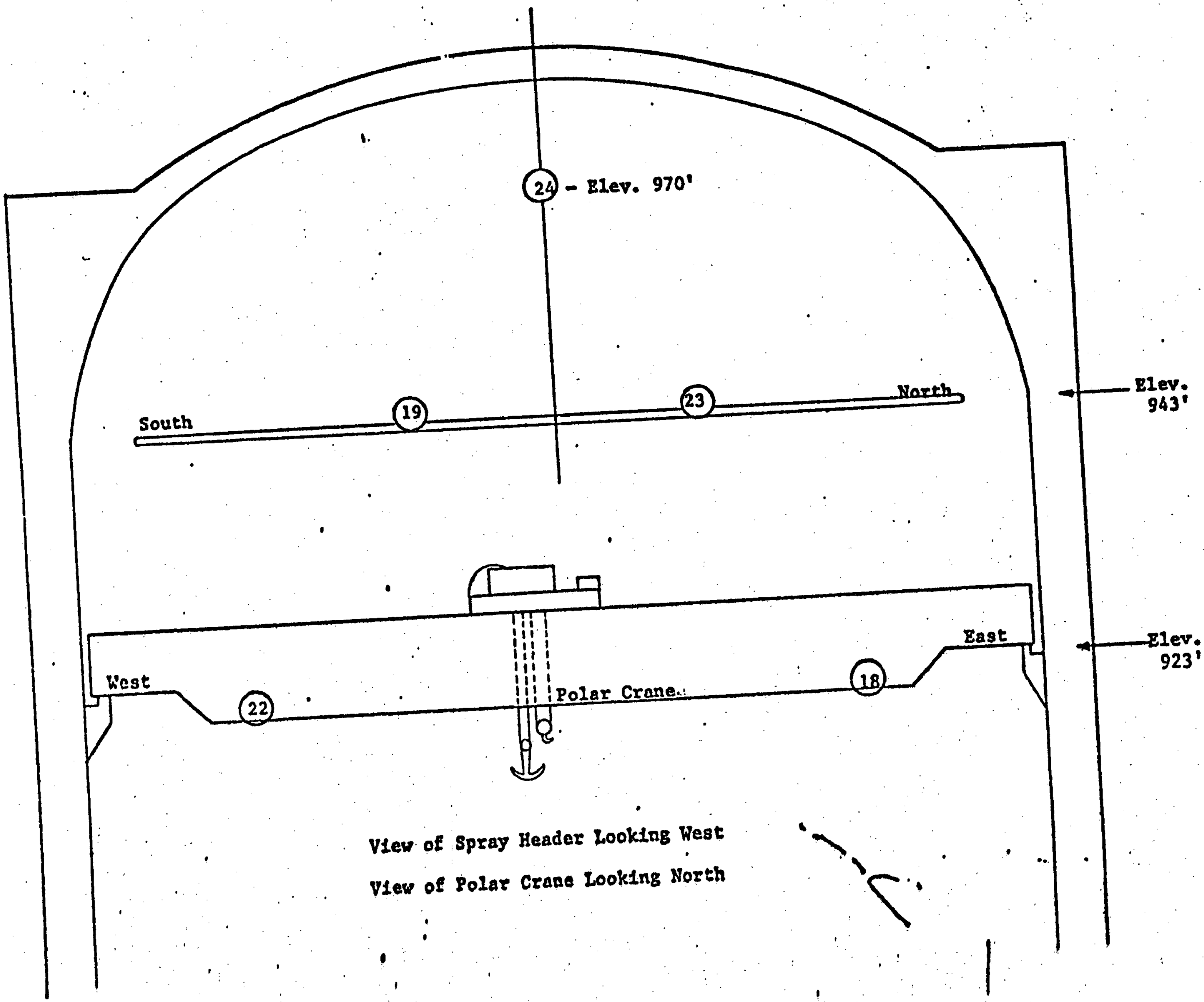


Figure 3.2-5



View of Spray Header Looking West

View of Polar Crane Looking North

Figure 3.2-6

REACTOR BUILDING PRESSURIZATION SYSTEM

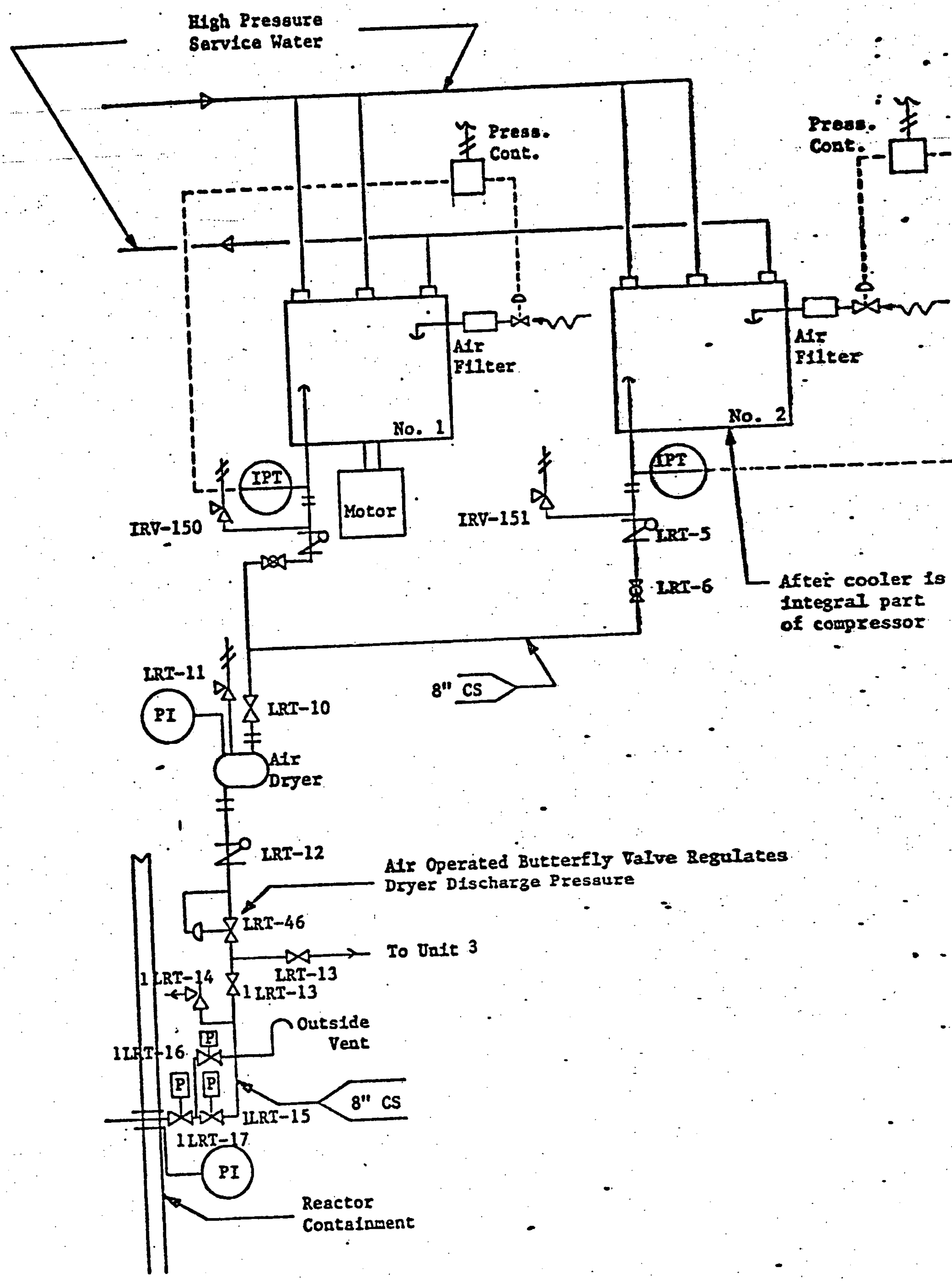


Figure 3.3-1

REACTOR BUILDING AIR RECIRCULATION SYSTEM

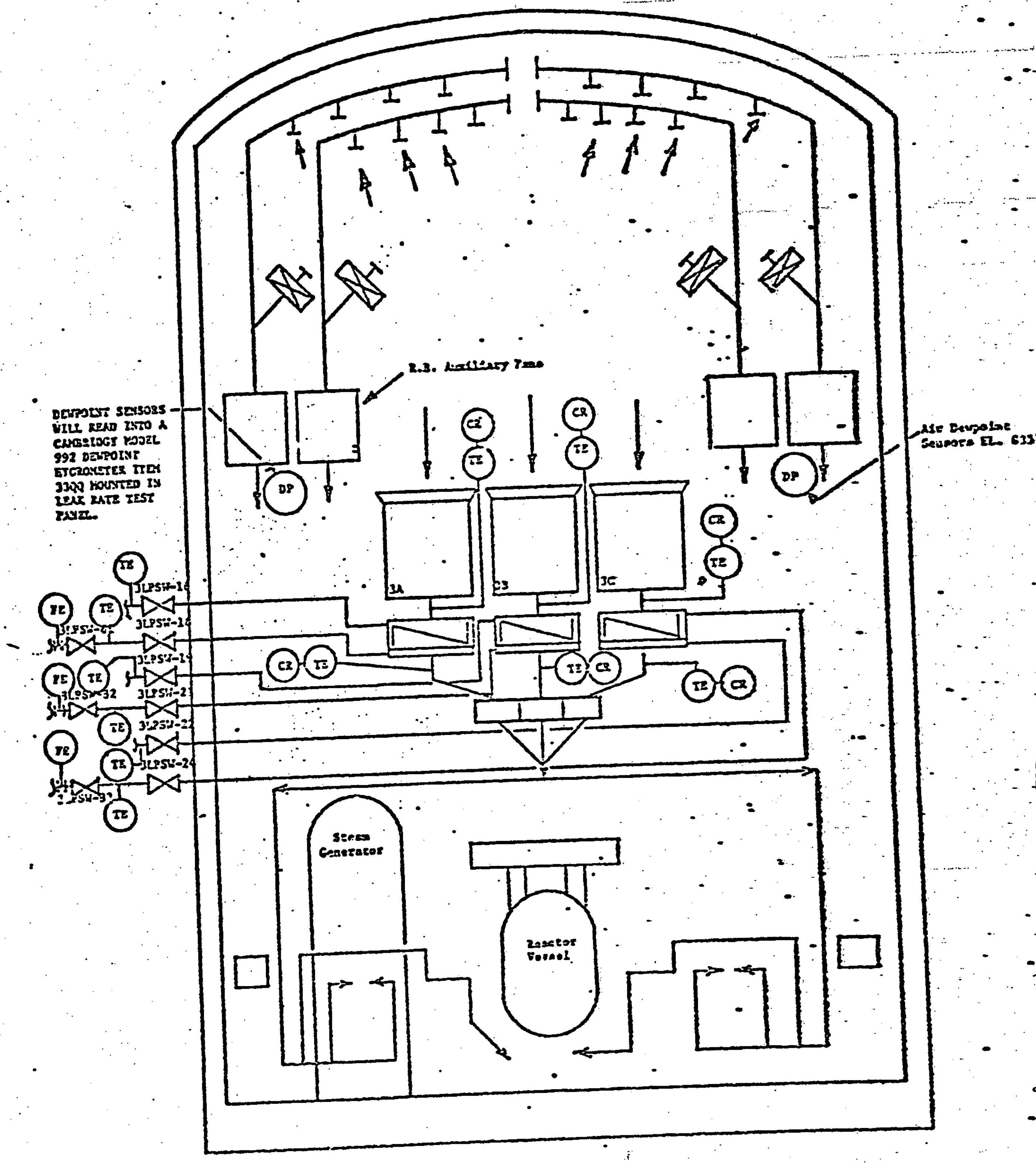


Figure 3.4-1

4.0 CONDUCT OF TEST PROGRAM

4.1 LOCAL LEAK RATE TEST

The purpose of the Local Leak testing program was to systematically check the integrity of valves (seats and packing), flanges, pipe and electrical penetration welds, seals and compression fittings that are part of the boundaries of the containment system. These tests, specified by section 4.4.1.2 of the Technical Specifications, have a combined Acceptance Criteria of less than or equal to 0.125% of the reactor building atmosphere per 24 hours. Final analysis of all penetration leakage rates shows that the total penetration leakage rate was approximately 14 percent of the allowable.

4.1.1 TEST METHOD

All electrical and mechanical penetration, including locks and hatches, were tested by pressurizing to ∿ 59 psig. The pressure, temperature and barometric pressure were recorded before and after the leak test (duration of test determined by penetration volume) and the leak rate determined by the mass difference method.

4.1.2 PENETRATION TEST RESULTS

Per Technical Specification 4.4.1.2.3, the total leakage from all penetrations and isolation valves shall not exceed .125% of the Reactor Building atmosphere in 24 hours. The total measured leak rate from all penetrations prior to this test was .018% per 24 hours. Results of all local penetration tests done since the last type A test are given in tables 4.1-1 through 4.1-2

4.2 COMPUTER CALCULATIONS AND RESULTS

4.2.1 29.5 psig ILRT

The curves for the 29.5 psig ILRT are shown in Figure 4.2-1 through 4.2-4. Supporting summary data is given in Table 4.2-1.

4.2.2 29.5 psig Verification Test

The curves for the 29.5 psig verification test are shown in Figure 4.2-5 through 4.2-8. Supporting summary data is given in Table 4.2-2.

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OCONEE NUCLEAR STATION
INTEGRATED LEAKRATE TEST

07/30/77

29.5 PSIG ILRT

TREND REPORT (FROM INIT CALCU / ABS)

DATA SET	TIME	PRESSURE (PSIA)	TEMPERATURE (F)	ABS LR MEASURED %/DAY	ABS LR CALCULATED %/DAY	95 % CONFIDENCE LIMITS LOWER	UPPER
2	1:15P	44.1930	84.9605	-0.06971	*	0.00000	0.00000
3	1:30P	44.1920	84.9467	-0.15499	-0.15499	*	*
4	1:45P	44.1880	84.9239	0.05551	0.09621	-0.69440	0.89541
5	2:00P	44.1860	84.9084	0.04720	0.05369	-0.18586	0.28026
6	2:15P	44.1830	84.8862	0.09126	0.09868	-0.04416	0.22567
7	2:30P	44.1810	84.8859	0.05268	0.09954	-0.07526	0.19062
8	2:45P	44.1800	84.8706	0.03801	0.09152	-0.09399	0.17991
9	3:00P	44.1770	84.8563	0.08414	0.10457	-0.02394	0.17822
10	3:15P	44.1750	84.8372	0.08636	0.11308	-0.01777	0.17049
11	3:30P	44.1750	84.8291	0.02028	0.09534	-0.07893	0.13950
12	3:45P	44.1700	84.8203	0.09140	0.10473	-0.01446	0.19727
13	4:00P	44.1700	84.8084	0.05441	0.10028	-0.04990	0.15873
14	4:15P	44.1660	84.7983	0.05488	0.09667	-0.04820	0.15795
15	4:30P	44.1630	84.7997	0.09980	0.10515	0.00359	0.17502
16	4:45P	44.1600	84.7888	0.09129	0.10947	0.00204	0.18054
17	5:00P	44.1590	84.7730	0.08189	0.11053	-0.00672	0.17051
18	5:15P	44.1580	84.7644	0.08108	0.11100	-0.00700	0.16915
19	5:30P	44.1540	84.7623	0.09597	0.11425	0.01487	0.17707
20	5:45P	44.1520	84.7332	0.09703	0.11503	0.00631	0.14775
21	6:00P	44.1500	84.7289	0.10087	0.11810	0.02349	0.19125

Table 4.2-1

22	6:15P	44.1490	84.7183	0.07088	0.11523	-0.03920	0.15036
23	6:30P	44.1470	84.7256	0.10945	0.11923	0.03559	0.18231
24	6:45P	44.1460	84.7244	0.10418	0.12168	0.03154	0.17682
25	7:00P	44.1450	84.7197	0.09677	0.12252	0.02433	0.15921
26	7:15P	44.1430	84.6887	0.08307	0.12110	0.01081	0.15533
27	7:30P	44.1420	84.6894	0.08074	0.11943	0.00864	0.15283
28	7:45P	44.1410	84.6836	0.07694	0.11737	0.00500	0.15998
29	8:00P	44.1400	84.6852	0.07064	0.11462	-0.00117	0.14244
30	8:15P	44.1390	84.6652	0.09487	0.11532	0.02320	0.16655
31	8:30P	44.1370	84.6704	0.08616	0.11477	0.01460	0.15771
32	8:45P	44.1380	84.7508	0.10409	0.11644	0.03264	0.17553
33	9:00P	44.1380	84.6971	0.07777	0.11475	0.00642	0.14911
34	9:15P	44.1360	84.6732	0.05965	0.11225	-0.00160	0.14089
35	9:30P	44.1330	84.6632	0.08180	0.11132	0.01064	0.15296
36	9:45P	44.1330	84.6567	0.07223	0.10940	0.00116	0.14331
37	10:00P	44.1330	84.6591	0.07141	0.10755	0.00062	0.14241
38	10:15P	44.1290	84.6533	0.05145	0.10376	-0.01947	0.12237
39	10:30P	44.1280	84.6527	0.07002	0.10216	-0.00083	0.14087
40	10:45P	44.1270	84.6533	0.06885	0.10057	-0.00193	0.13963
41	11:00P	44.1260	84.6492	0.06740	0.09895	-0.00332	0.13817
42	11:15P	44.1250	84.6461	0.06145	0.09688	-0.00921	0.13211

Table 4.2-1 (continued)

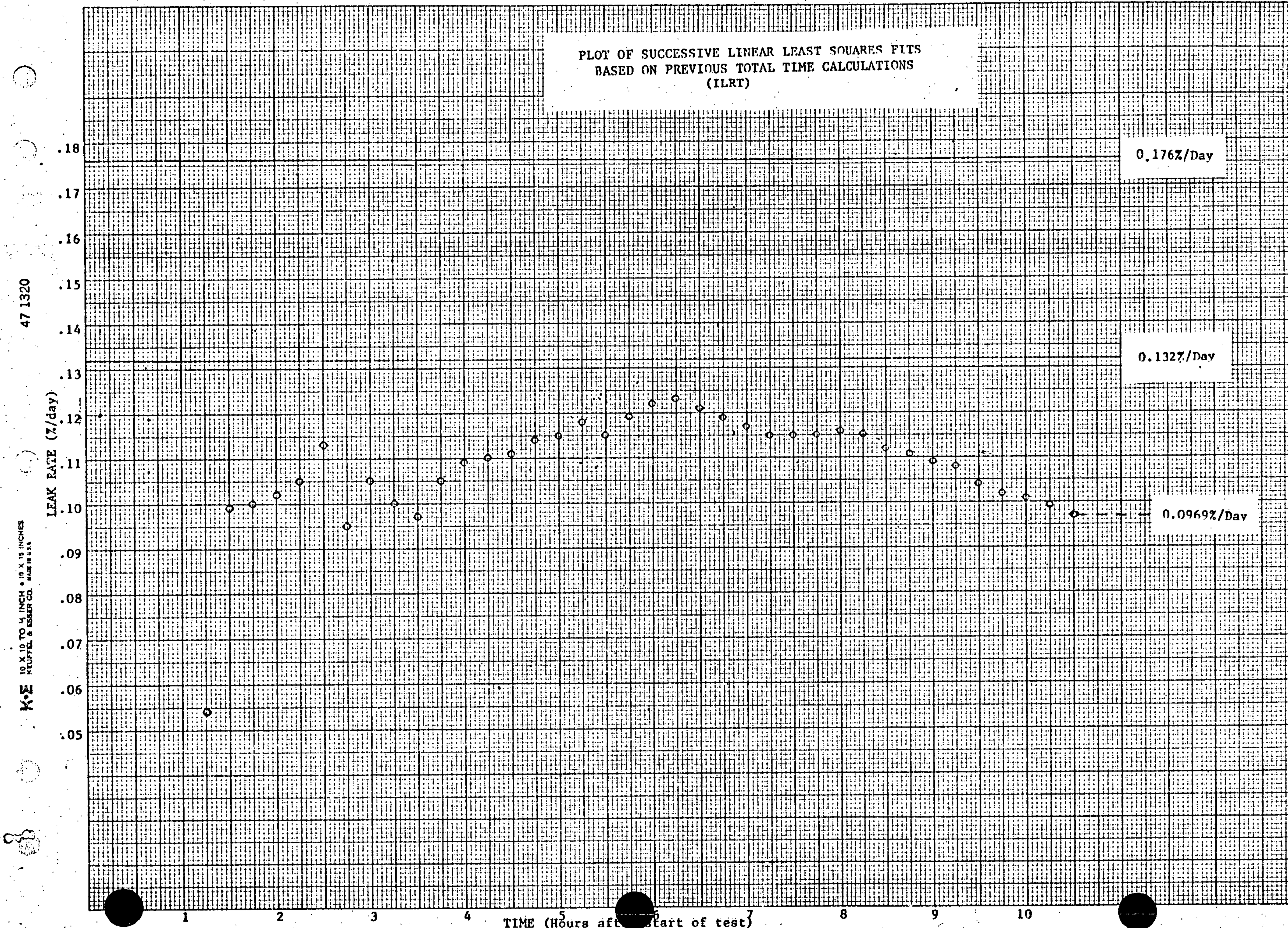
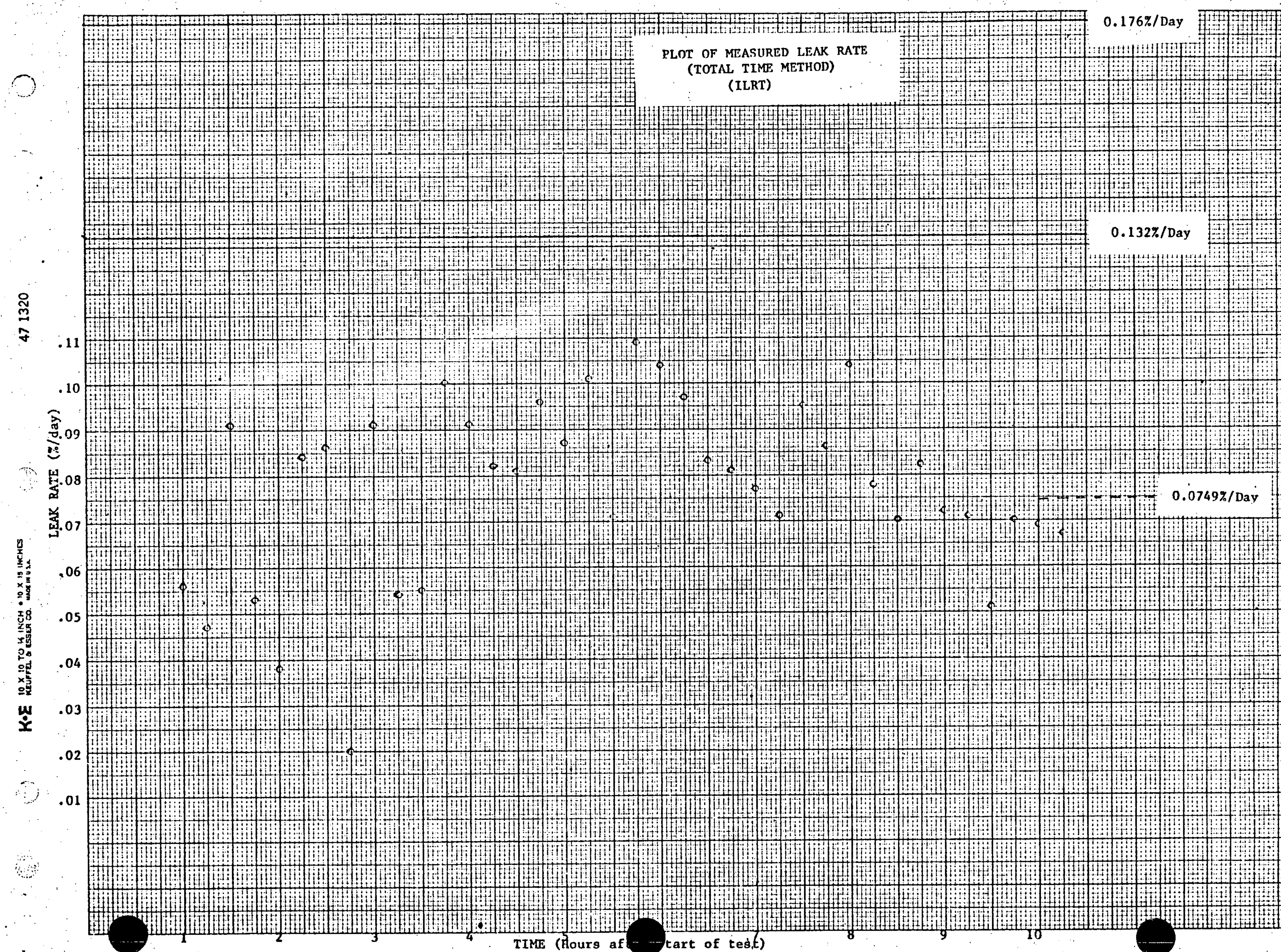

PLOT OF SUCCESSIVE LINEAR LEAST SQUARES FITS
BASED ON PREVIOUS TOTAL TIME CALCULATIONS
(ILRT)
0.176%/Day
0.132%/Day
0.0969%/Day
LEAK RATE (%/day)
.18
.17
.16
.15
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
1
2
3
4
5
6
7
8
9
10
TIME (Hours after start of test)
K+E 10 X 10 TO ½ INCH • 10 X 15 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
47 1320

Figure 4.2-1



K•E 10 X 10 TO ½ INCH • 10 X 15 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
47 1320
PLOT OF MEASURED LEAK RATE
(TOTAL TIME METHOD)
(ILRT)
0.176%/Day
0.132%/Day
0.0749%/Day
LEAK RATE (%/day)
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
1
2
3
4
5
6
7
8
9
10
TIME (Hours af tart of test)

Figure 4.2-2

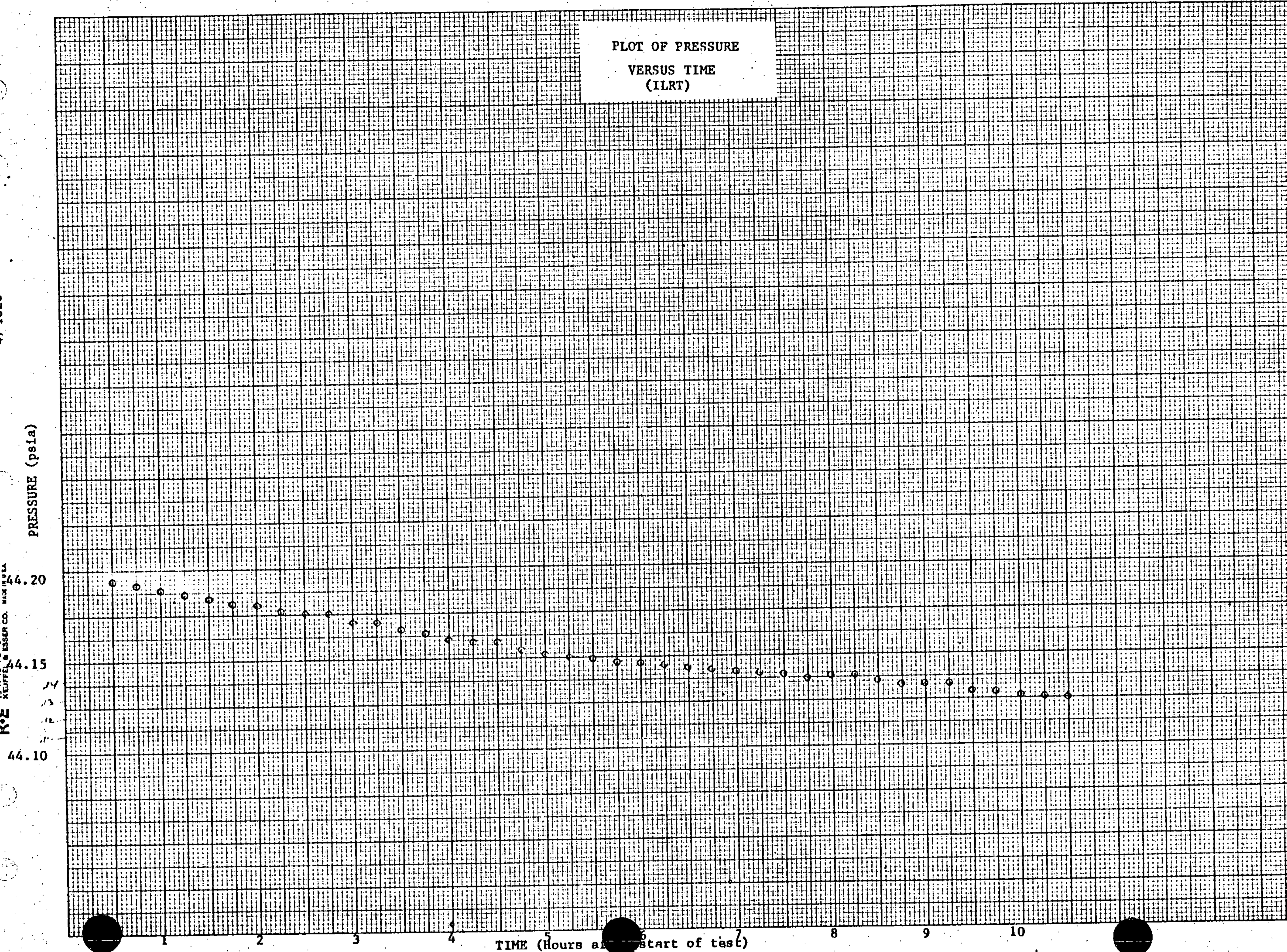

PLOT OF PRESSURE
VERSUS TIME
(ILRT)
PRESSURE (psia)
44.20
44.15
44.10
1
2
3
4
5
6
7
8
9
10
start of test)

Figure 4.2-3

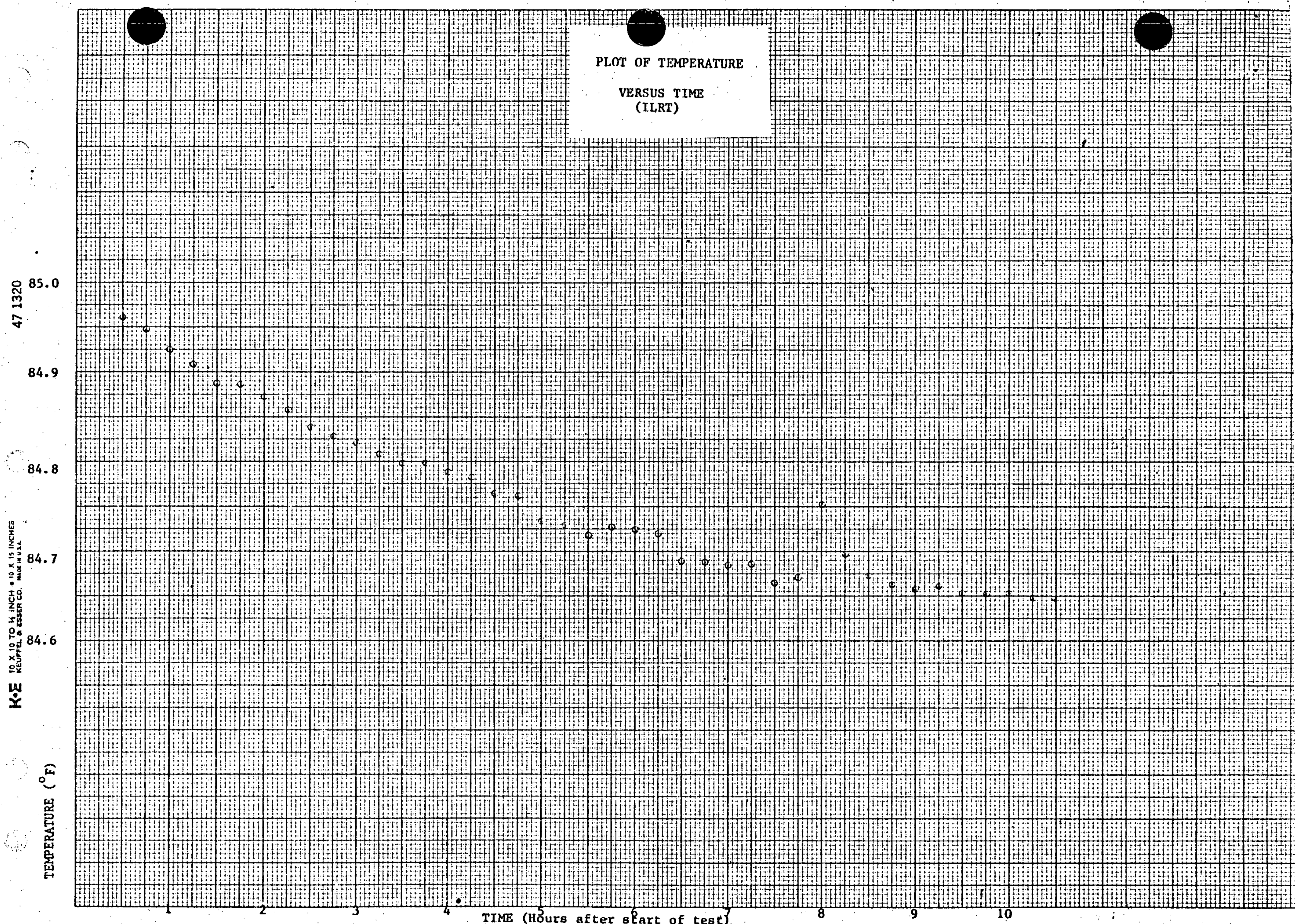

PLOT OF TEMPERATURE
VERSUS TIME
(ILRT)
85.0
84.9
84.8
84.7
84.6
TEMPERATURE (°F)
1
2
3
4
5
6
7
8
9
10
TIME (Hours after start of test)

Figure 4.2-4

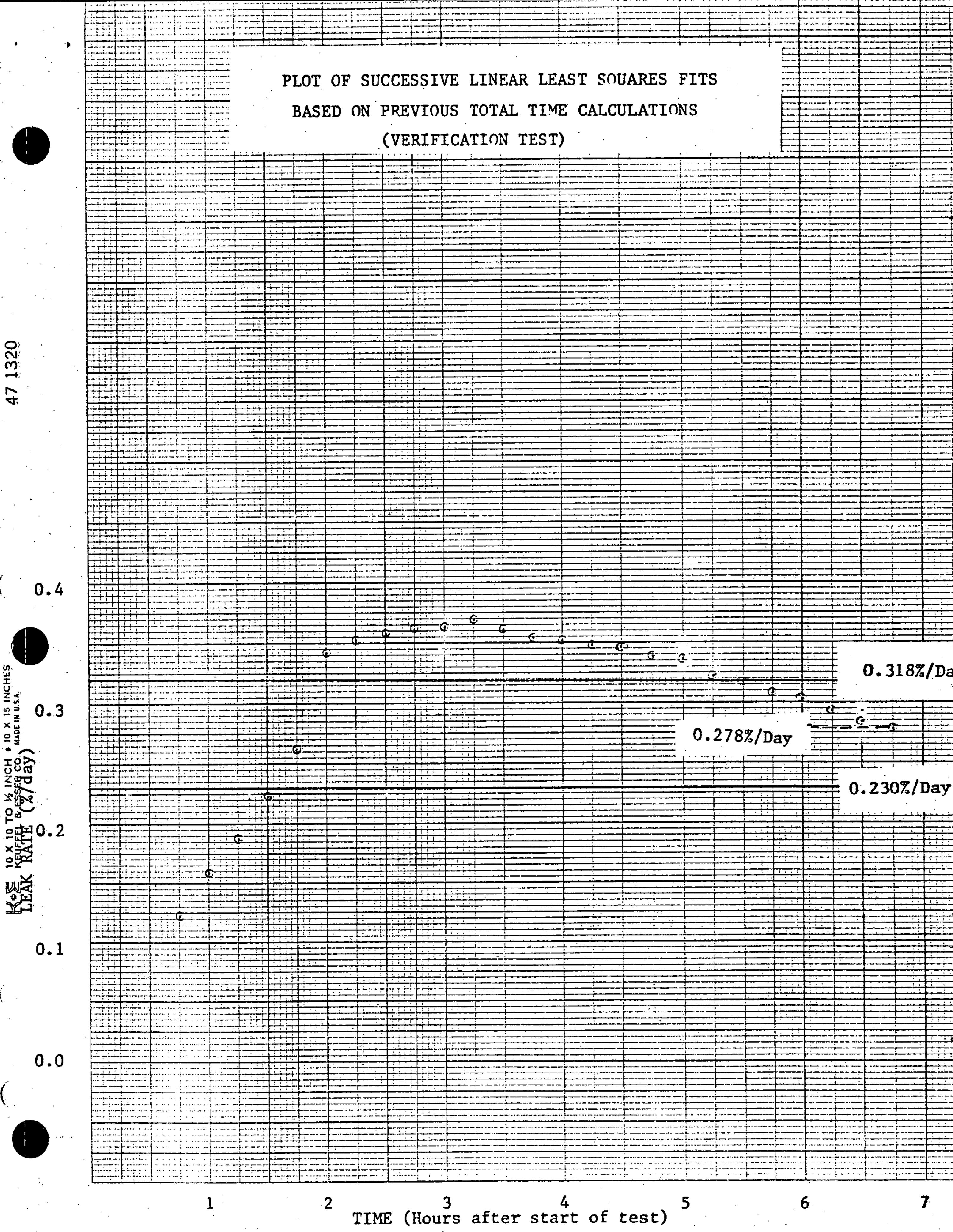

PLOT OF SUCCESSIVE LINEAR LEAST SQUARES FITS
BASED ON PREVIOUS TOTAL TIME CALCULATIONS
(VERIFICATION TEST)
0.318%/Da
0.278%/Day
0.230%/Day
0.4
0.3
0.2
0.1
0.0
LEAK RATE (%/day)
1
2
3
4
5
6
7
TIME (Hours after start of test)

Figure 4.2- 5

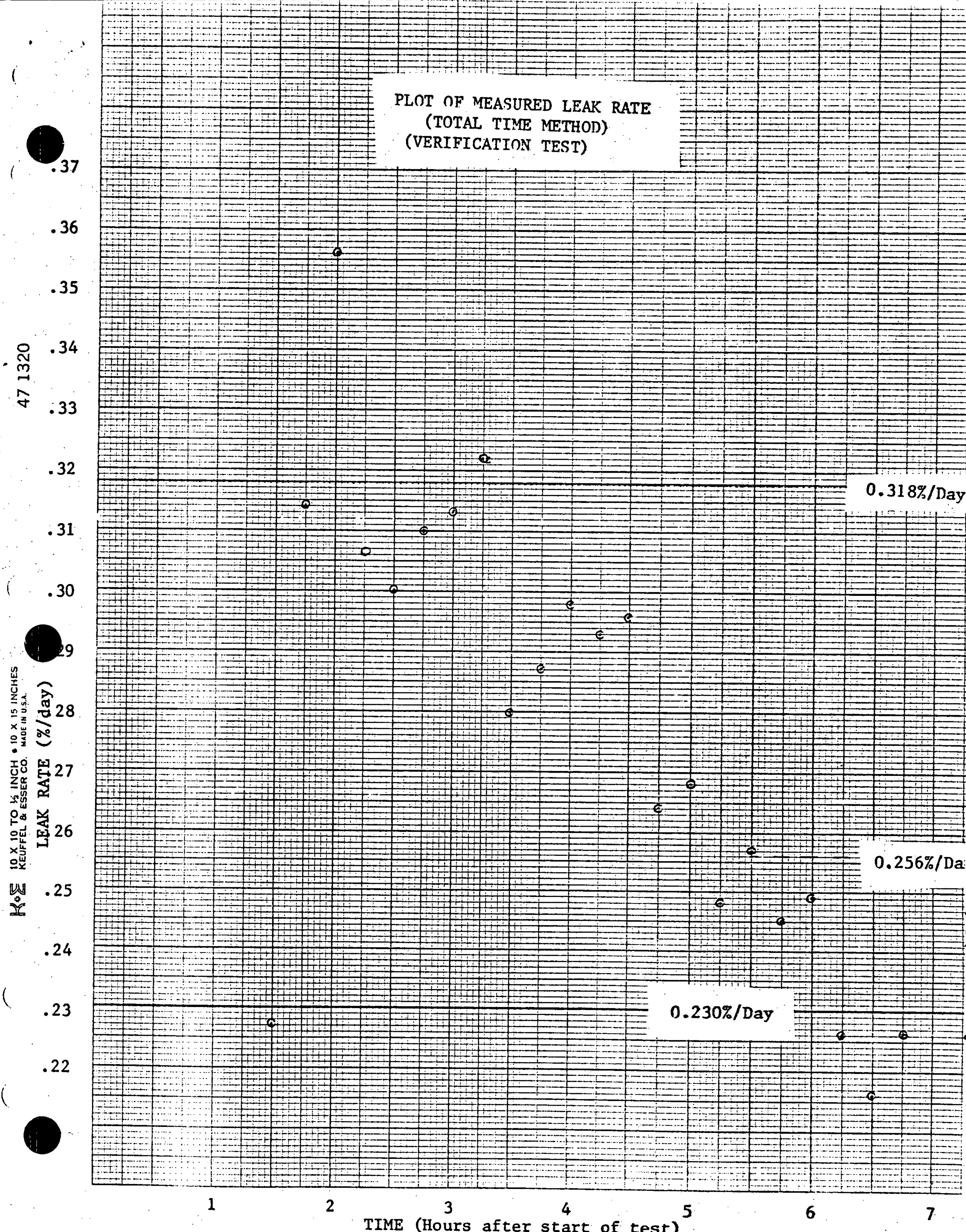

PLOT OF MEASURED LEAK RATE
(TOTAL TIME METHOD)
(VERIFICATION TEST)
LEAK RATE (%/day)
.37
.36
.35
.34
.33
.32
.31
.30
.29
.28
.27
.26
.25
.24
.23
.22
0.318%/Day
0.256%/Da
0.230%/Day
1
2
3
4
5
6
7
TIME (Hours after start of test)
47 1320
K&E 10 X 10 TO ½ INCH • 10 X 15 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 4.2-6

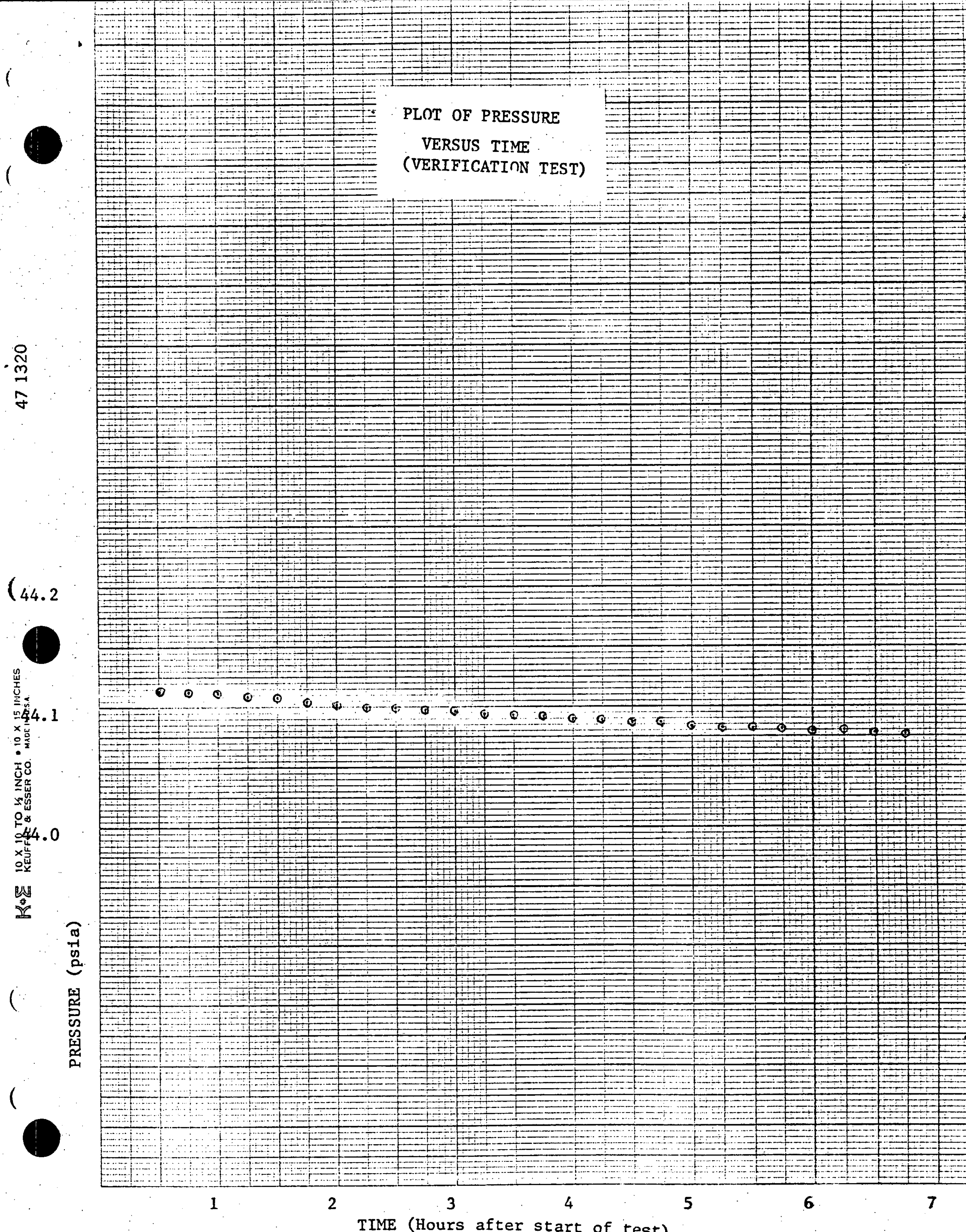

PLOT OF PRESSURE
VERSUS TIME
(VERIFICATION TEST)
44.2
44.1
44.0
PRESSURE (psia)
1
2
3
4
5
6
7
TIME (Hours after start of test)
47 1320
10 X 10 TO ½ INCH • 10 X 15 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 4.2-7

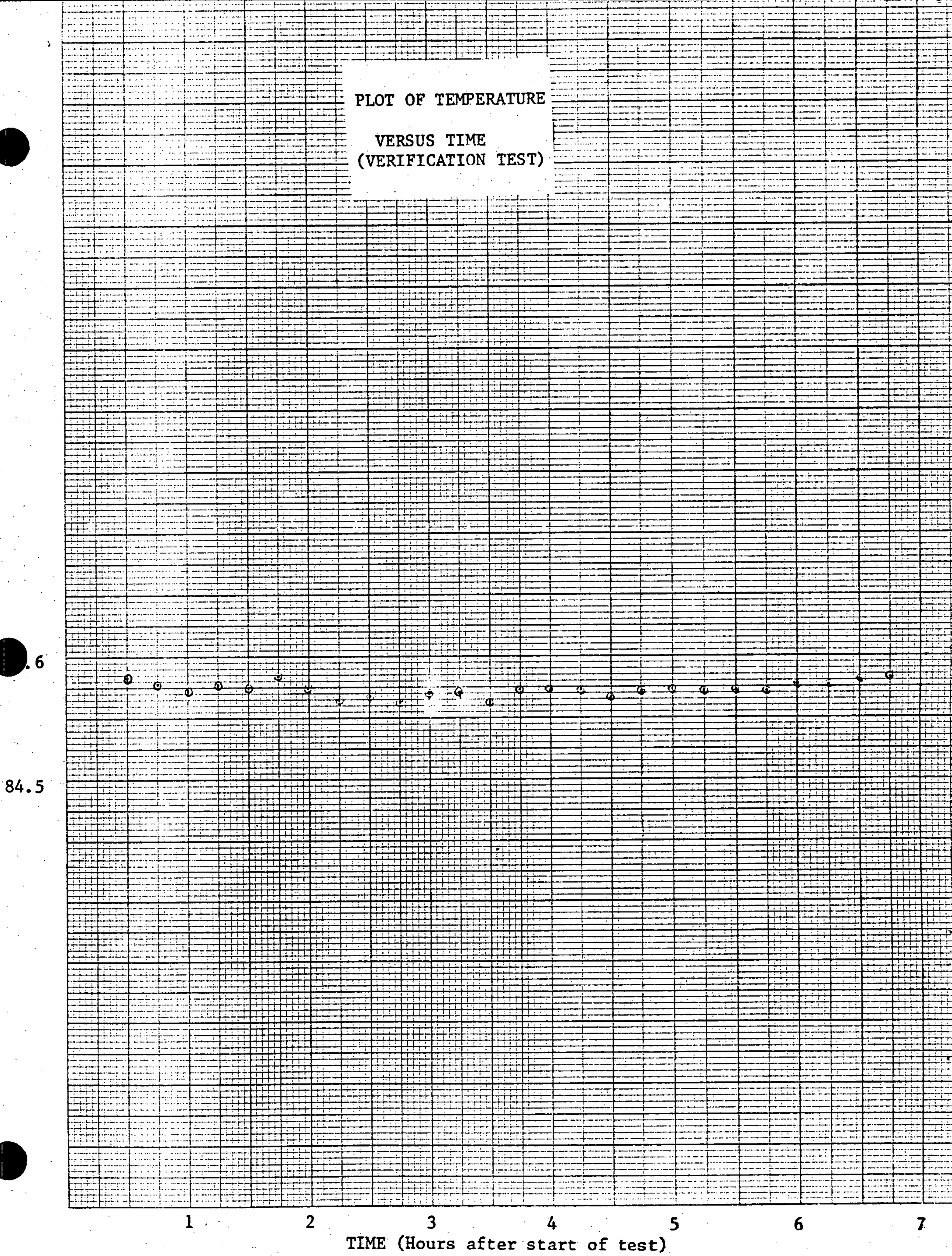

PLOT OF TEMPERATURE
VERSUS TIME
(VERIFICATION TEST)
.6
84.5
1
2
3
4
5
6
7
TIME (Hours after start of test)

Figure 4.2-8

TYPE B LOCAL LEAK RATE TEST RESULTS

Penetration	Date	Leak Rate (%/Day)
Electrical Penetration	03/06/75	2.85×10^{-5}
	06/07/76	3.72×10^{-5}
	07/15/77	2.12×10^{-5}
Fuel Transfer Tube Covers	10/27/73	0
	04/17/74	0
	09/11/75	0
	06/30/76	0
	07/27/77	0
Equipment Hatch	10/26/73	0
	04/23/74	0
	09/03/74	0
	10/17/74	0
	09/08/75	2.14×10^{-4}
	07/05/76	2.14×10^{-4}
	07/26/77	0
Personnel Hatch	10/29/73	2.3×10^{-3}
	05/05/74	3.29×10^{-3}
	09/16/74	2.63×10^{-3}
	01/08/75	6.26×10^{-3}
	05/15/75	0
	09/29/75	0
	01/23/76	1.05×10^{-3}
	07/05/76	4.61×10^{-3}
	11/09/76	4.61×10^{-3}
	03/16/77	2.63×10^{-3}
	07/28/77	2.63×10^{-3}
	08/08/77	1.28×10^{-3}
Emergency Personnel Hatch	10/27/73	7.57×10^{-3}
	01/21/74	0
	01/22/75	1.04×10^{-3}
	06/18/75	5.76×10^{-2}
	06/20/75	9.88×10^{-2}
	06/22/75	3.29×10^{-4}
	11/20/75	6.41×10^{-3}
	03/23/76	0
	07/27/76	0
	11/16/76	6.42×10^{-3}
	03/16/77	2.63×10^{-3}
	07/08/77	5.26×10^{-3}

Table 4.1-1

TYPE C LOCAL LEAK RATE TEST RESULTS

Penetration	Date	Leak Rate (%/Day)
Mechanical Penetrations	09/11/75	4.77×10^{-2}
	06/30/76	1.54×10^{-2}
	10/13/76	1.76×10^{-2}
	07/27/77	1.13×10^{-2}

Table 4.1-2

5.0 LOCAL LEAK RATE TEST FAILURE DATA

5.1 Introduction

It is required by 10CFR50, Appendix J "Primary Reactor Containment Leakage Testing for Water Cooled Power Reactor" to report failure data on type A, B and C leakage tests. This report contains all failure data on Oconee Unit II since July, 1973.

5.2 Failure Data

ITEM	DATE	REASON FOR FAILURE	CORRECTIVE ACTION
HP-37	9/2/75	Drain valve leaking past seat	Capped drain line
HP-124	9/2/75	Drain valve leaking past seat	Capped drain line
PR-1	9/9/75	Leakage past seat	Adjusted and lubricated valve seat
PR-2	9/9/75	Leakage past seat	Adjusted and lubricated valve seat
PR-5	9/9/75	Leakage past seat	Adjusted valve closure
HP-285	9/9/75	Leakage past seat	Lapped seat
HP-286	9/9/75	Leakage past seat	Lapped Seat
HP-146	9/9/75	Leakage past seat	Lapped seat
PR-5	5/18/76	Leakage past seat	Lubricated and adjusted seat
HP-120	6/10/76	Leakage past seat	Lapped seat
HP-286	5/12/76	Leakage past seat (seat cracked)	Replaced valve
HP-147	5/21/76	Leakage past seat	Replaced valve
PR-1	5/21/76	Leakage past seat	Adjusted and lubricated seat
PR-2	5/21/76	Leakage past seat	Adjusted and lubricated seat
PR-5	5/31/77	Leakage past seat	Adjusted and lubricated seat
PR-6	5/31/77	Leakage past seat	Adjusted and lubricated seat
PR-1	5/31/77	Leakage past seat	Adjusted and lubricated seat
PR-2	5/31/77	Leakage past seat	Adjusted and lubricated seat
HP-204	6/13/77	Drain valve leakage by seat	Replaced drain valve

NOTE: HP - High Pressure Injection System
PR - RB Purge System

DUKE POWER COMPANY
OCONEE NUCLEAR STATION
INTEGRATED LEAKRATE TEST

07/31/77

29.5 PSIG VERIFICATION TEST

TREND REPORT (FROM INIT CALCU / ABS)

DATA SET	TIME	PRESSURE (PSIA)	TEMPERATURE (F)	ABS LR MEASURED %/DAY	ABS LR CALCULATED %/DAY	95 % CONFIDENCE LIMITS LOWER	UPPER
2	2:45A	44.1140	84.5833	0.09514	*	0.00000	0.00000
3	3:00A	44.1130	84.5792	0.12131	0.12131	*	*
4	3:15A	44.1110	84.5677	0.15995	0.15787	0.15995	0.15995
5	3:30A	44.1090	84.5766	0.18446	0.18620	0.18446	0.18446
6	3:45A	44.1070	84.5743	0.22741	0.22319	0.22741	0.22741
7	4:00A	44.1040	84.5794	0.31446	0.28660	0.27181	0.35711
8	4:15A	44.1020	84.5736	0.35642	0.34105	0.31662	0.39622
9	4:30A	44.1000	84.5653	0.30616	0.35230	0.24030	0.37202
10	4:45A	44.0990	84.5672	0.30032	0.35606	0.21800	0.39265
11	5:00A	44.0970	84.5648	0.31005	0.36088	0.22201	0.39809
12	5:15A	44.0960	84.5716	0.31277	0.36425	0.21941	0.40612
13	5:30A	44.0940	84.5710	0.32245	0.36883	0.23046	0.41444
14	5:45A	44.0930	84.5645	0.27975	0.35991	0.17110	0.38839
15	6:00A	44.0920	84.5740	0.28745	0.35449	0.17462	0.40027
16	6:15A	44.0900	84.5744	0.29808	0.35240	0.19620	0.40997
17	6:30A	44.0890	84.5740	0.29276	0.34917	0.19167	0.40385
18	6:45A	44.0870	84.5686	0.29581	0.34693	0.19540	0.40622
19	7:00A	44.0860	84.5710	0.26400	0.33834	0.14930	0.37870
20	7:15A	44.0840	84.5729	0.26795	0.33179	0.15379	0.38211
21	7:30A	44.0830	84.5725	0.24845	0.32254	0.13011	0.36678

Table 4.2-2

22	7:45A	44.0810	84.5716	0.25680	0.31609	0.13891	0.37469
23	8:00A	44.0810	84.5708	0.24456	0.30843	0.12767	0.36206
24	8:15A	44.0790	84.5765	0.24869	0.30245	0.13155	0.35583
25	8:30A	44.0800	84.5758	0.22584	0.29365	0.10462	0.34705
26	8:45A	44.0780	84.5792	0.21548	0.28441	0.09457	0.33639
27	9:00A	44.0760	84.5822	0.22620	0.27787	0.10557	0.34684

Table 4.2-2 (continued)