KEWAUNEE NUCLEAR POWER PLANT

REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST

1980

WISCONSIN PUBLIC

WISCONSIN POWE

MADISON GAS &

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Kewaunee Nuclear Power Plant

Wisconsin Public Service Corporation

Reactor Containment Building

Integrated Leak Rate Test

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Summary Technical Report

Wisconsin Public Service Corporation

Wisconsin Power and Light Company

Madison Gas and Electric Company

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I. INTRODUCTION

This summary technical report describes the results of the 1980 primary reactor containment leak tests performed at the Kewaunee Nuclear Power Plant in accordance with Title 10, Code of Federal Regulations, Part 50, Appendix J. This report also describes additional leakage testing of penetrations which extend from the containment vessel to and beyond the Special Ventilation Zone of the Auxiliary Building, as required by the Kewaunee Nuclear Power Plant Technical Specifications paragraphs 4.4.b.6 and 4.4.b.7.

Type B and Type C tests were performed during May and June, 1980. The Type A test was performed in June, after completion of the Type B and Type C tests.

Measured leak rates were less than the maximum permitted by the Technical Specifications.

II. DISCUSSION OF RESULTS

A. TYPE B AND TYPE C TESTS

The purpose of Type B and Type C tests is to demonstrate integrity of penetration pressure boundaries and isolation valves. Kewaunee containment penetrations are identified in Table 1.

The acceptance criteria specified in 10CFR50 appendix J is combined measured leakage of all penetrations and valves subject to test shall not exceed sixty percent of the design basis accident leakage rate (La). For Kewaunee, La is 0.5% weight per day. All tests were performed at the design basis accident calculated peak internal pressure (Pa) of 46 psig using the equipment outlined in Figure 1. The Technical Specifications specify action levels for maintenance and retest for those penetrations whose through line leakage bypasses the annulus to the Special Ventilation Zone (Zone SV) and for those whose leakage bypasses both the annulus and Zone SV. Action limits are 0.10La for annulus bypass and 0.01La for annulus and Zone SV bypass.

Table 2 presents a summary of the as found and after repair Type B and Type C test results. The detailed test results of each penetration are available in Tables 4 and 5. Since the last Type A test, Type B and C tests were performed during refueling outages in 1978 and 1979. 1978 and 1979 results have been previously reported to the Commission.

No technical specification is given for the allowable leak rate of individual penetrations. The leak rate measured for each penetration was evaluated to determine the need for repair considering previous leakage, penetration size, accessibility, potential causes, anticipated future deterioration, and ALARA requirements. After careful evaluation, repair work was performed on five valves, as summarized in Table 3, and after repair leak tests performed.

During this refueling outage two new penetrations, 44NW and 49NE, were opened for service. Their leak rates are reported for the first time.

B. TYPE A INTEGRATED LEAK RATE TEST

The purpose of the Type A test is to measure the total primary reactor containment leakage from all sources under conditions simulating the design basis accident. The acceptance specified in 10CFR50, appendix J, is measured leakage shall not exceed 0.75La. The test was performed at the full design basis accident calculated peak internal pressure (Pa) of 46 psig for a duration of 24 hours.

Prior to the test a visual examination of accessible internal and external surfaces of the primary reactor containment was performed. No significant evidence of deterioration was discovered.

Within two months prior to the test all instrumentation used to calculate the leak rate was calibrated using NBS traceable standards. The instrumentation system included 24 RTDs, 12 dew cells, one absolute pressure gage, and associated digital displays. The instrumentation system is the same which was used for the pre-operational test and the first periodic test. The sensors were placed in the same locations reported in previous tests.

The containment was pressurized by five 900 CFM diesel driven rotary screw air compressors. The compressed air was cooled to approximately 75°F by an aftercooler and excess humidity removed by a moisture separator. After the test pressure of 46 psig was reached the temporary pressurization system was isolated and vented.

The Integrated Leak Rate Test commenced after a nine hour stabilization period. Data was collected at 15 minute intervals for the first eight hours of the test period, and at 30 minute intervals for the remaining sixteen hours. The test method selected was the absolute method and data analysis techniques included both point to point and total time. Prior to the start of the test the total time analysis was specified as the technique required to meet the acceptance criteria. The test method and data analysis techniques were the same utilized in the previously reported tests.

Data and leak rates calculated during the 24 hour test are presented in Table 6. The temperatures and dew points are containment ambient volume-fraction weighted averages. The calculated leak rates are plotted as a function of elapsed time since the begining of the test in Figure 2 and Figure 3.

The measured leak rate, Lam, was found to be 0.036 percent weight per day, 0.037 percent weight per day at a 95% confidence level, by a least-squares fit to the total time results. The acceptance criteria is less than 0.75La, or less than 0.375 percent weight per day.

C. SUPPLEMENTAL TEST

After conclusion of the 24 hour Integrated Leak Rate Test, a known leak was superimposed upon the containment to verify the accuracy of the Type A test. Air was leaked from the containment to the Auxiliary Building through a rotometer calibrated to NBS traceable standards. Rotometer indicated flow was corrected to barometric pressure and exhaust temperature. Containment data sets were collected at 15 minute intervals as during the 24 hour test. Rotometer indication was collected at the same time intervals. The mean of the corrected rotometer data, 0.371 %/day, was used as the superimposed leak rate, Lo. The same computational facilities were used to calculate the containment leak rate, Lc. The data sets are presented in Table 7.

The acceptance criteria specified in 10CFR50 Appendix J is the measured containment leak rate under supplemental test conditions (Lam') must agree with the 24 hour test result (Lam) within 0.25 La (0.125%/day).

$$Lam' = Lc - Lo$$

$Lc = 0.393$ %/day (0.423 %/day at a 95% confidence level)
$Lo = 0.371$ %/day

$$Lam' = 0.393 - 0.371 = 0.022 \text{ %/day}$$

$$|Lam' - Lam| = 0.022 - 0.036$$

$$|Lam' - Lam| = 0.014 \ll 0.125\text{%/day}$$

The supplemental test results verify the accuracy of the Type A Test.

D. LEAK RATE CALCULATION TECHNIQUES

The leak rate was computed using the Absolute Method as outlined in ANSI N45.4, *Leakage Rate Testing of Containment Structures for Nuclear Reactors*, March 16, 1972.

The leak rate was computed in the following manner:

$$P_1V = W_1RT_1 \tag{1}$$

$$P_2W = W_2RT_2 \tag{2}$$

$$L_1 \text{ (fractional measured leakage)} = \frac{W_1 - W_2}{W_1} \tag{3}$$

Substituting equations (1) and (2) in (3) yields:

$$L_1 = 1 - \frac{T_1 \cdot P_2}{T_2 \cdot P_1} \tag{4}$$

Correcting for vapor pressure yields:

$$L_2 = 1 - \frac{T_1 (P - P_{v2})}{T_2 (P - P_{v1})} \tag{5}$$

The measured leak rate, Lam, in percent weight per day (24 hours) is:

$$Lam = \frac{2400}{\Delta t} \cdot L_2$$

$$Lam = \frac{2400}{\Delta t} \left[1 - \frac{T_1 (P_2 - P_{v2})}{T_2 (P_1 - P_{v1})} \right] \tag{6}$$

Where:

T_1, T_2 = absolute temperature (^0R) volume-fraction weighted average at times t_1 and t_2 respectively.

P_1, P_2 = absolute pressure (psia) at times t_1 and t_2 respectively.

P_{v1}, P_{v2} = water vapor pressure (psia) at times t_1 and t_2, respectively

Δt = elapsed time between two measurements ($t_2 - t_1$)

Subscript 1 = data taken at start of Δt time interval.

Subscript 2 = data taken at end of Δt time interval.

For the Total Time analysis, t_1 is always the data set taken at the begining of the 24 hour test and t_2 is the latest data set. For the Point to Point analysis, t_2 is always the latest data set and t_1 is the last data set taken prior to t_2.

A linear least-squares fit of the measured leak rate was used to determine a statistically averaged leak rate in the Total Time analysis. The equation of the least-squares line is:

$$Y = A + BX \tag{7}$$

$$\text{and} \quad Y = 1 - L_2 \tag{8}$$

A and B are determined for a set of X and Y by:

$$A = \frac{1}{N} \cdot \left| (\Sigma Y) - B(\Sigma X) \right| = \frac{\Sigma Y \Sigma X^2 - \Sigma X \Sigma XY}{N\Sigma X^2 - (\Sigma X)^2} \tag{9}$$

$$B = \frac{N \cdot \Sigma XY - (\Sigma X)(\Sigma Y)}{N \cdot \Sigma X^2 - (\Sigma X)^2} \tag{10}$$

Where,

L_2 = Fractional measured leak rate calculated by equation (5)
N = Number of time intervals in duration of test
Y = volume remaining after leakage
A = Y axis intercept
B = slope of the line of regression.

The measured leak rate is then given by:

$$Lam = \frac{(2400)B}{A} \tag{11}$$

This is the leak rate value reported in Section II.B.

The maximum standard error of estimate of the data from the line of regression is derived as an envelope function of both the variance of the slope (S_B^2) and the variance of the intercept (S_A^2). The resulting deviation will be the maximum deviation that can be expected and will envelope the complete set of statistical data included in the confidence level chosen.

The variance in the leak rate (S_L^2) is calculated by:

$$S_L^2 = \left[\frac{-B}{A^2}\right]^2 \cdot S_A^2 + \left[\frac{1}{A}\right]^2 \cdot S_B^2 + 2\left[\frac{-B}{A^2}\right]\left[\frac{1}{A}\right] C_{AB} \tag{12}$$

where C_{AB} is the covariance of A and B and,

$$S_A^2 = S^2 \frac{\Sigma(X^2)}{N\Sigma(X^2) - (\Sigma X)^2} \tag{13}$$

$$S_B^2 = \frac{S^2}{\Sigma(X^2) - \frac{(\Sigma X)^2}{N}} \tag{14}$$

$$C_{AB} = S^2 \frac{\Sigma(X)}{N\Sigma(X^2) - (\Sigma X)^2} \tag{15}$$

$$S^2 = \frac{1}{N-2}\left[\Sigma(Y^2) - \frac{(\Sigma Y)^2}{N} - \frac{\Sigma(XY) - \frac{(\Sigma X)(\Sigma Y)}{N}}{\Sigma(X^2) - \frac{(\Sigma X)^2}{N}}\right] \tag{16}$$

A statistically averaged leak rate is calculated for the Point to Point analysis by taking the arithmetical mean of the observed leak rates. The variance is determined for the Point to Point analysis by:

$$S_L^2 = \frac{\Sigma(Y - \bar{Y})^2}{N - 1} \qquad (17)$$

where,

Y = observed leak rate

$\bar{Y}$ = arithmetic mean of calculated leak rates.

For both the Total Time and Point to Point techniques the tolerance interval was calculated using a t distribution with N - 2 degrees of freedom. The resulting 95% tolerance level is:

$$TOL = \pm \frac{S_L \cdot t_{(0.05,\ N-2)} \cdot 2400}{\sqrt{N - 1}} \qquad (18)$$

E. FIGURE OF MERIT ANALYSIS

A Figure of Merit analysis is performed as a guide for instrument selection. The instrumentation system utilized in the performance of the 1980 Integrated Leak Rate Test is the same instrumentation system utilized for the preoperational and first periodic Type A tests. The Figure of Merit for this system is 0.062 percent weight per day. This number was recalculated using the technique previously reported to the Commission. The revised calculation incorporated calibration tolerances in the error estimates, rather than manufacturers' accuracy specifications. Since the Figure of Merit is less than 0.25 La, the measurement system is sufficiently accurate for this application.

F. COMPUTATIONAL FACILITIES

The 24 RTDs and 12 dew cells terminate in a data logger located in the Auxiliary Building. The data logger punches a paper tape with the following information:

*Time (hours and minutes)

*Pressure (psia)

*Each RTD Temperature (^{0}F)

*Each Dew Cell voltage.

This paper tape was carried to the Control Room and read by the Plant Computer, a PRODAC 250. The Plant Computer provides hard copy of the information on the paper tape and calculates the volume-weighted temperature and dew point averages. Individual readings may be accepted or rejected by the Test Supervisor.

A CRT terminal was temporarily located in the Control Room and connected by commercial telephone lines to the Green Bay office computer facilities. Based upon the time, absolute pressure, volume-weighted temperature and dew point averages obtained from the PRODAC 250 output, the Green Bay facilities computed the point to point leak rate, point to point mean, total time leak rate, total time least-squares linear fit, and 95% confidence level for each technique. Results were continuously available on the Control Room CRT and hard copies were produced at the Green Bay facilities.

The following information, which could have affected test results, was also collected with each data set: outside temperature, outside relative humidity, barometric pressure, and weather conditions. This information was stored with each data set, but did not enter into leak rate calculations.

Prior to the test the validity of the Green Bay computer code was verified by submitting data from the first periodic test and observing the calculated leak rates to be identical to the first periodic test results.

III. SUMMARY

Periodic Type A, Type B, and Type C leak rate tests were conducted during May and June, 1980, at the Kewaunee Nuclear Power Plant. The measured leak rates were less than the maximum permitted by 10CFR50 Appendix J. The results presented in this report include two penetrations opened during this refueling outage.

These results indicate the continued reliability of the Kewaunee Nuclear Power Plant Reactor Containment System.

TABLE 1

CONTAINMENT PENETRATION IDENTIFICATION

Penetration Number	Service
1	Pressurizer Relief Tank Gas Sample
2	Pressurizer Relief Tank Nitrogen Supply
3-DWT	Dead Weight Tester
3-X	Transmitter (P-21119)
4	Primary System Vent Header
5	Reactor Coolant Drain Pumps Discharge
6W	Main Steam (from Gen. 1A)
6E	Main Steam (from Gen. 1B)
7W	Feedwater (to Gen 1A)
7E	Feedwater (to Gen 1B)
8S	Steam Generator 1A Blowdown
8N	Steam Generator 1B Blowdown
9	Residual Heat Removal Loop Out
10	Residual Heat Removal Loop In
11	Letdown Line
12	Charging Line
13N	Reactor Coolant Pump 1A Seal Water Supply
13E	Reactor Coolant Pump 1B Seal Water Supply
14	Reactor Coolant Pump 1A & 1B Seal Water Return

TABLE 1

CONTAINMENT PENETRATION IDENTIFICATION

Penetration Number	Service
15-SS	Pressurizer Steam Sample
15-LS	Pressurizer Liquid Sample
15-HLS	Pressurizer Hot Leg Sample
18	Fuel Transfer Tube
19	Service Air
20	Instrument Air
21	Reactor Coolant Drain Tank Gas Sample
22	Containment Air Sample In
23	Containment Air Sample Out
24	Service Water
25N	Containment Purge Exhaust Duct
25S	Containment Purge Supply Duct
26	Containment Sump A Discharge
27N-X1	Instrumentation (P-21117)
27N-X2	Instrumentation (P-21102)
27N-SW	Instrumentation (DPS-16427)
27NE-X1	Instrumentation (P-21105)
27NE-X2	Instrumentation (P-21100)
27NE-X3	Instrumentation (DP-21122)

TABLE 1

CONTAINMENT PENETRATION IDENTIFICATION

Penetration Number	Service
27EN	Instrumentation (ILRT)
27EN-X	Instrumentation (P-21101)
30E	Containment Sump B to RHR Pump 1A
30W	Containment Sump B to RHR Pump 1B
31	Nitrogen to Accumulators
32N	Component Cooling Water to RC Pump 1A
32E	Component Cooling Water to RC Pump 1B
33N	Component Cooling Water from RC Pump 1A
33E	Component Cooling Water from RC Pump 1B
35	Test Line for Safety Inj. and Accumulators
36N-X2	Instrumentation (P-21118)
36N-SW	Instrumentation (PS-16428)
36S	Containment Atmosphere Test Line
36W	Containment Atmosphere Test Line
36SE	Air Supply to Containment
36NW	Air Supply to Containment
37NW	Service Water to Containment Fan Coil Unit 1A
37NE	Service Water to Containment Fan Coil Unit 1B
37ES	Service Water to Containment Fan Coil Unit 1C

TABLE 1

CONTAINMENT PENETRATION IDENTIFICATION

Penetration Number	Service
37EN	Service Water to Containment Fan Coil Unit 1D
38NW	Service Water from Containment Fan Coil Unit 1A
38NE	Service Water from Containment Fan Coil Unit 1B
38ES	Service Water from Containment Fan Coil Unit 1C
38EN	Service Water from Containment Fan Coil Unit 1D
39	Component Cooling Water to Excess Letdown Heat Exchangers
40	Component Cooling Water from Excess Letdown Heat Exchangers
41S/S	Containment Vacuum Breaker
41E	Containment Vacuum Breaker
42N	Containment Vessel Pressurization Test
44NW	Volume Control Tank Return Line
45	Reactor Make-up Water to Pressurizer Relief Tank
48	Low Head Safety Injection to Reactor Vessel
49NE	Deaerated Drain Tank Return
SP1AB	Special Sheet for Penetrations 32N, 32E, 33N, 33E, 39, & 40

TABLE 2

SUMMARY OF TYPE B AND TYPE C TESTS

TEST	ACCEPTANCE CRITERIA	AS FOUND *	AS LEFT
Total leak rate of all components subject to Type B and Type C tests	<0.6La	>0.142	0.076
	<684 SCFH	>162.221	87.167
Leakage bypassing the annulus to Zone SV	<0.1La	>0.088	0.040
	<114 SCFH	>100.644	45.259
Leakage bypassing both the annulus and Zone SV	<0.01La	>0.020	0.003
	<11.4 SCFH	>22.836	3.167

NOTE The as found leak rate of four penetrations exceeded the capacity of the measurement device, 20 SCFH. 20 SCFH was used as the as found leak rate for each of these penetrations in calculating the total leak rates. Refer to Table 3 for identification of the penetrations.

TABLE 3

REPAIR SUMMARY

PENETRATION	COMPONENT	REPAIR	LEAK RATE, AS FOUND (SCFH)	LEAK RATE, AS LEFT (SCFH)	COMMENTS
13N	CVC 205A	Clean seat.	>20	0.164	No safety effect. Backup valve satisfactory.
13E	CVC 205B	Clean seat.	>20	1.830	No safety effect. Remains in service post-accident.
	CVC 206B	Replace valve.	>20	0.004	No safety effect. Remains in service post-accident.
15-SS	RC 402	Adjust stroke.	>20	0.985	No safety effect. Backup valve satisfactory.
24	SW 6011	Replace valve.	>20	0.331	No safety effect. Backup valve satisfactory.

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
			LEAKAGE (SCFH)			
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
1	1C 2C	MG(R) 513 MG(R) 512	0.052 OR 0.077	0.077	0.077	XXXXXX
2	1C 2C	NG 302 NG 304	0.084 OR 0.066	0.084	XXXXXX	0.084
3-DWT	B C	Dead Weight Tester 3/8" needle valve (DWT)	0.000 OR 0.000	0.000	XXXXXX	0.000
3-X	B 1C 2C	xmtr P-21119 3/8" globe valve #2 to xmtr 3/8" globe valve #1 to xmtr	0.000 OR 0.000 OR 0.000	0.000	XXXXXX	0.000
4	1C 2C	MG(R) 510 MG(R) 509	0.028 OR 0.020	0.028	0.028	XXXXXX
5	1C 2C	RC 508 RC 507	0.068 OR 0.038	0.068	0.068	XXXXXX
6W	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
6E	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
7W	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
7E	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
8S	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		0.257	0.173	0.084

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	LEAKAGE (SCFH) PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
8N	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
9	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
	1C 2C	RHR-1A, RHR-2A RHR-1B, RHR-2B	0.024 + 0.783	0.807	0.807	XXXXXX
10	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
11	1B 2B	Exp. Bellows Exp. Bellows	0.000 + 0.000	0.000	XXXXXX	XXXXXX
	1C 2C	LD-4A, LD-4B, LD-4C LD-6	4.710 OR 0.022	4.710	4.710	XXXXXX
12	1C 2C	CVC-7 CVC-10	0.060 OR 16.910	16.910	16.910	XXXXXX
13N	1C 2C	CVC 205A CVC 206A	0.164 OR 1.800	1.800	1.800	XXXXXX
13E	1C 2C	CVC 205B CVC 206B	1.830 OR 0.004	1.830	1.830	XXXXXX
14	1C 2C	CVC 212 CVC 211	0.323 OR 0.254	0.323	0.323	XXXXXX
15-SS	1C 2C	RC 403 RC 402	0.084 OR 0.985	0.985	0.985	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		27.365	27.365	0.000

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	LEAKAGE (SCFH) PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
15-LS	1C 2C	RC 413 RC 412	0.058 OR 0.075	0.075	0.075	XXXXXX
15-HLS	1C 2C	RC 423 RC 422	0.075 OR 0.033	0.075	0.075	XXXXXX
18	1B 2B 3B	Exp. Bellows Exp. Bellows Exp. Bellows	0.000 OR 0.000 OR 0.000	0.000	XXXXXX	XXXXXX
	4B	"O" ring seal	0.000	0.000	XXXXXX	0.000
19	1C 2C	SA 471 SA 472	0.709 OR 0.770	0.770	XXXXXX	0.770
20	1C 2C 3C	IA 101 IA 102 IA 103	0.850 OR 1.586 OR 1.920	1.920	XXXXXX	1.920
21	1C 2C	MG(R) 504 MG(R) 503	0.000 OR 0.043	0.043	0.043	XXXXXX
22	1C 2C	AS 32 AS 33	2.190 OR 2.940	2.940	2.940	XXXXXX
23	1C 2C	AS 1 AS 2	0.147 OR 0.015	0.147	0.147	XXXXXX
24	1C 2C	SW 6010 SW 6011	0.182 OR 0.331	0.331	XXXXXX	0.331
25N	C	RBV-4, RBV-3	0.413	0.413	XXXXXX	XXXXXX
25S	C	RBV-1, RBV-2	0.038	0.038	XXXXXX	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		6.752	3.280	3.021

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	LEAKAGE (SCFH) PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
26	1C 2C	MD(R) 135 MD(R) 134	0.062 OR 0.000	0.062	0.062	XXXXXX
27N-X1	B 1C 2C	xmtr P-21117 & bypass valve 3/8" globe valve #2 to xmtr 3/8" globe valve #1 to xmtr	0.008 OR 0.000 OR 0.000	0.008	0.008	XXXXXX
27N-X2	B 1C 2C	xmtr P-21102 3/8" globe valve #2 to xmtr 3/8" globe valve #1 to xmtr	0.000 OR 0.000 OR 0.000	0.000	XXXXXX	0.000
27N-SW	B 1C 2C	switch 16427 & bypass valve 3/8" globe valve #2 to switch 3/8" globe valve #1 to switch	0.000 OR 0.000 OR 0.000	0.000	XXXXXX	0.000
27NE-X1	B 1C 2C	xmtr P-21105 3/8" globe valve #2 to xmtr 3/8" globe valve #1 to xmtr	0.000 OR 0.000 OR 0.000	0.000	XXXXXX	0.000
27NE-X2	B 1C 2C	xmtr P-21100 3/8" globe valve #2 to xmtr 3/8" globe valve #1 to xmtr	0.000 OR 0.000 OR 0.000	0.000	XXXXXX	0.000
27NE-X3	B 1C 2C	xmtr DP-21122 & bypass valve 3/8" globe valve #2 to xmtr 3/8" globe valve #1 to xmtr	0.000 OR 0.000 OR 0.062	0.062	XXXXXX	0.062
27EN	B	Test Line plug (outside Containment)	0.000	0.000	0.000	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		0.132	0.070	0.062

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
			LEAKAGE (SCFH)			
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
27EN-X	B	xmtr P-21101	0.000 OR	0.000	XXXXXX	0.000
	1C	3/8" globe valve #2 to xmtr	0.000 OR			
	2C	3/8" globe valve #1 to xmtr	0.000			
30E	C	SI 350A, SI 351A	0.810	0.810	0.810	XXXXXX
30W	C	SI 350B, SI 351B	4.830	4.830	4.830	XXXXXX
31	C	NG 107, NG 108A, NG 108B	0.000	0.000	XXXXXX	0.000
35	C	SI 202A, SI 201A, SI 202B, SI 201B, SI 203A-1, SI 203B-1, SI 204	0.000	0.000	0.000	XXXXXX
36N-X2	B	xmtr P-21118	0.000 OR	0.000	XXXXXX	0.000
	1C	3/8" globe valve to xmtr	0.000 OR			
	2C	3/8" globe valve to xmtr	0.000			
36N-SW	B	switch 16428 & bypass valve	0.000 OR	0.000	XXXXXX	0.000
	1C	3/8" globe valve to switch	0.000 OR			
	2C	3/8" globe valve to switch	0.000			
36S	1C	RBV 15-1, RBV 16-1	5.130 OR	5.130	5.130	XXXXXX
	2C	RBV 14-3	0.000			
36W	1C	RBV 15-2, RBV 16-2	0.069 OR	0.069	0.069	XXXXXX
	2C	RBV 14-4	0.004			
36SE	1C	RBV 17-1	0.193 OR	0.558	0.558	XXXXXX
	2C	RBV 14-1	0.558			
36NW	1C	RBV 17-2	0.102 OR	0.138	XXXXXX	XXXXXX
	2C	RBV 14-2	0.138			
		TOTAL LEAKAGE, THIS SHEET:		11.535	11.397	0.000

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
			LEAKAGE (SCFH)			
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
41E	1B	"O" ring seals (VB-11B) (included in the Type C test)	0.000	XXXXXX	XXXXXX	XXXXXX
	2B	"O" ring seals (VB-10B) (included in the Type C test)	0.000	XXXXXX	XXXXXX	XXXXXX
	3B	"O" ring seals (VB-10B)	0.000 +	0.062	XXXXXX	XXXXXX
	C	VB-10B, VB-11B	0.062			
41S/S	1B	"O" ring seals (VB-11A) (included in the Type C test)	0.000	XXXXXX	XXXXXX	XXXXXX
	2B	"O" ring seals (VB-10A) (included in the Type C test)	0.000	XXXXXX	XXXXXX	XXXXXX
	3B	"O" ring seals (VB-10A)	0.000 +	0.556	XXXXXX	XXXXXX
	C	VB-10A, VB-11A	0.556			
42N	B	"O" ring seals (blind FLG)	0.000	0.000	XXXXXX	XXXXXX
44NW	B	penetration canister	0.000	0.000	0.000	XXXXXX
45	1C	MU 1010-1	0.000 OR	0.096	XXXXXX	XXXXXX
	2C	MU 1011	0.096			
48	C	SI 302B	0.194	0.194	0.194	XXXXXX
49NE	1C	WD 78-3	2.780 OR	2.780	2.780	XXXXXX
	2C	WD 77-1, WD 77-2	0.109			
A	B	manifold A electrical penetration canisters (8)	0.141	0.141	XXXXXX	XXXXXX
B	B	manifold B electrical penetration canisters (7)	0.193	0.193	XXXXXX	XXXXXX
C	B	manifold C electrical penetration canisters (5)	0,264	0.264	XXXXXX	XXXXXX
D	B	manifold D electrical penetration canisters (9)	0.472	0.472	XXXXXX	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		4.758	2.974	0.000

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	LEAKAGE (SCFH) PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
E	B	manifold E electrical penetration canisters (9)	0.255	0.255	XXXXXX	XXXXXX
F	B	manifold F electrical penetration canisters (10)	0.267	0.267	XXXXXX	XXXXXX
Equipment Door	B	Equipment Door double seals	0.068	0.068	XXXXXX	XXXXXX
Personnel Airlock	B	Personnel Airlock	0.050	0.050	XXXXXX	XXXXXX
	B	Personnel Airlock inner door double seals (included in the personnel airlock test)	0.151	XXXXXX	XXXXXX	XXXXXX
	B	Personnel Airlock outer door double seals (included in the Personnel Airlock test)	0.410	XXXXXX	XXXXXX	XXXXXX
	B	Personnel Airlock emergency air opening seal (included in the Personnel Airlock test)	0.000	XXXXXX	XXXXXX	XXXXXX
AL1	B	Personnel Airlock electrical penetration canister (included in the Personnel Airlock test)	0.000	XXXXXX	XXXXXX	XXXXXX
AL2	B	Personnel Airlock electrical penetration canister (included in the Personnel Airlock test)	0.007	XXXXXX	XXXXXX	XXXXXX
Emergency Airlock	B	Emergency Airlock	0.050	0.050	XXXXXX	XXXXXX
	B	Emergency Airlock emergency air opening seal (included in the Emergency Airlock test)	0.000	XXXXXX	XXXXXX	XXXXXX
	B	Emergency Airlock inner door double seals (included in the Emergency Airlock test)	0.007	XXXXXX	XXXXXX	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		0.690	0.000	0.000

TABLE 4

TABULATION OF LEAK RATES, VENTED SYSTEMS

1	2	3	4	5	6	7
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	LEAKAGE (SCFH) PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
Emergency Airlock	B	Emergency Airlock outer door double seals (included in the Emergency Airlock test)	0.000	XXXXXX	XXXXXX	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		0.000	0.000	0.000

TABLE 5

TABULATION OF LEAK RATES, NON VENTED SYSTEMS

1	2	3	4	5	6	7
PENETRATION NUMBER	TEST TYPE & NO.	ITEM TESTED	LEAKAGE (SCFH) PER TEST	PER PENETR.	TO ZONE SV	BYPASS ZONE SV
8S	C	BT-2A, BT-3A	0.092	0.092	XXXXXX	XXXXXX
8N	C	BT-2B, BT-3B	0.143	0.143	XXXXXX	XXXXXX
30E	B	enclosure for SI 350A	0.000	0.000	XXXXXX	XXXXXX
30W	B	enclosure for SI 350B	0.034	0.034	XXXXXX	XXXXXX
37NW & 38NW	C	SW 901A	0.294	0.294	XXXXXX	XXXXXX
37NE & 38NE	C	SW 901B	0.471	0.471	XXXXXX	XXXXXX
37ES & 38ES	C	SW 901C	0.044	0.044	XXXXXX	XXXXXX
37EN & 38EN	C	SW 901D	0.842	0.842	XXXXXX	XXXXXX
SP1AB (penetrations 32N, 32E, 33N, 33E, 39, &40)	1C	CC 601A, CC 601B	0.054	0.054	XXXXXX	XXXXXX
	2C	CC 602A	15.960	15.960	XXXXXX	XXXXXX
	3C	CC 612A	17.520	17.520	XXXXXX	XXXXXX
	4C	CC 602B	0.009	0.009	XXXXXX	XXXXXX
	5C	CC 612B	0.059	0.059	XXXXXX	XXXXXX
	6C	CC 653, CC 651	0.156	0.156	XXXXXX	XXXXXX
		TOTAL LEAKAGE, THIS SHEET:		35.678	0.000	0.000

TABLE 6

INTEGRATED LEAK RATE TEST DATA & RESULTS

ELAPSED TIME hours	PRESS. psia	TEMP. °F	DEW POINT °F	POINT TO POINT %/day	TOTAL TIME %/day
00.00	60.068	76.05	58.84		
00.25	60.068	76.05	58.47	-0.508	-0.508*
00.50	60.068	76.06	58.86	0.715	0.104
00.75	60.069	76.05	59.03	-0.105	0.034
01.00	60.068	76.11	59.33	0.054	0.039
01.25	60.090	76.19	59.06	-0.862	-0.141
01.50	60.096	76.29	59.26	1.115	0.068
01.77	60.100	76.33	59.48	0.362	0.113
01.98	60.104	76.37	59.14	-0.459	0.050
02.25	60.108	76.40	59.17	-0.056	0.037
02.45	60.110	76.43	59.25	0.413	0.068
02.77	60.113	76.48	59.42	0.518	0.120
03.02	60.115	76.51	58.91	-0.492	0.069
03.27	60.116	76.53	59.72	1.333	0.166
03.52	60.119	76.57	59.17	-0.535	0.116
03.77	60.120	76.56	59.74	0.461	0.139
04.35	60.127	76.64	59.40	-0.070	0.111
04.77	60.130	76.67	58.85	-0.424	0.064
04.82	60.129	76.68	59.39	5.458	0.120
05.02	60.130	76.67	58.59	-1.812	0.043
05.27	60.131	76.68	59.03	0.626	0.071
05.52	60.131	76.71	59.20	0.776	0.103
05.77	60.134	76.72	58.71	-0.980	0.056
06.02	60.136	76.72	58.78	-0.224	0.044
06.35	60.139	76.73	58.83	-0.174	0.033
06.52	60.138	76.74	58.97	0.800	0.052
06.77	60.139	76.74	58.85	-0.326	0.038
07.02	60.140	76.75	59.10	0.366	0.050
07.27	60.143	76.77	59.08	-0.149	0.043
07.52	60.144	76.79	59.11	0.241	0.050
07.77	60.144	76.77	59.28	-0.122	0.044
08.02	60.144	76.78	58.94	-0.293	0.034
08.52	60.148	76.80	59.19	0.033	0.034
09.02	60.147	76.79	59.10	-0.072	0.028
09.52	60.148	76.80	58.96	-0.087	0.022
10.02	60.148	76.81	58.76	-0.048	0.018
10.52	60.150	76.83	59.09	0.248	0.029
10.97	60.151	76.83	58.97	-0.182	0.020
11.47	60.149	76.81	58.97	-0.019	0.019

TABLE 6

INTEGRATED LEAK RATE TEST DATA & RESULTS

ELAPSED TIME hours	PRESS. psia	TEMP. °F	DEW POINT °F	POINT TO POINT %/day	TOTAL TIME %/day
11.97	60.149	76.81	58.94	-0.021*	0.017
12.47	60.148	76.80	59.06	0.073	0.019
12.97	60.144	76.78	58.94	0.058	0.021
13.47	60.139	76.71	58.89	-0.263	0.010
13.98	60.136	76.71	59.16	0.414	0.025
14.45	60.138	76.74	58.86	0.106	0.021
14.95	60.138	76.77	58.79	0.221	0.028
15.43	60.139	76.75	58.93	-0.169	0.021
15.88	60.139	76.76	58.96	0.123	0.024
16.38	60.138	76.77	58.94	0.156	0.028
16.80	60.138	76.76	58.60	-0.389	0.018
17.35	60.136	76.75	58.88	0.239	0.025
17.80	60.136	76.75	58.87	-0.008	0.024
18.27	60.139	76.79	59.11	0.306	0.031
18.77	60.139	76.84	58.79	0.228	0.037
19.25	60.142	76.88	58.53	-0.062	0.034
19.75	60.147	76.90	58.61	-0.166	0.029
20.23	60.148	76.94	58.45	0.176	0.033
20.75	60.154	77.02	58.99	0.590	0.046
21.23	60.158	77.09	58.76	0.154	0.049
21.75	60.164	77.13	58.69	-0.164	0.044
22.25	60.167	77.16	58.99	0.236	0.048
22.75	60.168	77.19	58.83	0.079	0.049
23.25	60.168	77.23	59.41	0.763	0.064
23.73	60.170	77.26	58.86	-0.283	0.057
24.03	60.169	77.23	58.68	-0.522	0.050

POINT TO POINT RESULTS	ACCEPTANCE CRITERIA
Mean = 0.110 percent weight per day	XXX
Mean at 95% UCL = 0.318 percent weight per day	XXX

TOTAL TIME RESULTS	
Least-squares fit = 0.036 percent weight per day	0.375 %/day
Least-squares fit at 95% UCL = 0.037 %/day	XXX

*Negative indicates gain in mass.

TABLE 7

SUPPLEMENTAL TEST DATA

ELAPSED TIME hours	PRESS. PSIA	TEMP °F	DEW POINT °F	POINT TO POINT %/day	TOTAL TIME %/day	IMPOSED LEAK SCFM
0.00	60.202	77.57	58.77			14.05
0.27	60.206	77.66	58.62	0.720	0.720	14.04
0.52	60.213	77.72	58.82	0.231	0.484	14.19
0.77	60.212	77.73	59.16	0.811	0.590	14.07
1.02	60.215	77.78	59.12	0.361	0.534	14.06
1.27	60.214	77.82	58.85	0.503	0.528	14.09
1.52	60.214	77.82	59.46	0.850	0.581	14.04
1.77	60.214	77.85	59.07	-0.007*	0.498	14.04
2.02	60.214	77.85	58.56	-0.704	0.349	14.03
2.27	60.214	77.88	58.78	0.840	0.403	14.05
2.52	60.212	77.88	59.03	0.666	0.429	14.05

*Negative indicates gain in mass.

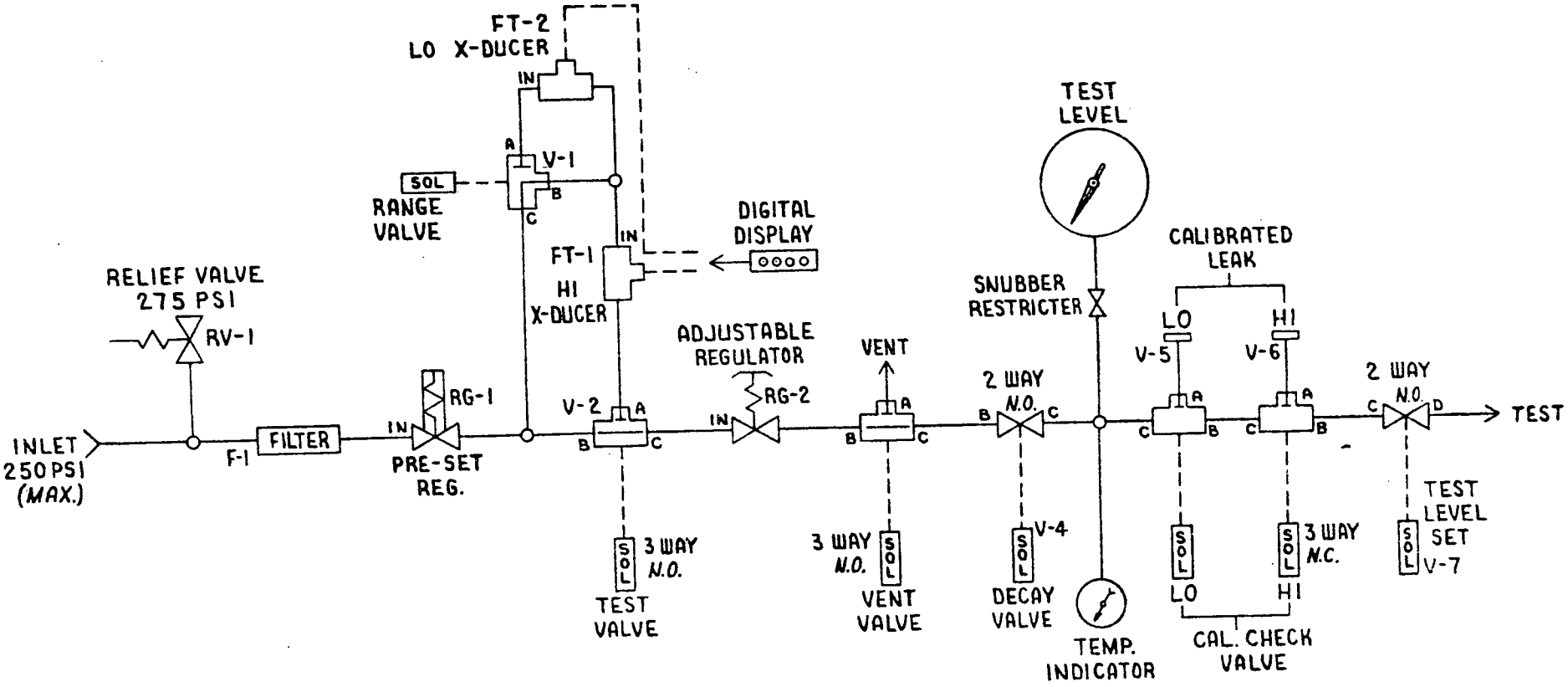
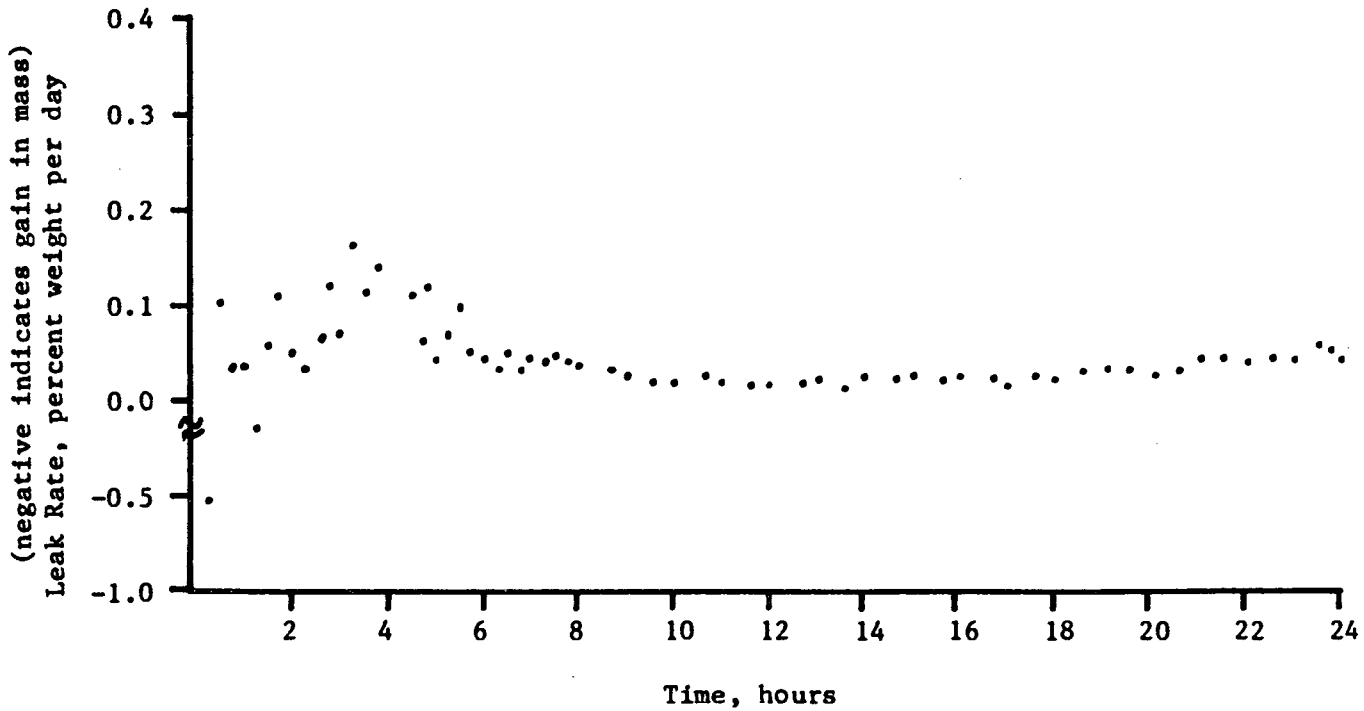


FIGURE 1 LEAK RATE MONITOR
PIPING AND INSTRUMENTATION DIAGRAM
VOLUMETRICS MODEL No. 14322

FIGURE 2



INTEGRATED LEAK RATE TEST AT 46 psig
TOTAL TIME ANALYSIS PLOT

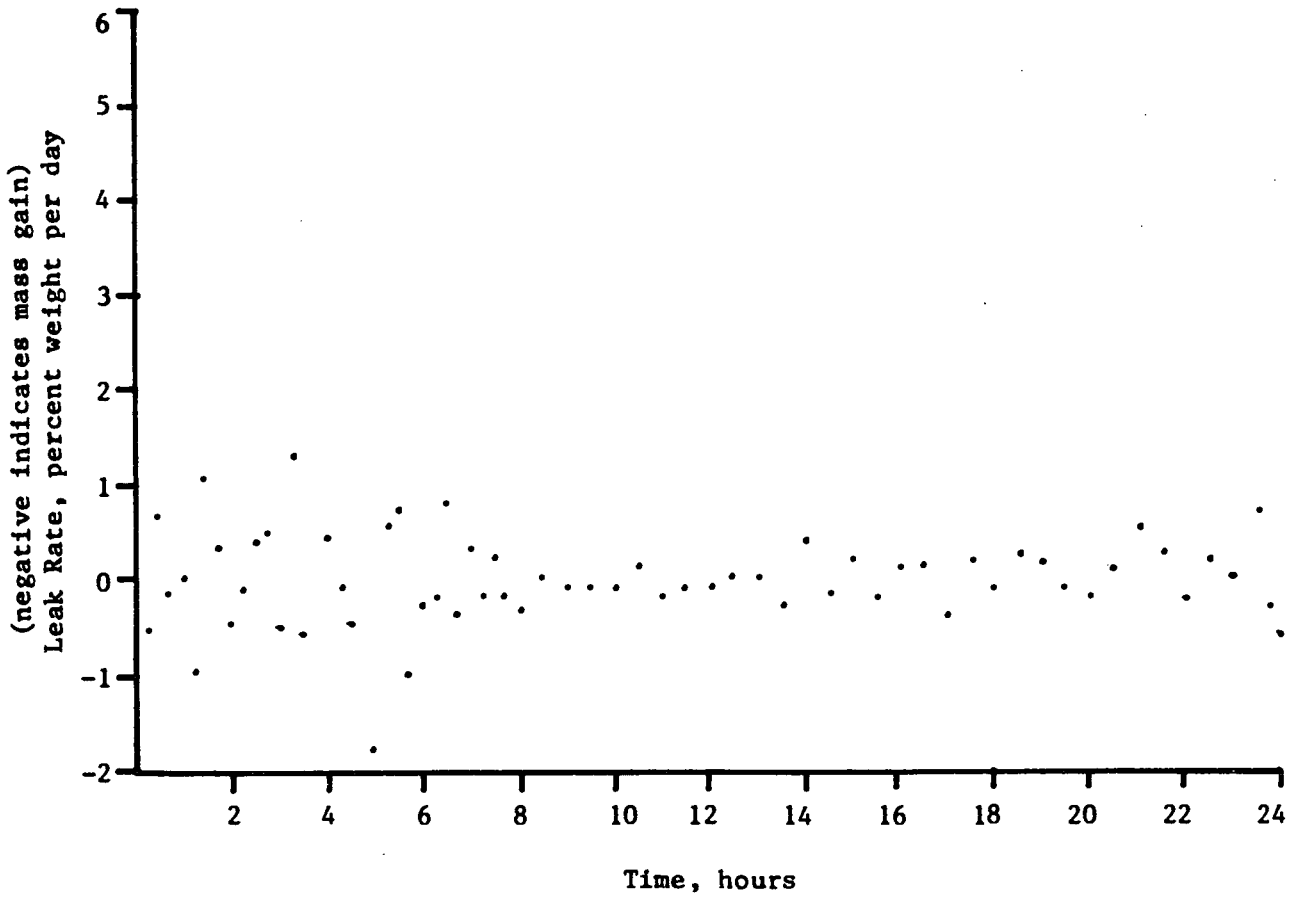


FIGURE 3

INTEGRATED LEAK RATE TEST AT 46 psig
POINT TO POINT ANALYSIS PLOT