H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2

REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST

NOVEMBER 1984

CAROLINA POWER & LIGHT COMPANY

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1.0 SYNOPSIS

The H. B. Robinson Steam Electric Plant Unit No. 2 reactor containment building was subjected to a periodic integrated leak rate test during the period of October 31, 1984 to November 2, 1984. The purpose of this test was to demonstrate the acceptability of the building leakage rate at an internal pressure of 21.0 psig (P_t). Testing was performed in conformance with the requirements of 10CFR50 Appendix J, ANSI N45.4-1972 and H. B. Robinson Steam Electric Plant Unit No. 2 Technical Specifications. In addition, the recommendations of ANS 56.8-1981 were considered where appropriate to reduced pressure testing.

The measured leakage rate based on the Mass Point Method of analysis was found to be 0.008% by weight per day at 21.0 psig. The leakage rate at the upper bound of the 95% confidence interval was 0.011% by weight per day which is well below the allowable leakage rate of 0.053% by weight per day at 21.0 psig.

The supplemental instrumentation verification at P_t demonstrated an agreement between measured reactor containment building integrated leakage rates of 18.3% of L_t which is within the 25% requirement of 10CFR50 Appendix J, Section III A.3.b.

All testing was performed by Carolina Power & Light Company with the technical assistance of Gilbert/Commonwealth, Inc. Procedural and calculational methods were witnessed by Nuclear Regulatory Commission personnel and audited by the Carolina Power & Light Company site Quality Control staff.

2.0 INTRODUCTION

The objective of the periodic integrated leak rate test was the verification of the overall leak tightness of the reactor containment building at 21.0 psig, one half the calculated design basis accident pressure. The allowable leakage is defined by the design basis accident applied in the safety analysis in accordance with site exposure guidelines specified by 10CFR100. For H. B. Robinson Steam Electric Plant Unit No. 2, the maximum allowable integrated leak rate at one half the design basis accident pressure, 21.0 psig (P_t), is 0.0707% by weight per day (L_t).

Testing was performed in accordance with the procedural requirements as stated in H. B. Robinson Steam Electric Plant Unit No. 2 Integrated Leak Rate Test Procedure CT-3-84. This procedure was approved by the H. B. Robinson Plant staff prior to the commencement of the test.

Leakage rate testing was accomplished at the pressure level of 21.0 psig for a period of 26.5 hours. The 26.5 hour period was followed by a four hour supplemental test for a verification of test instrumentation.

3.0 GENERAL, TECHNICAL, AND TEST DATA

3.1 GENERAL DATA

Owner:	Carolina Power & Light
Docket No.:	50-261
Location:	Six miles northwest of Hartsville, South Carolina
Containment Description:	Steel lined, partially insulated, reinforced concrete right vertical cylinder with a flat base and a hemispherical dome. The containment wall is prestressed using vertical tendons from the ring girder to the base. The base mat is founded on earth driven piles.
Date Test Completed:	November 2, 1984

3.2 TECHNICAL DATA

Containment Net Free Volume:	1.95×10^{6} cubic feet
Design Pressure:	42 psig
Design Temperature:	263°F
Calculated Accident Peak Pressure:	42 psig
Calculated Accident Peak Temperature:	263°F

3.3 TEST DATA

Test Method:	Absolute Method
Data Analysis:	Mass Point
Test Pressure:	36 psia

Max Allowable Leakage Rate (L_t):	0.0707 wt % per day
Measured Leakage Rate at UCL:	0.011 wt % per day
Supplemental Test Flow Rate:	0.061 wt % per day
Supplemental Test Measured Leak Rate:	0.082 wt % per day
Supplemental Test and L_{tm} Agreement:	18.3%

4.0 ACCEPTANCE CRITERIA

Acceptance criteria established prior to the test and as specified by 10CFR50 Appendix J, ANSI N45.4-1972 and the H. B. Robinson Steam Electric Plant Unit No. 2 Technical Specifications are as follows:

1. The measured leakage rate (L_{tm}) at one half the calculated design basis accident pressure of 21.0 psig (P_t) shall be less than 75% of the maximum allowable leakage rate (L_t) specified as 0.0707% by weight of the building atmosphere per day. The 1974 Integrated Leak Rate Test established the L_t/L_{am} ratio was greater than 0.7 and therefore the acceptance criteria is determined as follows:

$$L_t = L_a \left(\frac{P_t}{P_a}\right)^{1/2}$$

Where:

L_a = 0.10%

P_a = 42.0 psig

P_t = 21.0 psig

Substituting the values for L_a, P_a, and P_t,

L_t = 0.0707% per day

and $.75 L_t$ = 0.053% per day.

2. The test instrumentation shall be verified by means of a supplemental test. Agreement between the containment leakage measured during the Type A test and the containment leakage measured during the supplemental test shall be within 25% of L_t.

5.0 TEST INSTRUMENTATION

5.1 SUMMARY OF INSTRUMENTS

Test instruments employed are described, by system, in the following subsections.

5.1.1 Temperature Indicating System

1. Resistance Temperature Detectors (sensors)

Quantity	24
Manufacturer	Rosemount
Type	Model 78
Range, °C	-200 to 660
Range, °F (calibrated)	0 to 400
Accuracy, °F (interchangeability)	±0.1
Sensitivity, °F	±0.1

2. Digital Temperature Scanner/Printer

Quantity	1
Manufacturer	Fluke
Type	Model 2240C
Range, °F	0 to 200 (calibrated from 60°F to 100°F)
Accuracy, °F	±0.1
Repeatability, °F	±0.18

5.1.2 Dewpoint Indicating System

1. Dewcell Elements

Quantity	5
Manufacturer	Foxboro
Type	Model 2781
Range, °F	-50 to 140
Accuracy, °F	±2.0
Sensitivity, °F	±0.5

2. Digital Temperature Scanner/Printer

Quantity	1
Manufacturer	Fluke
Type	Model 2240C
Range, °F	0 to 200 (calibrated from 120°F to 160°F
Accuracy, °F	±0.1
Repeatability, °F	±0.18

5.1.3 Pressure Monitoring System

Precision Pressure Gauges

Quantity	2
Manufacturer	Texas Instruments
Type	Model 145 (with direct readout)
Range, psia	0 - 75
Accuracy, psia	0.015%
Sensor sensitivity, psia	0.0013% of full scale
Repeatbility, psia	±0.001% of full scale

5.1.4 Supplemental Test Flow Monitoring System

Flowmeter

Quantity	1
Manufacturer	Wallace & Tiernan
Type	Model 5210601108
Range scfm at 1 psig and 80°F	0 to 6
Accuracy, scfm	±2% of full scale

5.2 SCHEMATIC ARRANGEMENT

The arrangement of the four measuring systems summarized in Section 5.1 is depicted in Appendix A. Drybulb temperature sensors were placed throughout the reactor containment vessel volume to permit monitoring of internal temperature variations at 24 locations. Dewcells were placed at five locations to permit monitoring of the reactor containment partial pressure of water vapor.

5.3 CALIBRATION CHECKS

Temperature, dewpoint, pressure, and flow measuring systems were checked for calibration before the test in accordance with H. B. Robinson Steam Electric Plant Unit No. 2 ILRT Instrumentation Pre-Test Calibration Procedure CT-2-84, as recommended by ANSI N45.4-1972, Section 6.2 and 6.3 and ANS 56.8-1981, Section 4.2. The results of the calibration checks are on file at H. B. Robinson Steam Electric Plant Unit No. 2. The supplemental test at 21.0 psig confirmed the instrumentation acceptability.

5.4 INSTRUMENTATION PERFORMANCE

During the integrated leak rate test, one dewcell exhibited erratic behavior and had to be rejected. The volume weighting fraction assigned to the defective dewcell was then assigned to the other dewcell on the same elevation and all data points were recalculated. The remaining five dewcells, 24 RTDs, two precision pressure gauges, and flow meter performed satisfactorily throughout the performance of the integrated leak rate test and provided more than adequate coverage of the containment.

5.5 VOLUME WEIGHTING FACTORS

Weighting factors were assigned to each operable drybulb temperature sensor and dewcell temperature sensor based on the calculated volume of the reactor containment building each sensing device monitored. Drybulb and dewcell temperature sensors elevation and weighting factor for the test were as follows:

Elevation/ Coordinate	Temperature Element	Weighting Factor
240'/W	TE-101	.01509
240'/S	TE-106	.01509
240'/N	TE-111	.01509
240'/E	TE-117	.01509
253'/SE	DPTE-5	.19482
263'/S	TE-108	.01909
263'/E	TE-115	.01909
263'/N	TE-122	.01909
252'/Pump Bay	TE-102	.01987
252'/Pump Bay	TE-113	.01986
252'/Pump Bay	TE-121	.01986
252'/S	TE-116	.00879
252'/N	TE-119	.00879
304'/W	DPTE-3	.25511
304'/E	DPTE-4	.25511
314'/W	TE-103	.06463
314'/S	TE-104	.06463
314'/N	TE-118	.06463
314'/E	TE-123	.06463
335'/W	TE-109	.06293
335'/S	TE-110	.06293
335'/N	TE-112	.06293
335'/E	TE-114	.06293
364'/SW	DPTE-1	.14738
364'/NE	DPTE-2	.14748
375'/W	TE-105	.09832
375'/S	TE-107	.09832
375'/N	TE-120	.09832
375'/E	TE-124	.09832

5.6 SYSTEM ERROR ANALYSIS

Systematic error, in this test, is induced by the operation of the temperature indicating system, dewpoint indicating system, and the pressure indicating system.

Justification of instrumentation selection was accomplished using manufacturer's sensitivity and repeatability tolerances stated in Section 5.1 by computing the instrumentation selection guide (ISG) formula.

Containment leakage determined by the Absolute Method requires accurate measurement of small changes in containment pressure with suitable corrections for temperature and water vapor. Since the Absolute Method utilizes the change in a reading (i.e., pressure and temperature) to calculate leak rate, the repeatability, sensitivity, and readability of the instrument system is of more concern than the accuracy. To perform the ISG calculation, the sensitivity error of the sensor and the repeatability error of the measurement system must be used.

Sensitivity is defined as "the capability of a sensor to respond to change." Sensitivity is usually a function of the system measuring the sensor output. When the sensor energy state is raised or lowered an amount equal to the smallest value which the entire system will process, a change of indication will occur. To determine sensitivity for ILRT sensors, it is necessary to analyze the smallest value of the analog sensor output which will cause a one digit change in the digital display.

Repeatability is defined as "the capability of the measurement system to reproduce a given reading from a constant source."

Utilizing the methods, techniques, and assumptions in Appendix G to ANS 56.8-1981, the ISG formula was computed for the Absolute Method as follows.

1. Conditions:

L_t = 0.0707%/day

P = 36.05 psia

T = $84^{\circ}F = 543.69^{\circ}R$ dry bulb

T_{dp} = $78^{\circ}F$

t = 26.5 hours

2. Total Absolute Pressure: e_p

No. of sensors = 2

Range = 0 - 75 psia

Sensor sensitivity error (E) = ±0.0013% of full scale

Measurement system error (ε) = ±0.001% of full scale

$$e_p = \pm \left[(E_p)^2 + (\varepsilon_p)^2 \right]^{1/2} / [\text{no. of sensors}]^{1/2}$$

$$e_p = \pm \left[(0.000975)^2 + (0.00075)^2 \right]^{1/2} / [2]^{1/2}$$

$$e_p = \pm 0.00087 \text{ psia}$$

3. Water Vapor Pressure: e_{pv}

No. of sensors = 5

Sensor sensitivity error (E) = ±0.5°F

Measurement system error (ε) excluding sensor = ±0.1°F

At a dewpoint temperature of 78°F, the equivalent water vapor pressure change (as determined from the steam tables) is 0.0156 psia/°F.

$$E_{pv} = \pm 0.5^\circ F \ (0.0156 \text{ psia}/^\circ F)$$

$$E_{pv} = 0.0078 \text{ psia}$$

$$\varepsilon_{pv} = 0.1^\circ F \ (0.0156 \text{ psia}/^\circ F)$$

$$\varepsilon_{pv} = 0.00156 \text{ psia}$$

$$e_{pv} = \pm \left[(E_{pv})^2 + (\varepsilon_{pv})^2 \right]^{1/2} / [\text{no. of sensors}]^{1/2}$$

$$e_{pv} = \pm \left[(0.0078)^2 + (0.00156)^2 \right]^{1/2} / [5]^{1/2}$$

$$e_{pv} = \pm 0.0035 \text{ psia}$$

4. Temperature:

No. of sensors = 24

Sensor sensitivity error (E) = $\pm 0.1^{\circ}F = 0.1^{\circ}R$

Measurement system error (ε) excluding sensor = $\pm 0.1^{\circ}F = 0.1^{\circ}R$

$$e_T = \pm \left[(E_T)^2 + (\varepsilon_T)^2 \right]^{1/2} / [\text{no. of sensors}]^{1/2}$$

$$e_T = \pm \left[(0.1)^2 + (0.1)^2 \right]^{1/2} / [24]^{1/2}$$

$$e_T = \pm 0.0288^{\circ}R$$

5. Instrumentation Selection Guide (ISG):

$$ISG = \pm \frac{2400}{t} \left[2\left(\frac{e_p}{P}\right)^2 + 2\left(\frac{e_{pv}}{P}\right)^2 + 2\left(\frac{e_T}{T}\right)^2 \right]^{1/2}$$

$$ISG = \pm \frac{2400}{26.5} \left[2\left(\frac{0.00087}{36.05}\right)^2 + 2\left(\frac{0.0035}{36.05}\right)^2 + 2\left(\frac{0.0288}{543.69}\right)^2 \right]^{1/2}$$

$$ISG = \pm 9.6 \, [1.165 \times 10^{-9} + 1.885 \times 10^{-8} + 5.612 \times 10^{-9}]^{1/2}$$

$$ISG = \pm 0.014\%/\text{day}$$

The ISG formula does not exceed 0.25 L_t (0.0177%/day) and it is therefore concluded that the instrumentation selected was acceptable for use in determining the reactor containment integrated leakage rate.

5.7 SUPPLEMENTAL VERIFICATION

In addition to the calibration checks described in Section 5.3, test instrumentation operation was verified by a supplemental test subsequent to the completion of the 26.5 hour leakage rate test. This test consisted of imposing a known calibrated leakage rate on the reactor containment building. After the flow rate was established it was not altered for the duration of the test.

During the supplemental test, the measured leakage rate was

$$L_c = L_v' + L_o$$

Where:

L_c = Measured composite leakage rate consisting of the reactor building leakage rate plus the imposed leakage rate

L_o = Imposed leakage rate

L_v' = Leakage rate of the reactor building during the supplemental test phase

Rearranging the above equation,

$$L_v' = L_c - L_o$$

The reactor containment building leakage during the supplemental test can be calculated by subtracting the known superimposed leakage rate from the measured composite leakage rate.

The reactor containment building leakage rate during the supplemental test (L_v') was then compared to the measured reactor containment building leakage rate during the preceding 26.5 hour test (L_{tm}) to determine instrumentation acceptability. Instrumentation is considered acceptable if the difference between the two building leakage rates is within 25% of the maximum allowable leakage rate (L_t).

6.0 TEST PROCEDURE

6.1 PREREQUISITES

Prior to commencement of reactor containment building pressurization, the following basic prerequisites were satisfied:

1. Proper operation of all test instrumentation was verified.

2. All reactor containment building isolation valves were closed using the normal mode of operation. All associated system valves were placed in post-accident positions.

3. Equipment within the reactor containment building, subject to damage, was protected from external differential pressures.

4. Portions of fluid systems which, under post-accient conditions become extensions of the containment boundary, were drained and vented.

5. The penetration pressurization and fluid block systems were depressurized and vented for the test.

6. Pressure gauges were installed on the following systems to provide a means of detection for leakage into these systems:

   a. Purge supply

   b. Purge exhaust

   c. Personnel access lock doors

   d. Equipment access hatch

7. Containment recirculation fans were operational.

8. Potential pressure sources were removed or isolated from the containment.

9. A general inspection of the accessible interior and exterior areas of the containment was completed.

6.2 GENERAL DISCUSSION

Following the satisfaction of the prerequisites stated in Section 6.1, the reactor containment building pressurization was initiated at a rate of approximately 2.5 psi per hour. Building pressure, temperature, and the amperage required by the recirculation unit fans (HVH-1, 2, 3, and 4) were monitored half hourly. Leak rate testing was intiated at the 21.0 psig pressure level. For the duration of the 26.5 hour leak test and the four hour supplemental test, the average internal containment temperature was maintained within a band of $\pm 0.9^{o}F$ by varying the service water flow rate to the containment recirculation fan unit coolers.

During the test, the following occurred at 15 minute intervals (see Appendix B - Reduced Leakage Data):

1. Readings indicated by the two precision pressure gauges were recorded and entered into the computer. The computer then computed the average pressure in psia.

2. Readings indicated by the 24 RTDs were recorded and entered into the computer. The computer program calculated the average containment building drybulb temperature by use of a weighting factor that was assigned to each RTD. This value was subsequently converted to degrees Rankine for use in the ideal gas law equation to calculate containment building weight of air.

3. Readings indicated by the five dewcells were recorded and entered into the computer. The computer program then calculated the average containment dewpoint temperature by use of a weighting factor assigned to each sensor. This weighted average dewpoint temperature was then converted to a partial pressure of water vapor.

The use of water vapor pressure (P_{wv}), temperature (T), and the total pressure (P_t) is described in more detail in Section 7.1. All original data is on file at H. B. Robinson Steam Electric Plant Unit No. 2.

Data was entered into an Omotron attache micro computer located at the leak rate panel. The ILRT computer program utilized for the test had been previously checked with sample data of known results and certified prior to the test at H. B. Robinson Unit No. 2. The computer program then calculated the following at 15 minute intervals:

1. Total weight of containment air.

2. Mass Point least squares fit leakage rate.

3. Mass Point 95% upper confidence level leakage rate.

A plot of weighted average containment temperature, containment total pressure, containment average dewpoint temperature, and weight of air was performed for each 15 minute data set (see Appendix C).

Immediately following the 26.5 hour leak test, a superimposed leakage rate was established for an additional four hour period. During this time, temperature, pressure, and vapor pressure were monitored as described above.

6.3 TEST PERFORMANCE

6.3.1 Pressurization and Stabilization Phase

Pressurization of the reactor containment building was started on October 31, 1984 at 0010. The pressurization rate was approximately 2.5 psi per hour. When containment internal pressure reached 21.1 psig at approximately 0900 on October 31, pressurization was secured.

During the four hour temperature stabilization period, the average reactor containment building temperature decreased approximately 4^{o}F causing the average pressure to decrease slightly below P_T. At 1600 the compressors were restarted to raise containment pressure above P_T. When containment pressure reached 21.2 psig at 1630 on October 31, pressurization was secured. At 1645 leakage rate data recording, reduction, and analysis began.

6.3.2 Integrated Leak Rate Testing Phase

Fifteen minute frequency test data showed relatively unstable conditions within containment for the first several hours with several consecutive weight points increasing. As a result it was decided to commence the test starting at 1815 on October 31.

Test duration for the ILRT was extended to 26.5 hours to ensure that a stable leakage rate had been established prior to the start of the superimposed test. For the 26.5 hour period from 1815 on October 31 to 2045 on November 1, an acceptable leakage rate of 0.008%/day with an associated 95% confidence interval of 0.003% by weight per day was obtained.

6.3.3 Supplemental Leakage Rate Test Phase

Following completion of the 26.5 hour integrated leak rate test, a leakage rate of 1.94 scfm was imposed on the containment building through a calibrated flow meter at 2045 on November 1. Leakage rate data was again collected at 15 minute intervals for a period of four hours. With an imposed leak rate of 0.061% per day, a measured composite leakage rate of 0.082% per day was obtained. This results in a containment building leakage rate agreement of 18.3% of L_T with the results of the 26.5 hour test which is within the acceptance limit of 25% of L_T.

6.3.4 Depressurization Phase

After all required data was obtained and evaluated, containment building depressurization to 0 psig was started. A post-test inspection of the reactor containment building revealed no unusual findings. However, during the post-test valve realignment it was found that the nitrogen supply line to the RCDT had been improperly vented. Using the local leak rate test rig for measuring leakage and duplicating the conditions during the integrated leak rate test revealed no measurable leakage of nitrogen through the isolation valve.

6.3.5 Local Testing

Additional leakage rates must be applied to the measured leakage rate at the upper 95% confidence level to account for penetration paths not properly vented during the performance of the integrated leakage rate test. The lines used for the precision pressure gauges, flow verification instruments, and nitrogen supply line to the RCDT were tested using local leakage rate methods. The leakage from the parallel paths in the nitrogen line was measured to be 97 sccm; leakage from the instrument lines was measured to be 0 sccm. This value is equivalent to 0.0001%/day. The addition of this negligible value does not change the results of the integrated leakage rate test.

7.0 METHODS OF ANALYSIS

7.1 GENERAL DISCUSSION

The Absolute Method of leakage rate determination was employed during testing at the 21.0 psig pressure level. The Gilbert/Commonwealth, Inc. ILRT computer code calculates the percent per day leakage rate using the Mass Point data analysis technique.

The Mass Point method of computing leakage rates uses the following ideal gas law equation to calculate the weight of air inside containment for each 15 minute interval:

$$W = \frac{144\ PV}{RT} = \frac{KP}{T}$$

Where:

W = Mass of air inside containment, lbm

$K = 144\ V/R = 5.26336 \times 10^6 \ \frac{\text{lbm} - {}^{\circ}\text{R} - \text{in.}^2}{\text{lbf}}$

P = Partial pressure of air, psia

T = Average internal containment temperature, $^{\circ}R$

$V = 1.95 \times 10^6\ \text{ft}^3$

$R = 53.35\ \frac{\text{lbf} - \text{ft}}{\text{lbm} - {}^{\circ}\text{R}}$

The partial pressure of air, P, is calculated as follows:

$$P = P_T - P_{wv}$$

Where:

P_T = Total containment pressure

P_{wv} = Partial pressure of water vapor determined by averaging the five dewpoint temperatures and converting to partial pressure of water vapor, psia.

The average internal containment temperature, T, is calculated as follows:

T = Sum of the products of each RTD x assigned weighting factor + $459.69^{\circ}R$

The weight of air is plotted versus time for the 26.5 hour test and for the four hour supplemental test. The Gilbert/Commonwealth, Inc. ILRT computer code fits the locus of these points to a straight line using a linear least squares fit. The equation of the linear least squares fit line is of the form W = At + B where A is the slope in lbm per hour and B is the initial weight at time zero. The least squares parameters are calculated as follows:

$$A = \frac{N(\Sigma t_i W_i) - (\Sigma t_i)(\Sigma W_i)}{S_{xx}}$$

$$B = \frac{(\Sigma t_i^2)(\Sigma W_i) - (\Sigma t_i)(\Sigma t_i W_i)}{S_{xx}}$$

Where:

$$S_{xx} = N(\Sigma t_i^2) - (\Sigma t_i)^2$$

The weight percent leakage per day can then be determined from the following equation:

$$L_{tm} = \frac{-2400\ A}{B}$$

where the negative sign is used since A is a negative slope to express the leakage rate as a positive quantity.

7.2 STATISTICAL EVALUATION

The upper 95% confidence limit for the Mass Point leakage rate is calculated as follows:

$$C_L = 2400\ t_{95}\ (S_A/B)$$

Where:

C_L = Upper 95% confidence limit

t_{95} = Student's t distribution with N-2 degrees of freedom

S_A = Standard deviation of the slope of the least squares fit line

B = Intercept of the least squares fit line

The standard deviation of the slope of the least squares fit line (S_A) is calculated as follows:

$$S_A = \frac{S\ (N)^{1/2}}{[N(\Sigma t_i^2) - (\Sigma t_i)^2]^{1/2}}$$

Where:

S = Common standard deviation of the weights from the least squares fit line

N = Number of data points

t_i = Time interval of the ith data point

The common standard deviation (S) is defined by:

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

Where:

W_i = Observed mass of air

W = Least squares calculated mass of air

The ILRT computer code calculates an upper 95% confidence leakage rate as follows:

$$UCL = L_{tm} + 2400\ t_{95}\ (S_A/B)$$

This UCL value is then used to determine that the measured leakage rate at the upper 95% confidence limit meets the acceptance criteria.

8.0 DISCUSSION OF RESULTS

8.1 RESULTS AT P_T

Data obtained during the leak rate test at P_T indicated the following maximum changes (highest reading to lowest reading) during the 26.5 hour test.

Variable	Maximum Change
P_T	0.073 psia
P_{wv}	0.023 psia
T	0.72°F

The method used in calculating the Mass Point leakage rate is defined in Section 7.1. The results of this calculation is a Mass Point leakage rate of 0.008%/day (see Appendix D).

The 95% confidence limit associated with this leakage rate is 0.003% per day. Thus the leakage rate at the upper bound of the 95% confidence level becomes:

$$UCL = 0.008 + 0.003$$

$$UCL = 0.011\%/day$$

The measured leakage rate and the measured leakage rate at the upper bound of the 95% confidence level are well below the acceptance criteria of 0.053% per day (0.75 L_T).

8.2 SUPPLEMENTAL TEST RESULTS

After conclusion of the 26.5 hour test at 21 psig (P_T), the flowmeter was placed in service and a flow rate of 1.94 scfm was established. This flow rate is equivalent to a leakage rate of 0.061% per day. After the flow rate was established it was not altered for the duration of the supplemental test. The measured leakage rate (L_c) during the supplemental test was calculated to be 0.082% per day using the Mass Point method of analysis (see Appendix D).

The building leakage rate during the supplemental test is then determined as follows:

$$L_v' = L_c - L_o$$

$$L_v' = 0.082\%/day - 0.061\%/day$$

$$L_v' = 0.021\%/day$$

Comparing this leakage rate with the building leakage rate measured during the 26.5 hour test yields the following:

$$\frac{|L_{tm} - L_{v'}|}{L_t} = \frac{|0.008 - 0.021|}{0.0707\%/day} = .183$$

The building leakage rates agree within 18.3 percent of L_T which is below the acceptance criteria of 25% of L_T.

Using the formulation of ANS 56.8-1981,

$$(L_o + L_{tm} - 0.25\ L_t) \leq L_c \leq (L_o + L_{tm} + 0.25\ L_t)$$

$$(0.061 + 0.008 - 0.018) \leq L_c \leq (0.061 + 0.008 + 0.018)$$

$$0.051 \leq L_c \leq 0.087$$

Since L_c was measured to be 0.082% per day, this value falls within the acceptable range of 0.051% to 0.087% per day. Therefore, the acceptability of the test instrumentation is considered to have been verified.

9.0 TYPE B AND C LEAKAGE RATE HISTORIES SINCE 1982 ILRT REPORT

9.1 DISCUSSION OF TYPE B TESTS

Leakage from containment penetrations and some isolation valves is constantly monitored by the penetration pressurization system. The total leakage from this system is maintained below .3 L_a during normal plant operation. The containment personnel hatch has been tested with dates and results listed below:

Date	Leakage
July 10, 1982	0.21 scfm
January 11, 1983	0.35 scfm
July 1, 1983	0 scfm
January 11, 1984	0.08 scfm
October 23, 1984	0.37 scfm

9.2 DISCUSSION OF TYPE C TESTS

The isolation valve seal water system precludes Type C testing on containment isolation valves it services. The measured leakage from this system was observed to be 10.8 cc/min. water leakage. The seven lines which are Type C tested had a combined leakage rate of 2293.5 sccm. This value is equivalent to 0.081 scfm which is well below the acceptance limit (.3 L_a) of 1.57 scfm.

10.0 REFERENCES

1. CT-3-84 - Integrated Leak Rate Test Procedure.

2. Code of Federal Regulations, Title 10, Part 50, Appendix J (1-1-75).

3. ANSI N45.4-1972 - Leakage Rate Testing of Containment Structures for Nuclear Reactors, American Nuclear Society (March 16, 1972).

4. Steam Tables, American Society of Mechanical Engineers (1967).

5. ILRT Computer Code, Gilbert/Commonwealth, Inc.

6. ANS 56.8-1981, Containment System Leakage Testing Requirements, American Nuclear Society (February 19, 1981).

APPENDICES

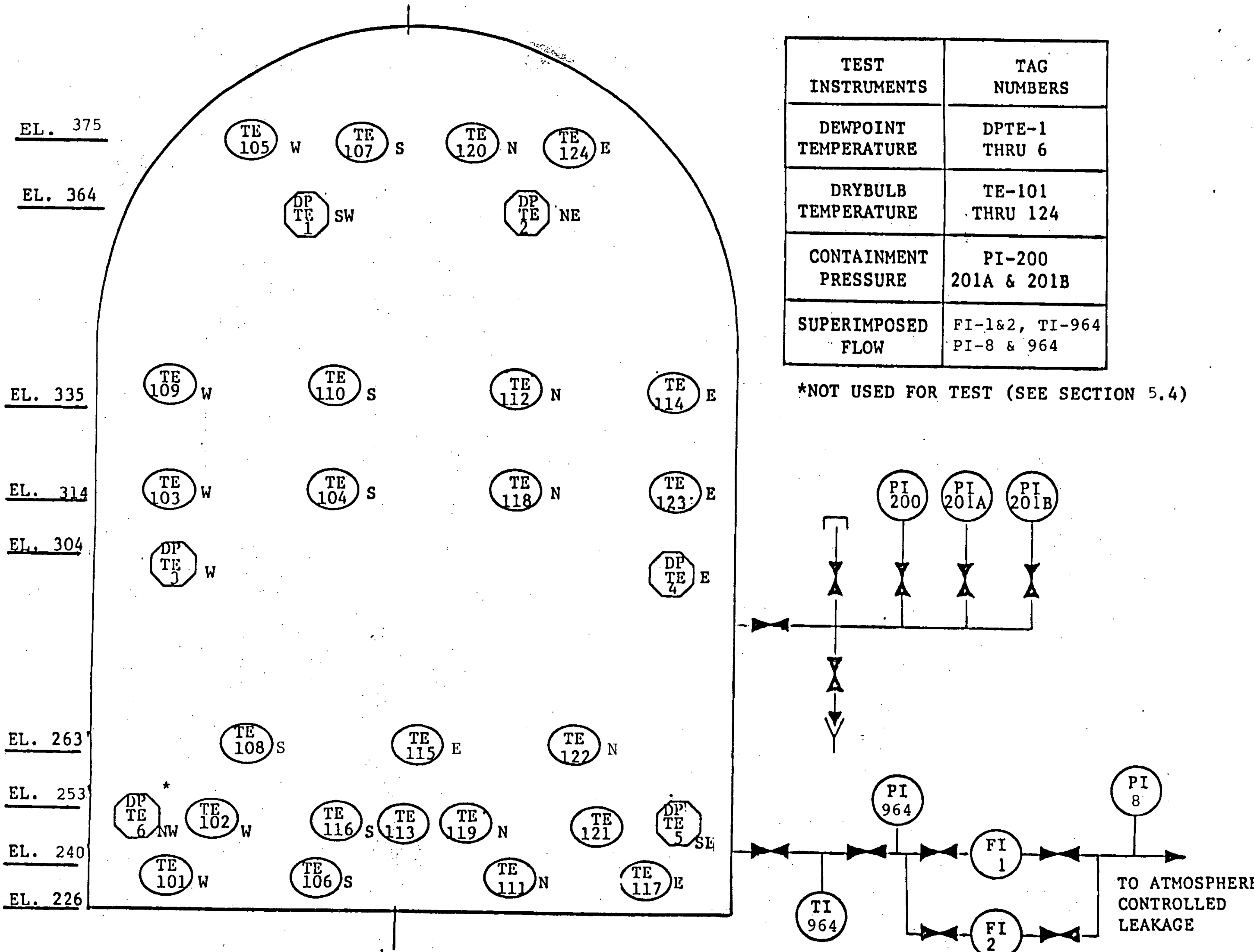
APPENDIX A

SCHEMATIC ARRANGEMENT OF TEST INSTRUMENTATION

APPENDIX A
SCHEMATIC ARRANGEMENT OF TEST INSTRUMENTATION

TEST INSTRUMENTS	TAG NUMBERS
DEWPOINT TEMPERATURE	DPTE-1 THRU 6
DRYBULB TEMPERATURE	TE-101 THRU 124
CONTAINMENT PRESSURE	PI-200 201A & 201B
SUPERIMPOSED FLOW	FI-1&2, TI-964 PI-8 & 964

*NOT USED FOR TEST (SEE SECTION 5.4)



APPENDIX B

REDUCED TEST DATA

APPENDIX B
REDUCED TEST DATA

Date	Time	PAVG	PWV	TAVG	Weight
10-31-84	1815	36.057	.493	83.95	344,325
	1830	36.056	.490	83.93	344,349
	1845	36.055	.492	83.94	344,313
	1900	36.054	.492	83.93	344,306
	1915	36.053	.488	83.92	344,346
	1930	36.052	.490	83.92	344,312
	1945	36.051	.489	83.91	344,328
	2000	36.051	.490	83.91	344,315
	2015	36.050	.491	83.89	344,307
	2030	36.049	.487	83.90	344,326
	2045	36.048	.488	83.90	344,317
	2100	36.048	.489	83.88	344,316
	2115	36.048	.487	83.87	344,335
	2130	36.047	.489	83.89	344,297
	2145	36.046	.488	83.87	344,304
	2200	36.046	.490	83.86	344,295
	2215	36.045	.486	83.86	344,322
	2230	36.045	.487	83.85	344,322
	2245	36.045	.486	83.85	344,332
	2300	36.043	.482	83.85	344,353
	2315	36.043	.484	83.86	344,328
	2330	36.042	.486	83.85	344,305
	2345	36.041	.487	83.85	344,284
11-01-84	0000	36.041	.486	83.86	344,283
	0015	36.039	.485	83.86	344,277
	0030	36.038	.484	83.86	344,283
	0045	36.038	.485	83.85	344,275
	0100	36.038	.485	83.86	344,269
	0115	36.039	.486	83.86	344,278
	0130	36.038	.488	83.83	344,258
	0145	36.037	.486	83.83	344,268
	0200	36.036	.486	83.83	344,256
	0215	36.036	.487	83.82	344,254
	0230	36.035	.481	83.82	344,306
	0245	36.034	.485	83.80	344,259
	0300	36.034	.482	83.78	344,310
	0315	36.033	.484	83.78	344,280
	0330	36.032	.482	83.78	344,287
	0345	36.03	.484	83.76	344,270
	0400	36.03	.481	83.75	344,298
	0415	36.029	.483	83.75	344,268
	0430	36.029	.480	83.74	344,309
	0445	36.028	.486	83.75	344,236

Appendix B (Cont'd)

Date	Time	PAVG	PWV	TAVG	Weight
11-01-84	0500	36.028	.483	83.75	344,266
	0515	36.028	.482	83.74	344,276
	0530	36.027	.486	83.74	344,230
	0545	36.027	.482	83.73	344,272
	0600	36.027	.478	83.73	344,309
	0615	36.027	.482	83.73	344,269
	0630	36.026	.480	83.72	344,286
	0645	36.025	.482	83.72	344,266
	0700	36.025	.479	83.71	344,296
	0715	36.024	.481	83.68	344,291
	0730	36.023	.479	83.69	344,290
	0745	36.022	.483	83.68	344,240
	0800	36.021	.477	83.66	344,303
	0815	36.019	.481	83.65	344,260
	0830	36.017	.475	83.60	344,319
	0845	36.016	.482	83.60	344,245
	0900	36.014	.478	83.58	344,287
	0915	36.013	.480	83.55	344,269
	0930	36.012	.479	83.52	344,293
	0945	36.011	.479	83.52	344,280
	1000	36.01	.476	83.52	344,306
	1015	36.01	.479	83.51	344,280
	1030	36.01	.478	83.51	344,286
	1045	36.01	.477	83.50	344,304
	1100	36.01	.476	83.49	344,313
	1115	36.009	.477	83.48	344,309
	1130	36.009	.476	83.47	344,322
	1145	36.009	.480	83.46	344,294
	1200	36.009	.478	83.48	344,299
	1215	36.009	.481	83.47	344,276
	1230	36.009	.479	83.46	344,303
	1245	36.009	.477	83.47	344,313
	1300	36.009	.479	83.46	344,300
	1315	36.009	.479	83.47	344,293
	1330	36.009	.478	83.46	344,308
	1345	36.01	.482	83.46	344,279
	1400	36.01	.477	83.49	344,313
	1415	36.009	.474	83.47	344,339
	1430	36.007	.478	83.46	344,288
	1445	36.006	.481	83.44	344,265
	1500	36.005	.476	83.42	344,317
	1515	36.004	.479	83.42	344,277
	1530	36.004	.477	83.41	344,301
	1545	36.003	.479	83.42	344,266

Appendix B (Cont'd)

Date	Time	PAVG	PWV	TAVG	Weight
11-01-84	1600	36.003	.476	83.40	344,305
	1615	36.002	.480	83.40	344,258
	1630	36.002	.480	83.39	344,262
	1645	36.002	.479	83.38	344,275
	1700	36.001	.475	83.37	344,307
	1715	36.0	.478	83.38	344,270
	1730	35.999	.476	83.36	344,290
	1745	35.998	.478	83.36	344,271
	1800	35.997	.479	83.35	344,266
	1815	35.995	.473	83.34	344,295
	1830	35.994	.472	83.32	344,312
	1845	35.993	.479	83.31	344,247
	1900	35.992	.473	83.28	344,313
	1915	35.99	.475	83.27	344,280
	1930	35.99	.478	83.25	344,247
	1945	35.988	.470	83.26	344,319
	2000	35.987	.474	83.26	344,265
	2015	35.986	.475	83.25	344,252
	2030	35.985	.471	83.22	344,292
	2045	35.984	.473	83.23	344,260

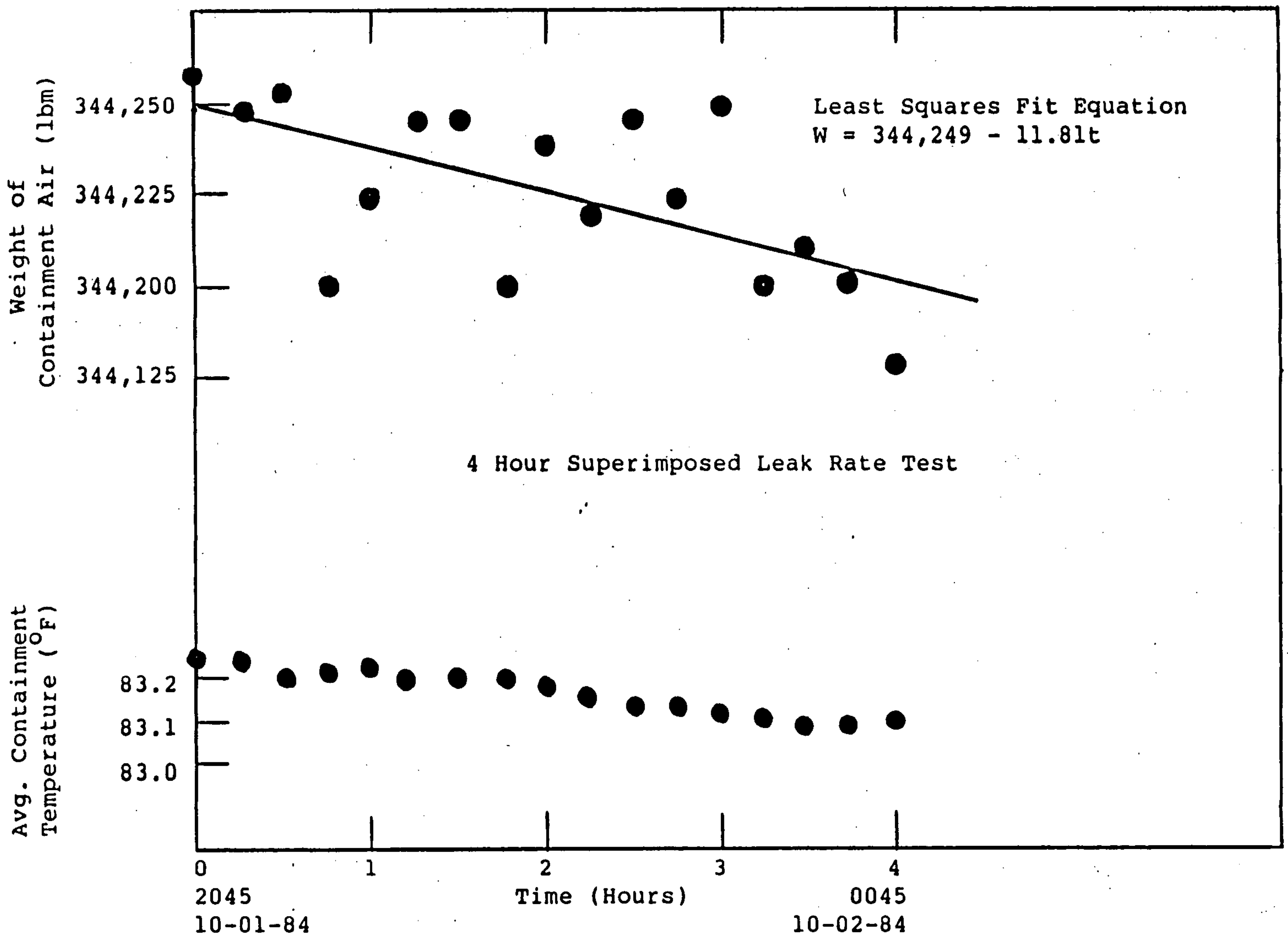
Verification Test

Date	Time	PAVG	PWV	TAVG	Weight
11-01-84	2100	35.983	.473	83.23	344,248
	2115	35.982	.473	83.21	344,256
	2130	35.982	.477	83.22	344,199
	2145	35.981	.474	83.23	344,223
	2200	35.981	.472	83.21	344,246
	2215	35.980	.472	83.21	344,247
	2230	35.978	.475	83.21	344,199
	2245	35.976	.471	83.19	344,235
	2300	35.974	.472	83.16	344,219
	2315	35.973	.469	83.14	344,244
	2330	35.972	.471	83.14	344,223
	2345	35.971	.468	83.12	344,250
11-02-84	0000	35.969	.472	83.11	344,198
	0015	35.968	.471	83.09	344,210
	0030	35.967	.472	83.09	344,200
	0045	35.966	.472	83.10	344,178

APPENDIX C

LEAKAGE RATE TEST GRAPHS

APPENDIX C
WEIGHT OF CONTAINMENT AIR AND
AVERAGE CONTAINMENT TEMPERATURE VERSUS TIME



APPENDIX D

COMPUTER RESULTS

APPENDIX D
COMPUTER RESULTS

1. Mass Point Results:

   A = Slope of least squares line (lbs/hr) is 1.116

   B = Intercept of least squares line (lbs) is 344,305.75

   L_{tm} = Measured leak rate is 0.008%/day

   UCL = 95% upper confidence leakage rate is 0.011%/day

2. Verification Test:

   A = Slope of least squares line (lbs/hr) is -11.81

   B = Intercept of least squares line (lbs) is 344,249

   L_c = Composite leakage rate is 0.0823%/day

APPENDIX E

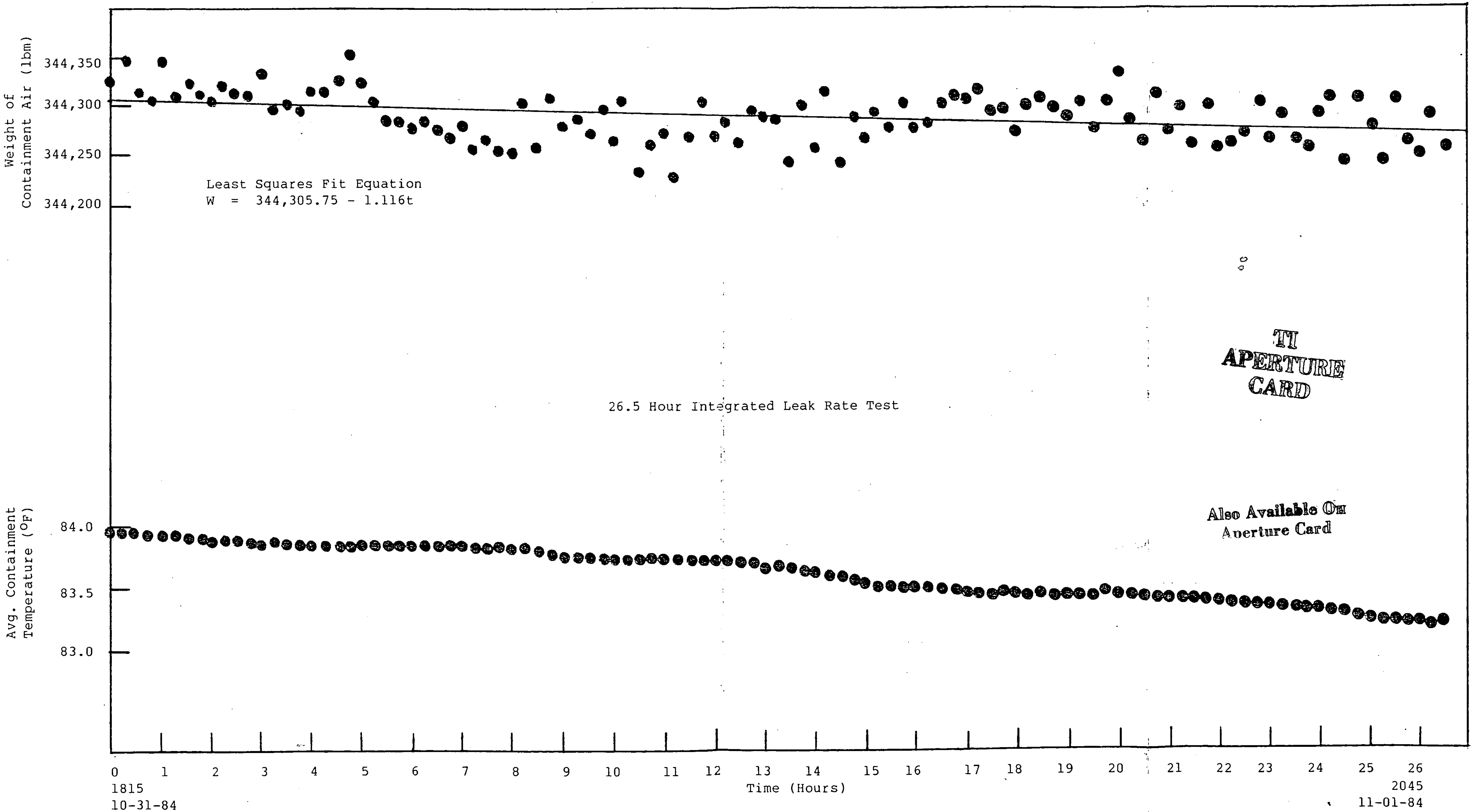
TYPE C SUMMARY

APPENDIX E -TYPE C SUMMARY

PENETRATION DESCRIPTION	AS-FOUND LEAKAGE	AS-LEFT LEAKAGE
CONTAINMENT MANOMETER LINE	227.07 sccm	227.07 sccm
POST ACCIDENT SAMPLING	635 sccm	635 sccm
NITROGEN SUPPLY TO ACCUMULATORS	104.7 sccm	104.7 sccm
NITROGEN SUPPLY TO PRESSURIZER RELIEF TANK	0	0
NITROGEN SUPPLY TO REACTOR COOLANT DRAIN TANK	193.7 sccm	193.7 sccm
CONTAINMENT INSTRUMENT AIR HEADER	*>40,000 sccm	1,113 sccm
CONTAINMENT FIREWATER SUPPLY	0	0
TOTAL	>41,160.47 sccm	2293.5 sccm

*Check valve V8-5 in the containment instrument air header exhibited excessive leakage during the initial testing. The valve would not seat due to rust build-up around the plug. The valve was replaced and as-left leakage was acceptable. PCV-1716, the air operated globe valve in series with V8-5, exhibited zero leakage during the initial leakage test.

APPENDIX C
WEIGHT OF CONTAINMENT AIR AND
AVERAGE CONTAINMENT TEMPERATURE VERSUS TIME



TI APERTURE CARD

Also Available On Aperture Card

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