VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

January 15, 1991

U.S. Nuclear Regulatory Commission
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Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT 2
REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST

Pursuant to 10 CFR 50, Appendix J, Section V.B, enclosed is the Reactor Containment Building Integrated Leak Rate Test Report for North Anna Power Station Unit 2.

If you have any questions or require additional information, please contact us.

Very truly yours,

W. L. Stewart
Senior Vice President - Nuclear

Enclosure

cc: U.S. Nuclear Regulatory Commission
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NORTH ANNA POWER STATION

UNIT 2

REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST

OCTOBER 1990

VIRGINIA ELECTRIC AND POWER COMPANY

INDEX

SECTIONS

APPENDICES

SECTION 1

INTRODUCTION

This report has been prepared to provide a description and an analysis of the October 1990 containment integrated leakage rate test (ILRT) performed on Virginia Electric and Power Company's (VEPCO's) North Anna Power Station, Unit 2 and to provide a summary of the local leakage rate tests (LLRTs) performed on the Unit 2 containment penetrations since the last Unit 2 ILRT which was performed in April 1989.

Bechtel Power Corporation (Containment Test Group) provided engineering consultation services to VEPCO during the performance of the October 1990 Unit 2 ILRT.

This report is submitted as required by 10CFR50, Appendix J, Section V.B.

SECTION 2

SUMMARY

2.1 October 1990 CONTAINMENT INTEGRATED LEAKAGE RATE TEST (ILRT)

The final containment walkdown and penetration preparations were completed by 1230 on 10/16/90.

Pressurization began at 1617 on 10/16/90. During the pressurization, extensive leak checks were performed by visually inspecting potential leak paths such as the mechanical penetration area, the electrical penetration area, the personnel air lock, and the main steam lines. No significant leakage paths were discovered.

Pressurization was secured at 0339 on 10/17/90 at a containment pressure of 44.55 psig. Stablization requirements were met and the ILRT started at 1800 on 10/17/90. One of the containment air recirculation fans tripped at 1634 on 10/18/90. Fortunately this occurred late in the test, thus a statistically acceptable test was still obtainable.

The ILRT portion of the procedure was successfully completed at 1800 on 10/18/90. The 24 hour 95% UCL mass point leakage rate was 0.022 weight %/24 hours.

The verification test was initiated at 1900 on 10/18/90. The verification test required 9 hours to complete because of the effects of the containment air recirculation fan tripping. The verification test was successfully completed at 0400 on 10/19/90 with a measured mass point composite leakage rate of 0.104 wt %/24 hrs, which was within the allowable range of 0.095 wt %/24 hrs to 0.145 wt %/24 hrs.

2.2 LOCAL LEAKAGE RATE TESTS (LLRTs)

The local leakage rate tests (LLRTs) of the containment isolation valves and primary containment penetrations have been conducted since the performance of the last Unit 2 ILRT performed in April 1989 as required by 10CFR50, Appendix J and the Station's Unit 2 Technical Specifications using appropriate Station procedures.

In accordance with 10CFR50, Appendix J, Section V.B, the data for the Unit 2 LLRTs performed since April 1989 are summarized in Appendices D and E of this report.

SECTION 3

GENERAL AND TECHNICAL DATA

3.1 GENERAL DATA

3.1.1	Owner:	Virginia Electric and Power Company
	Plant Name:	North Anna Power Station
	Unit:	2
3.1.2	Docket No.:	50-339
3.1.3	Plant Location:	South shore of Lake Anna Louisa County, Virginia
3.1.4	Containment Description:	Reinforced concrete, steel lined, Operating at subatmospheric pressure
3.1.5	ILRT Completion Date:	October 19, 1990

TECHNICAL DATA

3.2.1	Containment Net Free Volume:	1.825×10^6 cubic feet
3.2.1	Design Pressure:	45.0 psig
3.2.3	Design Temperature:	280 °F
3.2.4	Calculated LOCA Peak Pressure:	44.1 psig
3.2.5	Calculated LOCA Peak Temperature:	280 °F

SECTION 4

ACCEPTANCE CRITERIA

4.1 ILRT

4.1.1	Test Method:	Absolute Method
4.1.2	Data Analysis Technique:	24 Hour Test Duration using the Mass Point Data Analysis Method
4.1.3	Test Pressure:	44.1 psig - 45.0 psig
4.1.4	Maximum Allowable Leakage Rate:	0.1 weight%/24 hours (304.4 SCFH)
4.1.5	Maximum Unit 2 Technical Specification Leakage Rate:	0.075 wt %/24 hours

4.2 VERIFICATION TEST

4.2.1	Superimposed Leakage Rate Range:	0.075 wt%/24 hrs - 0.125 wt%/24 hrs
4.2.2	Required Agreement for Composite Leakage Rate:	+/- 0.025 wt %/24 hours

SECTION 5

TEST INSTRUMENTATION

5.1 INSTRUMENTATION SELECTION GUIDE (ISG) FORMULA CALCULATION RESULTS

Appendix B provides the calculations of the ISG at the ILRT conditions.

5.2 MEASUREMENT SYSTEM COMPONENT DESCRIPTION

For the ILRT, eighteen resistance temperature detectors (RTDs), 5 moisture temperature detectors (MTDs), and 2 absolute manometers were used.

In addition to the above instrumentation, two laminar flow elements were used for the verification test.

5.3 PERFORMANCE OF INSTRUMENTATION

All of the test instrumentation performed as required during the ILRT and the verification test except RTD 2-LM-TE-200-16 which erratically fluctuated high and low. It was deleted from all leak rate calculations.

SECTION 6

TEST PROCEDURE

6.1 INITIAL CONDITIONS FOR TESTING

In accordance with the North Anna Power Station Unit 2 ILRT procedures, 2-PT-61.1 and 2-PT-61.1 A-K, the following initial conditions were met and documented prior to commencing containment pressurization. The following is not an all inclusive listing of the procedural initial conditions.

6.1.1 In accordance with 10CFR50, Appendix J, Section V.A, a general inspection of the accessible interior and exterior surfaces of the containment structure was satisfactorily performed.

6.1.2 All test instrumentation was calibrated within six months of the test.

6.1.3 All required system valve line-ups were completed, including the venting of possible pressurization sources.

6.1.4 All required local leakage rate testing was completed and reviewed by the Test Director.

6.1.5 A leak check of the absolute side of the leakage monitoring system was successfully completed.

6.1.6 The computers were operational and programmed for the ILRT.

6.1.7 A containment walkdown was performed to ensure no pressurization sources were present in containment.

6.1.8 The containment air recirculation system was operational and maintaining stable containment atmospheric conditions.

6.1.9 The official log of events was established.

6.1.10 Site meteorological data was recorded during the performance of the test.

6.2 PRESSURIZATION PHASE

Pressurization of the containment was achieved by the use of ten diesel driven air compressors. Compressed air was piped through two aftercoolers in parallel and then through a refrigerant air dryer. Adequate instrumentation and controls were installed to maintain control of the compressed air quality during the pressurization phase. The total capacity of the pressurization system was slightly in excess of 10,000 cubic feet per minute. Pressurization was initiated at 1617 on 10/16/90 and was secured at 0339 on 10/17/90 at a containment pressure of 44.55 psig.

6.3 ILRT PHASE

The various containment parameters were monitored by the Leakage Monitoring (LM) system instrumentation. The instrumentation consisted of eighteen resistance temperature detectors (RTDs), 5 moisture temperature detectors (MTDs), and two absolute manometers.

Stablization requirements were met and the ILRT started at 1800 on 10/17/90. Containment air recirculating fan 2-HV-F-1B tripped at 1634 on 10/18/90 with approximately 1½ hours remaining in the test. A statistically acceptable test was obtained despite this disturbance.

The ILRT portion of the procedure continued until 1800 on 10/18/90. Data from RTD 2-LM-TE-200-16 was discounted from all test calculations because of observed

erratic output. The levels of tanks and vessels located inside containment were monitored hourly during the testing portion with no significant differences noted except reduction in pressurizer level and increase in containment sump level. The pressurizer level decrease was expected due to the known RCS leak. A calculation has been performed which verifies that that there was no resultant change in containment free volume. The 24 hour 95% UCL mass point leakage rate was 0.022 weight %/24 hours.

6.4 VERIFICATION PHASE

The verification test was initiated at 1900 on 10/18/90. The test required 9 hours because of the disruption of air flow in the containment which resulted from the recirculating air fan tripping.

The verification test was completed at 0400 on 10/19/90 with a measured mass point composite leakage rate of 0.104 wt %/24 hrs, which was within the allowable range of 0.095 wt %/24 hrs to 0.145 wt %/24 hrs.

6.5 DEPRESSURIZATION PHASE

The containment was depressurized through a T-connection and ball valve installed in the temporary pressurization piping. The post containment walkdown revealed no significant deficiencies.

SECTION 7

ANALYSIS METHODS

7.1 DATA ACQUISITION SYSTEM

The data acquisition system used for the ILRT and the verification test, with exception of the flowmeters, was the Unit 2 Westinghouse Prodac P250 plant computer. Monitoring of the flowmeters during the verification test was accomplished by local observation of the digital displays to ensure a constant flow rate.

The instantaneous P250 data was inputted at fifteen minute intervals to a personal computer and processed by the Bechtel Power Corporation's ILRT computer program. This program verifies the validity of the data, weights the RTD and MTD readings, and performs the necessary leakage rate calculations. The inputting of data continued from the start of pressurization until the end of the verification test.

Instantaneous values of the ILRT instruments were printed at 15 minute intervals during the test period using the P250 digital trend function on the operator's console.

7.2 ABSOLUTE METHOD OF MASS POINT ANALYSIS

The absolute method of mass point analysis consists of calculating air masses within the containment structure over the test period using pressure, temperature, and air moisture inputs. The air masses are computed using the ideal gas law as follows:

$$M = \frac{144V\,(P-P_v)}{RT}$$

where: M = containment air mass, lbm

P = total containment pressure, psia

P_v = containment vapor pressure, psia

R = universal gas constant for air, 53.35 ft-lb_f/lb_m-R

T = average containment temperature, R

V = containment volume, 1.825×10^6 ft^3.

The leakage rate is then determined by plotting the containment air mass as a function of time, using a least squares fit to determine the slope.

A 95-percent confidence interval is calculated using a Student's t distribution. The sum of the leakage rate and the 95-percent confidence interval is the UCL. Appendix B provides further description of the program.

7.3 STATISTICAL EVALUATION

Appendices A and B provide the necessary information for the statistical evaluation of the data.

SECTION 8

TEST RESULTS

8.1 ILRT

Measured Leakage Rate: 0.020 weight %/24 hours
UCL: 0.022 weight %/24 hours

	As Found	As Left
Leakage Savings:	0.012 wt %/24 hrs	0.000 wt %/24 hrs
Type C Penalties:	0.003 wt %/24 hrs	0.003 wt %/24 hrs
Total Reported Leakage:	0.037 wt %/24 hrs	0.025 wt %/24 hrs

8.1.1 Leakage Savings Description

The leakage savings for the As Found ILRT is the difference in the minimum pathway leakage (MPL) from the premaintenance Type C values recorded at the start of the 1990 Unit 2 outage and MPL from the Type C values recorded after maintenance and prior to the Unit 2 October 1990 ILRT. The leakage savings for the As Left ILRT is the difference in the MPL from the Type C values recorded at the time of the Unit 2 October 1990 ILRT and the MPL from the Type C values recorded after post ILRT maintenance and prior to the November 1990 Unit 2 Cycle 8 start-up.

ILRT As Found Leakage Savings

Penetration Number	Outage As Found MPL (SCFH)	ILRT MPL (SCFH)	Leakage Savings (SCFH)
38	1.0	0	1.0
39	2.0	0	2.0
53	0.1	0	0.1
56A	0.50	0	0.05
64	0.4	0	0.4
71	1.2	0	1.2
84	16.0	0	16.0
85	12.0	0	12.0
89	0.35	0	0.35
90	1.2	0.4	0.8
91	3.4	0.8	2.6
Emergency Escape Air Lock	1.35	1.15	0.40
Personnel Air Lock	2.75	3.2	0
Electrical Penetrations	0.934	0.494	0.44
		Total Leakage Savings:	37.34 SCFH

ILRT As Left Leakage Savings

-NONE-

Calculation of As Found Leakage Savings: $\frac{37.34 \text{ SCFH}}{304.4 \text{ SCFH}} \times 0.1 \text{ wt \%/24 hrs}$

$= 0.012 \text{ wt \%/24 hrs}$

8.1.2 Type C Penalties Description

A minimum pathway leakage (MPL) Type C penalty was applied for all containment piping penetrations whose containment isolation valves were not exposed to the ILRT pressure. The listing of the applicable penetrations and the associated MPLs are given below.

Penetration	MPL (SCFH)	Penetration	MPL (SCFH)
1	3.9	56D	0
2	0.9	57A	0
4	2.0	60	0
5	2.6	61	0
7	0	62	0
8	0	63	0
9	0	64	0
10	0	66	0
11	0	67	0
12	0.55	70	0
13	0.15	71	0
14	0	79	0
15	0	80	0
16	0	81	0
17	0	82	0
18	0	83	0
19	0	84	0
20	0	85	0
22	0	86	0
24	0	92	0
25	0	93	0
26	0	97A	0
27	0	97B	0
28	0	97C	0
31	0	98A	0
39	0	98B	0
40	0	103	0
41	0	105B	0
46	0.1	105C	0
55D	0	105D	0
56A	0	109	0
56B	0	113	0
56C	0	114	0
		Total:	10.20 SCFH

Calculation of Type C Penalties:

$$\frac{10.20 \text{ SCFH}}{304.4 \text{ SCFH}} \times 0.1 \text{ wt \%/24 hrs}$$

$$\approx 0.003 \text{ wt \%/24 hrs}$$

8.2 VERIFICATION TEST

The calculated superimposed leakage rate (L_o) was

$$\frac{5.16 \text{ scfm} \times 60 \text{ min/hr}}{3044 \text{ SCFH}} \times 0.1 \text{ wt \%/24 hrs} = 0.1005 \text{ wt \%/24 hrs.}$$

The measured leakage rate (L_{am}) was 0.020 wt %/24 hrs.

The limits for the composite leakage rate (L_c) were:

$L_{am} + L_o + 0.25L_a = 0.095$ wt %/24 hrs

$L_{am} + L_o - 0.25L_a = 0.145$ wt %/24 hrs.

The measured composite leakage rate (L_c) was 0.104 wt %/24 hrs.

SECTION 9

LOCAL LEAKAGE RATE TESTING

Appendix D contains a summary of all of the LLRTs performed on Unit 2 components since the last Unit 2 ILRT which was performed in April 1990.

Appendix E contains information on all of the LLRTs performed on Unit 2 components since April 1990 that had leakages greater the $0.60L_a$.

SECTION 10

REFERENCES

10.1 North Anna Power Station, Unit 2, Periodic Test procedures:

2-PT-61.1	Reactor Containment Integrated Leak Rate Test
2-PT-61.1A	Containment Structural Inspection
2-PT-61.1B	ILRT Instrumentation Set-up and Calibration
2-PT-61.1C	Cooling Water Hookups for ILRT Air Pressurization Equipment
2-PT-61.1D	Leak Check of Absolute Side of LM System
2-PT-61.1F	Leak Check of Steam Generators
2-PT-61.1G	Checkout of ILRT Air Pressurization Equipment
2-PT-61.1H	ILRT Penetration Lineups
2-PT-61.1I	Secondary System Instrumentation Integrity for ILRT
2-PT-61.1J	Venting of Containment for ILRT
2-PT-61.1K	Mechanical ILRT Set-up of Containment Equipment

10.2 10CFR50, Appendix J, Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors

10.3 ANSI N45.4-1972, American National Standard, Leakage Rate Testing of Containment Structures for Nuclear Reactors

10.4 ANSI 56.8-1987, American National Standard, Containment System Leakage Testing Requirements

10.5 Bechtel Power Corporation, Bechtel ILRT Program, Version 4.0, 10/14/88

APPENDIX A

COMPUTER PRINTOUTS

NORTH ANNA POWER STATION - UNIT 2
SUMMARY DATA

ALMAX = .100 VOLUME = 1825000.
VRATET = .119 VRATEM = .120

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME	AIRMASS
345	1017	538.515	59.2695	.2511	1825000.0	542156.3
400	1017	538.396	59.2561	.2509	1825000.0	542153.7
415	1017	538.282	59.2438	.2523	1825000.0	542155.1
430	1017	538.202	59.2353	.2513	1825000.0	542158.8
445	1017	538.122	59.2256	.2526	1825000.0	542149.8
500	1017	538.062	59.2167	.2537	1825000.0	542129.5
515	1017	537.998	59.2112	.2521	1825000.0	542143.3
530	1017	537.944	59.2032	.2535	1825000.0	542124.9
545	1017	537.894	59.1977	.2527	1825000.0	542124.8
600	1017	537.849	59.1905	.2539	1825000.0	542103.8
615	1017	537.807	59.1858	.2530	1825000.0	542103.3
630	1017	537.761	59.1795	.2539	1825000.0	542091.6
645	1017	537.731	59.1741	.2541	1825000.0	542072.8
700	1017	537.706	59.1698	.2535	1825000.0	542057.9
715	1017	537.663	59.1636	.2550	1825000.0	542045.6
730	1017	537.630	59.1601	.2539	1825000.0	542046.4
745	1017	537.601	59.1553	.2542	1825000.0	542030.8
800	1017	537.578	59.1516	.2537	1825000.0	542021.5
815	1017	537.545	59.1473	.2538	1825000.0	542014.6
830	1017	537.516	59.1432	.2537	1825000.0	542005.9
845	1017	537.499	59.1392	.2536	1825000.0	541987.3
900	1017	537.472	59.1344	.2546	1825000.0	541970.2
915	1017	537.459	59.1327	.2527	1825000.0	541967.6
930	1017	537.424	59.1262	.2556	1825000.0	541943.0
945	1017	537.402	59.1251	.2532	1825000.0	541955.1
1000	1017	537.373	59.1213	.2534	1825000.0	541949.5
1015	1017	537.322	59.1182	.2531	1825000.0	541972.4
1030	1017	537.302	59.1150	.2530	1825000.0	541963.5
1045	1017	537.278	59.1122	.2525	1825000.0	541962.1
1100	1017	537.259	59.1080	.2535	1825000.0	541942.3
1115	1017	537.247	59.1054	.2531	1825000.0	541931.1
1130	1017	537.224	59.1022	.2533	1825000.0	541925.1
1145	1017	537.210	59.0996	.2530	1825000.0	541914.5
1200	1017	537.189	59.0970	.2525	1825000.0	541912.4
1215	1017	537.178	59.0968	.2500	1825000.0	541922.1
1230	1017	537.157	59.0923	.2514	1825000.0	541901.4
1245	1017	537.135	59.0883	.2523	1825000.0	541887.7
1300	1017	537.118	59.0859	.2517	1825000.0	541882.0
1315	1017	537.092	59.0863	.2486	1825000.0	541912.0
1330	1017	537.082	59.0815	.2506	1825000.0	541877.8
1345	1017	537.071	59.0792	.2501	1825000.0	541868.8
1400	1017	537.045	59.0785	.2481	1825000.0	541888.2
1415	1017	537.032	59.0734	.2506	1825000.0	541854.2
1430	1017	537.014	59.0713	.2500	1825000.0	541853.2
1445	1017	536.994	59.0670	.2516	1825000.0	541834.1
1500	1017	536.990	59.0658	.2504	1825000.0	541827.3
1515	1017	536.977	59.0632	.2505	1825000.0	541816.8
1530	1017	536.961	59.0630	.2482	1825000.0	541830.8
1545	1017	536.943	59.0595	.2491	1825000.0	541817.0
1600	1017	536.929	59.0578	.2481	1825000.0	541815.4
1615	1017	536.915	59.0533	.2501	1825000.0	541787.9
1630	1017	536.899	59.0532	.2479	1825000.0	541803.4
1645	1017	536.880	59.0497	.2490	1825000.0	541790.7
1700	1017	536.862	59.0466	.2498	1825000.0	541780.1
1715	1017	536.842	59.0471	.2468	1825000.0	541804.5
1730	1017	536.833	59.0432	.2482	1825000.0	541779.1
1745	1017	536.820	59.0414	.2478	1825000.0	541774.1
1800	1017	536.800	59.0398	.2471	1825000.0	541780.3

NORTH ANNA POWER STATION - UNIT 2
SUMMARY DATA

ALMAX = .100 VOLUME = 1825000.
VRATET = .119 VRATEM = .120

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME	AIRMASS
1800	1017	536.800	59.0398	.2471	1825000.0	541780.3
1815	1017	536.787	59.0370	.2475	1825000.0	541768.1
1830	1017	536.766	59.0365	.2458	1825000.0	541784.6
1845	1017	536.750	59.0353	.2446	1825000.0	541789.6
1900	1017	536.735	59.0315	.2461	1825000.0	541769.4
1915	1017	536.716	59.0298	.2455	1825000.0	541773.0
1930	1017	536.695	59.0273	.2457	1825000.0	541772.0
1945	1017	536.680	59.0248	.2459	1825000.0	541763.3
2000	1017	536.656	59.0229	.2455	1825000.0	541771.1
2015	1017	536.643	59.0212	.2451	1825000.0	541768.4
2030	1017	536.626	59.0202	.2441	1825000.0	541776.6
2045	1017	536.601	59.0186	.2436	1825000.0	541787.1
2100	1017	536.595	59.0155	.2445	1825000.0	541763.9
2115	1017	536.579	59.0143	.2437	1825000.0	541769.1
2130	1017	536.551	59.0120	.2438	1825000.0	541776.1
2145	1017	536.543	59.0096	.2443	1825000.0	541762.9
2200	1017	536.525	59.0088	.2431	1825000.0	541773.4
2215	1017	536.511	59.0080	.2421	1825000.0	541779.9
2230	1017	536.505	59.0051	.2430	1825000.0	541760.5
2245	1017	536.486	59.0027	.2437	1825000.0	541756.8
2300	1017	536.476	59.0026	.2419	1825000.0	541765.9
2315	1017	536.457	59.0018	.2406	1825000.0	541777.9
2330	1017	536.442	59.0007	.2401	1825000.0	541783.3
2345	1017	536.430	58.9978	.2412	1825000.0	541768.1
0	1018	536.416	58.9954	.2419	1825000.0	541760.4
15	1018	536.408	58.9933	.2424	1825000.0	541749.6
30	1018	536.395	58.9949	.2393	1825000.0	541777.3
45	1018	536.369	58.9908	.2418	1825000.0	541766.1
100	1018	536.366	58.9908	.2405	1825000.0	541768.0
115	1018	536.366	58.9905	.2393	1825000.0	541765.5
130	1018	536.349	58.9885	.2398	1825000.0	541765.2
145	1018	536.346	58.9871	.2398	1825000.0	541754.4
200	1018	536.327	58.9847	.2408	1825000.0	541751.9
215	1018	536.318	58.9855	.2386	1825000.0	541768.3
230	1018	536.319	58.9832	.2396	1825000.0	541746.9
245	1018	536.314	58.9806	.2407	1825000.0	541728.3
300	1018	536.303	58.9806	.2394	1825000.0	541739.0
315	1018	536.290	58.9778	.2407	1825000.0	541726.5
330	1018	536.283	58.9778	.2393	1825000.0	541733.6
345	1018	536.267	58.9765	.2392	1825000.0	541737.2
400	1018	536.256	58.9757	.2386	1825000.0	541740.9
415	1018	536.245	58.9740	.2388	1825000.0	541736.2
430	1018	536.239	58.9716	.2396	1825000.0	541720.3
445	1018	536.228	58.9720	.2378	1825000.0	541736.0
500	1018	536.216	58.9704	.2378	1825000.0	541733.5
515	1018	536.212	58.9679	.2390	1825000.0	541713.3
530	1018	536.191	58.9683	.2370	1825000.0	541739.3
545	1018	536.191	58.9659	.2381	1825000.0	541716.9
600	1018	536.173	58.9653	.2371	1825000.0	541730.2

NORTH ANNA POWER STATION - UNIT 2
SUMMARY DATA

ALMAX = .100 VOLUME = 1825000.
VRATET = .119 VRATEM = .120

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME	AIRMASS
615	1018	536.169	58.9636	.2372	1825000.0	541718.9
630	1018	536.164	58.9623	.2369	1825000.0	541711.4
645	1018	536.146	58.9601	.2372	1825000.0	541709.2
700	1018	536.133	58.9589	.2366	1825000.0	541711.3
715	1018	536.122	58.9574	.2363	1825000.0	541708.4
730	1018	536.107	58.9563	.2355	1825000.0	541712.6
745	1018	536.103	58.9554	.2346	1825000.0	541709.1
800	1018	536.082	58.9528	.2354	1825000.0	541706.0
815	1018	536.077	58.9512	.2350	1825000.0	541697.4
830	1018	536.054	58.9485	.2359	1825000.0	541695.4
845	1018	536.041	58.9496	.2329	1825000.0	541719.2
900	1018	536.035	58.9475	.2334	1825000.0	541704.8
915	1018	536.016	58.9448	.2342	1825000.0	541700.5
930	1018	536.008	58.9441	.2330	1825000.0	541701.1
945	1018	535.994	58.9443	.2311	1825000.0	541718.3
1000	1018	535.981	58.9402	.2337	1825000.0	541693.0
1015	1018	535.980	58.9400	.2321	1825000.0	541692.8
1030	1018	535.966	58.9390	.2315	1825000.0	541696.8
1045	1018	535.949	58.9364	.2325	1825000.0	541690.1
1100	1018	535.950	58.9366	.2308	1825000.0	541692.0
1115	1018	535.942	58.9330	.2330	1825000.0	541666.0
1130	1018	535.924	58.9331	.2314	1825000.0	541685.0
1145	1018	535.908	58.9321	.2310	1825000.0	541692.5
1200	1018	535.903	58.9320	.2299	1825000.0	541697.1
1215	1018	535.882	58.9310	.2295	1825000.0	541707.9
1230	1018	535.884	58.9283	.2309	1825000.0	541682.1
1245	1018	535.871	58.9279	.2299	1825000.0	541691.1
1300	1018	535.865	58.9258	.2308	1825000.0	541677.9
1315	1018	535.853	58.9252	.2301	1825000.0	541683.8
1330	1018	535.856	58.9237	.2303	1825000.0	541667.4
1345	1018	535.837	58.9226	.2303	1825000.0	541676.7
1400	1018	535.828	58.9220	.2297	1825000.0	541680.6
1415	1018	535.820	58.9221	.2284	1825000.0	541689.4
1430	1018	535.817	58.9210	.2287	1825000.0	541682.6
1445	1018	535.814	58.9191	.2293	1825000.0	541668.3
1500	1018	535.801	58.9165	.2308	1825000.0	541657.1
1515	1018	535.795	58.9167	.2292	1825000.0	541664.9
1530	1018	535.783	58.9159	.2289	1825000.0	541669.6
1545	1018	535.777	58.9155	.2283	1825000.0	541671.4
1600	1018	535.766	58.9146	.2285	1825000.0	541674.3
1615	1018	535.757	58.9134	.2283	1825000.0	541673.1
1630	1018	535.744	58.9118	.2292	1825000.0	541670.9
1645	1018	535.692	58.9098	.2257	1825000.0	541705.7
1700	1018	535.637	58.9045	.2277	1825000.0	541712.9
1715	1018	535.591	58.9020	.2263	1825000.0	541736.5
1730	1018	535.561	58.8999	.2250	1825000.0	541747.3
1745	1018	535.531	58.8984	.2243	1825000.0	541763.0
1800	1018	535.515	58.8955	.2245	1825000.0	541752.5

NORTH ANNA POWER STATION - UNIT 2
SUMMARY DATA

ALMAX = .100 VOLUME = 1825000.
VRATET = .119 VRATEM = .120

TIME	DATE	TEMP	PRESSURE	VPRS	VOLUME	AIRMASS
1815	1018	535.485	58.8951	.2226	1825000.0	541780.4
1830	1018	535.479	58.8929	.2228	1825000.0	541765.8
1845	1018	535.452	58.8921	.2217	1825000.0	541785.2
1900	1018	535.443	58.8890	.2222	1825000.0	541765.4
1915	1018	535.427	58.8887	.2199	1825000.0	541779.9
1930	1018	535.414	58.8848	.2211	1825000.0	541757.3
1945	1018	535.399	58.8826	.2209	1825000.0	541751.2
2000	1018	535.383	58.8809	.2199	1825000.0	541752.1
2015	1018	535.367	58.8790	.2193	1825000.0	541750.8
2030	1018	535.352	58.8767	.2190	1825000.0	541744.9
2045	1018	535.331	58.8748	.2184	1825000.0	541748.4
2100	1018	535.317	58.8722	.2183	1825000.0	541739.0
2115	1018	535.297	58.8698	.2180	1825000.0	541737.8
2130	1018	535.289	58.8683	.2170	1825000.0	541730.9
2145	1018	535.271	58.8659	.2168	1825000.0	541726.9
2200	1018	535.251	58.8622	.2178	1825000.0	541713.9
2215	1018	535.236	58.8626	.2147	1825000.0	541732.6
2230	1018	535.220	58.8581	.2163	1825000.0	541707.6
2245	1018	535.204	58.8547	.2169	1825000.0	541692.7
2300	1018	535.190	58.8538	.2151	1825000.0	541698.3
2315	1018	535.176	58.8505	.2156	1825000.0	541682.1
2330	1018	535.162	58.8487	.2147	1825000.0	541679.7
2345	1018	535.140	58.8456	.2148	1825000.0	541673.8
0	1019	535.128	58.8428	.2147	1825000.0	541660.6
15	1019	535.112	58.8420	.2130	1825000.0	541668.6
30	1019	535.094	58.8383	.2136	1825000.0	541652.5
45	1019	535.070	58.8362	.2129	1825000.0	541658.0
100	1019	535.054	58.8337	.2124	1825000.0	541650.8
115	1019	535.032	58.8312	.2119	1825000.0	541649.9
130	1019	535.015	58.8282	.2122	1825000.0	541639.9
145	1019	535.014	58.8265	.2120	1825000.0	541625.3
200	1019	535.000	58.8244	.2123	1825000.0	541620.0
215	1019	534.989	58.8219	.2127	1825000.0	541608.1
230	1019	534.986	58.8202	.2123	1825000.0	541594.9
245	1019	534.962	58.8178	.2126	1825000.0	541597.5
300	1019	534.962	58.8166	.2116	1825000.0	541586.1
315	1019	534.939	58.8136	.2119	1825000.0	541582.3
330	1019	534.920	58.8117	.2112	1825000.0	541584.4
345	1019	534.904	58.8095	.2106	1825000.0	541580.1
400	1019	534.893	58.8062	.2114	1825000.0	541560.3

APPENDIX B

DATA ANALYSIS INFORMATION

SECTION B.1: CONTAINMENT TEMPERATURE STABILIZATION CRITERIA

SECTION B.2: INSTRUMENT SELECTION GUIDE (ISG) CALCULATION

SECTION B.3: DESCRIPTION OF BECHTEL MASS POINT ANALYSIS CALCULATIONS

SECTION B.4: ILRT MASS POINT DATA ANALYSIS

SECTION B.5: ILRT DATA TREND REPORT

SECTION B.6: VERIFICATION TEST MASS POINT DATA ANALYSIS

SECTION B.1: Containment Temperature Stabilization Criteria

NORTH ANNA POWER STATION - UNIT 2
TEMPERATURE STABILIZATION

FROM A STARTING TIME AND DATE OF: 345 1017 1990

TIME (HOURS)	TEMP (°R)	ANSI AVE Δ T (4HRS)	ANSI AVE Δ T (1HR)	ANSI DIFF	BN-TOP-1 AVE Δ T (2HRS)	MS-021-5 AVE Δ T (2HRS)
.00	538.515					
.25	538.396					
.50	538.282					
.75	538.202					
1.00	538.122					
1.25	538.062					
1.50	537.998					
1.75	537.944					
2.00	537.894				-.311*	.158*
2.25	537.849				-.273*	.157*
2.50	537.807				-.237*	.090*
2.75	537.761				-.220*	.075*
3.00	537.731				-.196*	.069*
3.25	537.706				-.178*	.090*
3.50	537.663				-.168*	.024*
3.75	537.630				-.157*	.040*
4.00	537.601	-.228	-.129	-.099*	-.146*	.037*
4.25	537.578	-.205	-.129	-.076*	-.136*	.040*
4.50	537.545	-.184	-.118	-.067*	-.131*	.031*
4.75	537.516	-.171	-.114	-.057*	-.123*	.004*
5.00	537.499	-.156	-.103	-.053*	-.116*	.016*
5.25	537.472	-.147	-.106	-.042*	-.117*	.039*
5.50	537.459	-.135	-.086	-.049*	-.102*	.046*
5.75	537.424	-.130	-.092	-.038*	-.103*	-.015*
6.00	537.402	-.123	-.096	-.026*	-.099*	.005*
6.25	537.373	-.119	-.099	-.020*	-.102*	.008*
6.50	537.322	-.121	-.137	.016*	-.111*	-.050*
6.75	537.302	-.115	-.122	.007*	-.107*	-.007*
7.00	537.278	-.113	-.124	.011*	-.110*	.007*
7.25	537.259	-.112	-.114	.002*	-.106*	-.015*
7.50	537.247	-.104	-.076	-.028*	-.106*	.053*
7.75	537.224	-.101	-.078	-.024*	-.100*	-.003*
8.00	537.210	-.098	-.068	-.030*	-.096*	.035*
8.25	537.189	-.097	-.070	-.027*	-.092*	.068*
8.50	537.178	-.092	-.069	-.023*	-.072*	.020*
8.75	537.157	-.090	-.067	-.023*	-.073*	.006*
9.00	537.135	-.091	-.075	-.016*	-.072*	-.006*
9.25	537.118	-.088	-.071	-.017*	-.070*	-.010*
9.50	537.092	-.092	-.085	-.006*	-.077*	-.007*
9.75	537.082	-.085	-.075	-.011*	-.071*	.008*
10.00	537.071	-.083	-.064	-.019*	-.070*	.021*
10.25	537.045	-.082	-.073	-.009*	-.072*	-.032*
10.50	537.032	-.073	-.060	-.012*	-.073*	.019*
10.75	537.014	-.072	-.068	-.004*	-.072*	.008*
11.00	536.994	-.071	-.076	.005*	-.070*	-.006*
11.25	536.990	-.067	-.055	-.013*	-.064*	.049*
11.50	536.977	-.068	-.056	-.012*	-.058*	-.008*
11.75	536.961	-.066	-.053	-.013*	-.061*	-.009*
12.00	536.943	-.067	-.051	-.015*	-.064*	.018*
12.25	536.929	-.065	-.061	-.004*	-.058*	-.003*
12.50	536.915	-.066	-.061	-.004*	-.059*	.010*
12.75	536.899	-.064	-.062	-.003*	-.057*	.007*
13.00	536.880	-.064	-.063	.000*	-.057*	-.035*
13.25	536.862	-.064	-.067	.003*	-.064*	-.009*
13.50	536.842	-.063	-.073	.010*	-.067*	-.009*
13.75	536.833	-.062	-.067	.004*	-.064*	.018*
14.00	536.820	-.063	-.059	-.003*	-.061*	.004*
14.25	536.800	-.061	-.062	.001*	-.064*	-.014*

* INDICATES TEMPERATURE STABILIZATION HAS BEEN SATISFIED

SECTION B.2: Instrument Selection Guide (ISG) Calculation

ISG CALCULATION
(ANSI/ANS 56.8 - 1987)

CALIBRATION DATA

	# OF SENSORS	SENSOR SENSITIVITY(E)	DISPLAY REPEATABILITY(r)
TEMPERATURE(T)	18	0.0121 deg. F	0.1000 deg. F
PRESSURE(P)	2	0.0001 psia	0.0001 psia
VAPOR PRESS(Pv)	5	0.0625 deg. F	0.1000 deg. F

LENGTH OF TEST(t)	8.00 hrs
PRESSURE(P)	58.80 psia
TEMPERATURE(T)	540.0 deg. R
VAPOR PRESS(Pv)	0.01658 psi/deg. F (at 80 deg. F)
La	0.100 wt%/day

INSTRUMENT MEASUREMENT ERRORS

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

eT = 0.02374 deg. F

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

eP = 0.00010 psia

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

ePv = 0.00087 psia

INSTRUMENT SELECTION GUIDE

$$ISG = 2400/t[\ 2(eP/P)^2 + 2(ePv/P)^2 + 2(eT/T)^2\ ]^{1/2}$$

ISG = 0.020 wt%/day

.25La = 0.025 wt%/day

SECTION B.3: Description of Bechtel Mass Point Analysis Calculations

DESCRIPTION OF BECHTEL ILRT COMPUTER PROGRAM

A. Program and Report Description

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

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

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

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

5. The program generates a predictor report based on "Suggested Criteria for a Short Duration ILRT", Ted Brown and Louis Estenssoro, Proceedings of the First Workshop on Containment Testing, January 18, 1982. The "predictor" is an estimate of the upper bound on the change in mass point calculated leakage rate which will occur during the next four hours. The estimate is based on the mass point calculated leakage rates and 95% UCLs during the previous four hours.

6. The program is written in a high level language and is designed for use on a micro-computer with direct data input from the data acquisition system. Brief descriptions of program use, formulae used for leakage rate computations, and program logic are provided in the following paragraphs.

B. Explanation of Program

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

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

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

   b. Volume fractions assigned to each of the above sensors

   c. Calibration data for above sensors

   d. Test title

   e. Maximum allowable leakage rate at test pressure

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

   a. Time and date

   b. Containment atmosphere drybulb temperatures

   c. Containment atmosphere pressure(s)

   d. Containment atmosphere dewpoint temperatures

   e. Containment free air volume.

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

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

C. Leakage Rate Formulae

1. Computations Using the Total Time Method:

a. Measured leakage rate from data:

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

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

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

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

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

where

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

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

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

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

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

Δt_i = Elapsed time from t_1 to t_i, hr.

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

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

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

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

where

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

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

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

b. Calculated leakage rate from regression analysis:

$$\bar{L} = a + b\ \Delta t_N \tag{5}$$

where

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

$$a = (\Sigma L_i - b\ \Sigma \Delta t_i)/N \tag{6}$$

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

N = Number of data points.

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

c. 95% upper confidence limit on the calculated leakage rate:

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

where

UCL = 95% upper confidence limit wt.%/day, at elapsed time Δt_N.

For $\Delta t_N < 24$

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

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

For $\Delta t_N \geq 24$

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

where $t_s = \dfrac{1.6449(N-2)^2 + 3.5283(N-2) + 0.85602}{(N-2)^2 + 1.2209(N-2) - 1.5162}$

$\bar{L}_i$ = Calculated leakage rate computed using equation (5) at total elapsed time Δt_i, %/day.

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

2. Computation using the Mass Point Method:

a. Contained mass of dry air from data:

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

where

All symbols as previously defined.

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

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

where

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

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

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

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

N = Number of data points.

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

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

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

$$a = W_1 \left[1 + (\Sigma \frac{\Delta W_i}{W_1} - \frac{b}{W_1}\Sigma\Delta t_i)/N \right] \tag{14}$$

$$b = W_1 \left[\frac{N\ (\Sigma \frac{\Delta W_i}{W_1} \Delta t_i) - \Sigma \frac{\Delta W_i}{W_1} \Sigma \Delta t_i}{N(\Sigma \Delta t_i^2) - (\Sigma \Delta t_i)^2} \right] \tag{15}$$

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

c. 95% upper confidence limit.

$$UCL = \frac{-2400}{a} (b - S_b) \tag{16}$$

where

UCL = 95% upper confidence limit, wt.%/day.

$$S_b = t_s \frac{SN^{1/2}}{[N\Sigma\Delta t_i^2 - (\Sigma\Delta t_i)^2]^{1/2}} \qquad (17)$$

$$\text{where } t_s = \frac{1.6449\ (N-2)^2 + 3.5283\ (N-2) + 0.85602}{(N-2)^2 + 1.2209\ (N-2) - 1.5162}$$

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

$$= W_1 \left\{ \frac{1}{N-2} \left[\Sigma (\Delta W_i/W_1)^2 - [\Sigma (\Delta W_i/W_1)]^2/N - \frac{[\Sigma (\Delta W_i/W_1)\Delta t_i - \Sigma(\Delta W_i/W_1)(\Sigma \Delta t_i)/N]^2}{\Sigma(\Delta t_i^2) - (\Sigma \Delta t_i)^2/N} \right] \right\}^{1/2} \qquad (18)$$

d. Predictor:

$$\text{Predictor} = \frac{100\ [2(UCL-L) + 4\ (|B| + 2\ S_A)]}{La}$$

where

UCL = 95% upper confidence limit of mass point calculated leakage rate at end of test.

L = Mass point calculated leakage rate at end of test.

B = Value of linear regression analysis slope of mass point calculated leakage rate vs. time for last 4 hours of test data.

S_A = Linear regression analysis standard deviation of slope.

La = Allowable leakage rate.

In terms of elapsed time, Δt and mass point calculated leakage rate Lm_i calculated at the end of i^{th} time interval.

$$A = \frac{1}{M}\left[\sum_{4\ hr} Lm_i - B \sum_{4\ hr} \Delta t_i\right] \quad (19)$$

$$B = \frac{M \sum_{4\ hr} Lm_i \Delta t_i - \sum_{4\ hr} Lm_i \sum_{4\ hr} \Delta t_i}{M \sum_{4\ hr} \Delta t_i^2 - \left(\sum_{4\ hr} \Delta t_i\right)^2} \quad (20)$$

$$S_A = \sqrt{\frac{\sum_{4\ hr} Lm_i - A \sum_{4hr} Lm_i - B \sum_{4hr} Lm_i \Delta t_i}{(M-2)\left[M \sum_{4\ hr} \Delta t_i^2 - \left(\sum_{4\ hr} \Delta t_i\right)^2\right]}}\ (M) \quad (21)$$

Lm_i = mass point calculated leakage rate evaluated using data up to time Δt_i.

4 hr = summation over last 4 hours of test data.

$$\Sigma = \sum_{N-M+1}^{N}$$

M = number of data points for last 4 hours of test.

D. Program Logic

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

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

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

E. Computer Report and Data Printout

MASS POINT REPORT

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

TOTAL TIME REPORT

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

TREND REPORT

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

PREDICTOR REPORT

The predictor reports presents a predicted upper bound on the change in calculated mass point leakage rate over the next four hours.

SUMMARY DATA REPORT

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

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

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

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

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

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

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

7. AIRMASS: Calculated dry air mass (lbm).

F. Summary of Measured Data and Summary of Corrected Data

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

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

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

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

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

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

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

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

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

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

SECTION B.4: ILRT Mass Point Data Analysis

NORTH ANNA POWER STATION - UNIT 2
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 1800 1017 1990
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
1800	536.800	59.0398	541780.3		
1815	536.787	59.0370	541768.1	12.2	48.9
1830	536.766	59.0365	541784.6	-16.5	-8.6
1845	536.750	59.0353	541789.6	-5.1	-12.5
1900	536.735	59.0315	541769.4	20.2	10.9
1915	536.716	59.0298	541773.0	-3.6	5.8
1930	536.695	59.0273	541772.0	1.0	5.5
1945	536.680	59.0248	541763.3	8.7	9.7
2000	536.656	59.0229	541771.1	-7.8	4.6
2015	536.643	59.0218	541768.4	2.6	5.3
2030	536.626	59.0202	541776.6	-8.2	1.5
2045	536.601	59.0186	541787.1	-10.5	-2.5
2100	536.595	59.0155	541763.9	23.2	5.5
2115	536.579	59.0143	541769.1	-5.2	3.4
2130	536.551	59.0120	541776.1	-7.0	1.2
2145	536.543	59.0096	541762.9	13.2	4.6
2200	536.525	59.0088	541773.4	-10.4	1.7
2215	536.511	59.0080	541779.9	-6.6	.1
2230	536.505	59.0051	541760.5	19.4	4.4
2245	536.486	59.0027	541756.8	3.7	5.0
2300	536.476	59.0026	541765.9	-9.2	2.9
2315	536.457	59.0018	541777.9	-11.9	.5
2330	536.442	59.0007	541783.3	-5.4	-.5
2345	536.430	58.9978	541768.1	15.2	2.1
0	536.416	58.9954	541760.4	7.7	3.3
15	536.408	58.9933	541749.6	10.8	4.9
30	536.395	58.9949	541777.3	-27.7	.5
45	536.369	58.9908	541766.1	11.2	2.1
100	536.366	58.9908	541768.0	-1.9	1.8
115	536.366	58.9905	541765.5	2.5	2.0
130	536.349	58.9885	541765.2	.3	2.0
145	536.346	58.9871	541754.4	10.8	3.3
200	536.327	58.9847	541751.9	2.5	3.5
215	536.318	58.9855	541768.3	-16.4	1.5
230	536.319	58.9832	541746.9	21.4	3.9
245	536.314	58.9806	541728.3	18.6	5.9
300	536.303	58.9806	541739.0	-10.7	4.6
315	536.290	58.9778	541726.5	12.5	5.8
330	536.283	58.9778	541733.6	-7.1	4.9
345	536.267	58.9765	541737.2	-3.6	4.4
400	536.256	58.9757	541740.9	-3.7	3.9
415	536.245	58.9740	541736.2	4.7	4.3
430	536.239	58.9716	541720.3	15.9	5.7
445	536.228	58.9720	541736.0	-15.7	4.1
500	536.216	58.9704	541733.5	2.5	4.3
515	536.212	58.9679	541713.3	20.3	6.0
530	536.191	58.9683	541739.3	-26.0	3.6

NORTH ANNA POWER STATION - UNIT 2
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 1800 1017 1990
TEST DURATION: 24.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
545	536.191	58.9659	541716.9	22.3	5.4
600	536.173	58.9653	541730.2	-13.2	4.2
615	536.169	58.9636	541718.9	11.3	5.0
630	536.164	58.9623	541711.4	7.5	5.5
645	536.146	58.9601	541709.2	2.2	5.6
700	536.133	58.9589	541711.3	-2.1	5.3
715	536.122	58.9574	541708.4	2.9	5.4
730	536.107	58.9563	541712.6	-4.2	5.0
745	536.103	58.9554	541709.1	3.5	5.2
800	536.082	58.9528	541706.0	3.1	5.3
815	536.077	58.9512	541697.4	8.6	5.8
830	536.054	58.9485	541695.4	2.0	5.9
845	536.041	58.9496	541719.2	-23.7	4.1
900	536.035	58.9475	541704.8	14.4	5.0
915	536.016	58.9448	541700.5	4.3	5.2
930	536.008	58.9441	541701.1	-.6	5.1
945	535.994	58.9443	541718.3	-17.1	3.9
1000	535.981	58.9402	541693.0	25.3	5.5
1015	535.980	58.9400	541692.8	.3	5.4
1030	535.966	58.9390	541696.8	-4.0	5.1
1045	535.949	58.9364	541690.1	6.7	5.4
1100	535.950	58.9366	541692.0	-1.9	5.2
1115	535.942	58.9330	541666.0	26.0	6.6
1130	535.924	58.9331	541685.0	-19.0	5.4
1145	535.908	58.9321	541692.5	-7.5	4.9
1200	535.903	58.9320	541697.1	-4.6	4.6
1215	535.882	58.9310	541707.9	-10.7	4.0
1230	535.884	58.9283	541682.1	25.8	5.3
1245	535.871	58.9279	541691.1	-9.0	4.8
1300	535.865	58.9258	541677.9	13.1	5.4
1315	535.853	58.9252	541683.8	-5.9	5.0
1330	535.856	58.9237	541667.4	16.5	5.8
1345	535.837	58.9226	541676.7	-9.3	5.2
1400	535.828	58.9220	541680.6	-3.8	5.0
1415	535.820	58.9221	541689.4	-8.8	4.5
1430	535.817	58.9210	541682.6	6.8	4.8
1445	535.814	58.9191	541668.3	14.3	5.4
1500	535.801	58.9165	541657.1	11.2	5.9
1515	535.795	58.9167	541664.9	-7.9	5.4
[illegible]	535.783	58.9159	541669.6	-4.6	5.2
154	535.777	58.9155	541671.4	-1.9	5.0
1600	535.766	58.9146	541674.3	-2.8	4.8
1615	535.757	58.9134	541673.1	1.1	4.8
1630	535.744	58.9118	541670.9	2.3	4.9
1645	535.692	58.9098	541705.7	-34.8	3.3
1700	535.637	58.9045	541712.9	-7.2	2.9
1715	535.591	58.9020	541736.5	-23.6	1.9
1730	535.561	58.8999	541747.3	-10.8	1.4
1745	535.531	58.8984	541763.0	-15.7	.7
1800	535.515	58.8955	541752.5	10.5	1.2

FREE AIR VOLUME USED (CU. FT.)	=1825000.0
REGRESSION LINE	
INTERCEPT (LBM)	= 541781.5
SLOPE (LBM/HR)	= -4.5
MAXIMUM ALLOWABLE LEAKAGE RATE	= .100
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE	= .075
THE UPPER 95% CONFIDENCE LIMIT	= .022
THE CALCULATED LEAKAGE RATE	= .020

SECTION B.5: ILRT DATA Trend Report

NORTH ANNA POWER STATION - UNIT 2
TREND REPORT

TIME AND DATE AT START OF TEST: 1800 1017 1990

NO. PTS	END TIME	TOTAL TIME ANALYSIS MEAS.	CALCULATED	UCL	MASS POINT ANALYSIS CALCULATED	UCL
2	1815	.217	.217	99.000	.217	99.000
3	1830	-.038	-.038	99.000	-.038	1.220
4	1845	-.055	-.095	.844	-.079	.127
5	1900	.048	-.036	.607	.000	.144
6	1915	.026	-.020	.416	.014	.101
7	1930	.025	-.011	.328	.019	.077
8	1945	.043	.004	.291	.033	.077
9	2000	.020	.004	.252	.027	.062
10	2015	.023	.006	.226	.026	.053
11	2030	.007	.002	.200	.017	.041
12	2045	-.011	-.007	.175	.005	.028
13	2100	.024	-.003	.168	.010	.031
14	2115	.015	-.002	.158	.011	.028
15	2130	.005	-.003	.147	.008	.023
16	2145	.020	-.001	.143	.011	.025
17	2200	.008	-.002	.135	.009	.021
18	2215	.000	-.004	.127	.006	.017
19	2230	.019	-.002	.124	.009	.019
20	2245	.022	.001	.123	.011	.021
21	2300	.013	.001	.119	.011	.020
22	2315	.002	-.001	.113	.009	.017
23	2330	-.002	-.003	.108	.005	.014
24	2345	.009	-.003	.105	.006	.013
25	0	.015	-.002	.103	.007	.014
26	15	.022	.000	.103	.010	.017
27	30	.002	-.001	.099	.008	.014
28	45	.009	-.001	.097	.008	.014
29	100	.008	-.001	.094	.007	.013
30	115	.009	-.001	.093	.007	.013
31	130	.009	.000	.091	.007	.012
32	145	.015	.000	.090	.008	.013
33	200	.016	.001	.089	.009	.014
34	215	.006	.001	.087	.008	.013
35	230	.017	.002	.087	.010	.014
36	245	.026	.004	.088	.012	.017
37	300	.020	.005	.088	.013	.018
38	315	.026	.006	.088	.015	.020
39	330	.022	.007	.088	.016	.021
40	345	.020	.008	.087	.017	.021
41	400	.017	.009	.087	.017	.021
42	415	.019	.009	.086	.018	.022
43	430	.025	.010	.086	.019	.023
44	445	.018	.011	.086	.019	.023
45	500	.019	.011	.085	.019	.023
46	515	.026	.012	.085	.020	.024
47	530	.016	.012	.085	.020	.024
48	545	.024	.013	.085	.021	.024
49	600	.019	.013	.084	.021	.024
50	615	.022	.014	.084	.021	.024

NORTH ANNA POWER STATION - UNIT 2
TREND REPORT

TIME AND DATE AT START OF TEST: 1800 1017 1990

NO. PTS	END TIME	TOTAL TIME ANALYSIS MEAS.	CALCULATED	UCL	MASS POINT ANALYSIS CALCULATED	UCL
51	630	.024	.014	.084	.022	.025
52	645	.025	.015	.083	.022	.025
53	700	.024	.015	.083	.023	.026
54	715	.024	.016	.083	.023	.026
55	730	.022	.016	.083	.023	.026
56	745	.023	.017	.082	.024	.026
57	800	.024	.017	.082	.024	.026
58	815	.026	.018	.082	.024	.027
59	830	.026	.018	.082	.025	.027
60	845	.018	.018	.081	.024	.027
61	900	.022	.018	.081	.024	.027
62	915	.023	.019	.081	.025	.027
63	930	.023	.019	.080	.025	.027
64	945	.017	.019	.080	.024	.026
65	1000	.024	.019	.080	.025	.027
66	1015	.024	.019	.079	.025	.027
67	1030	.022	.020	.079	.025	.027
68	1045	.024	.020	.079	.025	.027
69	1100	.023	.020	.078	.025	.027
70	1115	.029	.021	.079	.026	.027
71	1130	.024	.021	.078	.026	.027
72	1145	.022	.021	.078	.026	.027
73	1200	.020	.021	.078	.025	.027
74	1215	.018	.021	.077	.025	.027
75	1230	.024	.021	.077	.025	.027
76	1245	.021	.021	.076	.025	.027
77	1300	.024	.021	.076	.025	.027
78	1315	.022	.021	.076	.025	.027
79	1330	.026	.021	.076	.025	.027
80	1345	.023	.022	.075	.025	.027
81	1400	.022	.022	.075	.025	.027
82	1415	.020	.022	.075	.025	.026
83	1430	.021	.022	.074	.025	.026
84	1445	.024	.022	.074	.025	.026
85	1500	.026	.022	.074	.025	.027
86	1515	.024	.022	.074	.025	.027
87	1530	.023	.022	.074	.025	.027
88	1545	.022	.022	.073	.025	.026
89	1600	.021	.022	.073	.025	.026
90	1615	.021	.022	.073	.025	.026
91	1630	.022	.022	.072	.025	.026
92	1645	.015	.022	.072	.024	.026
93	1700	.013	.022	.071	.024	.025
94	1715	.008	.021	.071	.023	.024
95	1730	.006	.021	.070	.022	.024
96	1745	.003	.020	.069	.021	.023
97	1800	.005	.019	.027	.020	.022

SECTION B.6: Verification Test Mass Point Data Analysis

NORTH ANNA POWER STATION - UNIT 2
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 1900 1018 1990
TEST DURATION: 9.00 HOURS

TIME	TEMP (R)	PRESSURE (PSIA)	CTMT. AIR MASS (LBM)	MASS LOSS (LBM)	AVERAGE MASS LOSS (LBM/HR)
1900	535.443	58.8890	541765.4		
1915	535.427	58.8887	541779.9	-14.5	-58.0
1930	535.414	58.8848	541757.3	22.6	16.2
1945	535.399	58.8826	541751.2	6.1	18.9
2000	535.383	58.8809	541752.1	-.9	13.3
2015	535.367	58.8790	541750.8	1.3	11.6
2030	535.352	58.8767	541744.9	5.9	13.6
2045	535.331	58.8748	541748.4	-3.5	9.7
2100	535.317	58.8722	541739.0	9.4	13.2
2115	535.297	58.8698	541737.8	1.3	12.3
2130	535.289	58.8683	541730.9	6.8	13.8
2145	535.271	58.8659	541726.9	4.0	14.0
2200	535.251	58.8622	541713.9	13.1	17.2
2215	535.236	58.8626	541732.6	-18.8	10.1
2230	535.220	58.8581	541707.6	25.1	16.5
2245	535.204	58.8547	541692.7	14.9	19.4
2300	535.190	58.8538	541698.3	-5.7	16.8
2315	535.176	58.8505	541682.1	16.3	19.6
2330	535.162	58.8487	541679.7	2.4	19.0
2345	535.140	58.8456	541673.8	5.9	19.3
0	535.128	58.8428	541660.6	13.1	21.0
15	535.112	58.8420	541668.6	-7.9	18.4
30	535.094	58.8383	541652.5	16.1	20.5
45	535.070	58.8362	541658.0	-5.5	18.7
100	535.054	58.8337	541650.8	7.2	19.1
115	535.032	58.8312	541649.9	.9	18.5
130	535.015	58.8282	541639.9	9.9	19.3
145	535.014	58.8265	541625.3	14.7	20.8
200	535.000	58.8244	541620.0	5.3	20.8
215	534.989	58.8219	541608.1	11.9	21.7
230	534.986	58.8202	541594.9	13.2	22.7
245	534.962	58.8178	541597.5	-2.6	21.7
300	534.962	58.8166	541586.1	11.4	22.4
315	534.939	58.8136	541582.3	3.9	22.2
330	534.920	58.8117	541584.4	-2.2	21.3
345	534.904	58.8095	541580.1	4.3	21.2
400	534.893	58.8062	541560.3	19.8	22.8

FREE AIR VOLUME USED (CU. FT.) =1825000.0
REGRESSION LINE
INTERCEPT (LBM) = 541783.3
SLOPE (LBM/HR) = -23.4
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT = .145
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT = .095
THE CALCULATED LEAKAGE RATE = .104

APPENDIX C

GRAPHS

SECTION C.1: CONTAINMENT AIR MASS PLOT FOR TEST DURATION

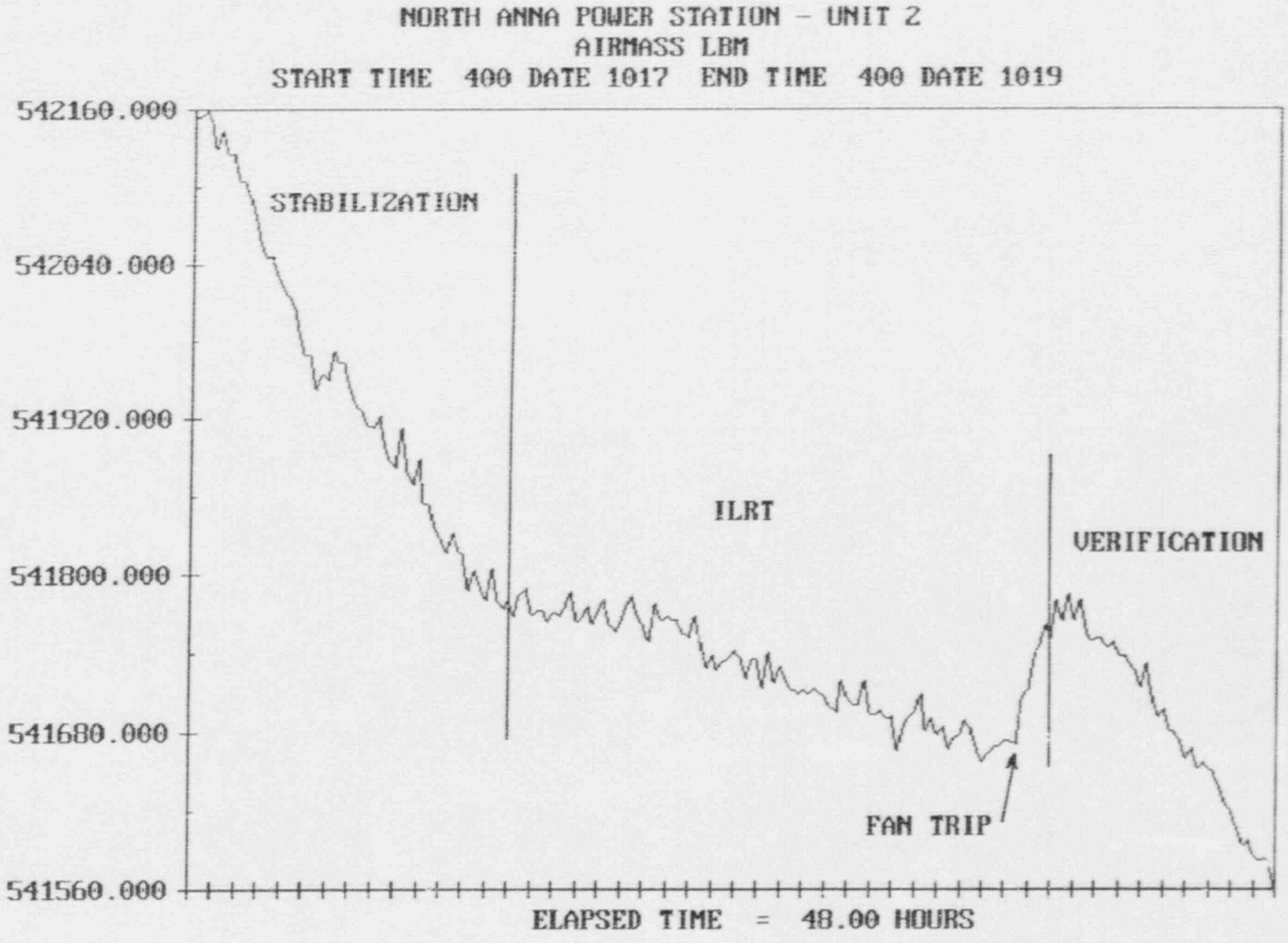
SECTION C.2: REGRESSION LINE OF ILRT CONTAINMENT AIR MASS

SECTION C.3: ILRT MASS POINT LEAKAGE RATE AND UCL

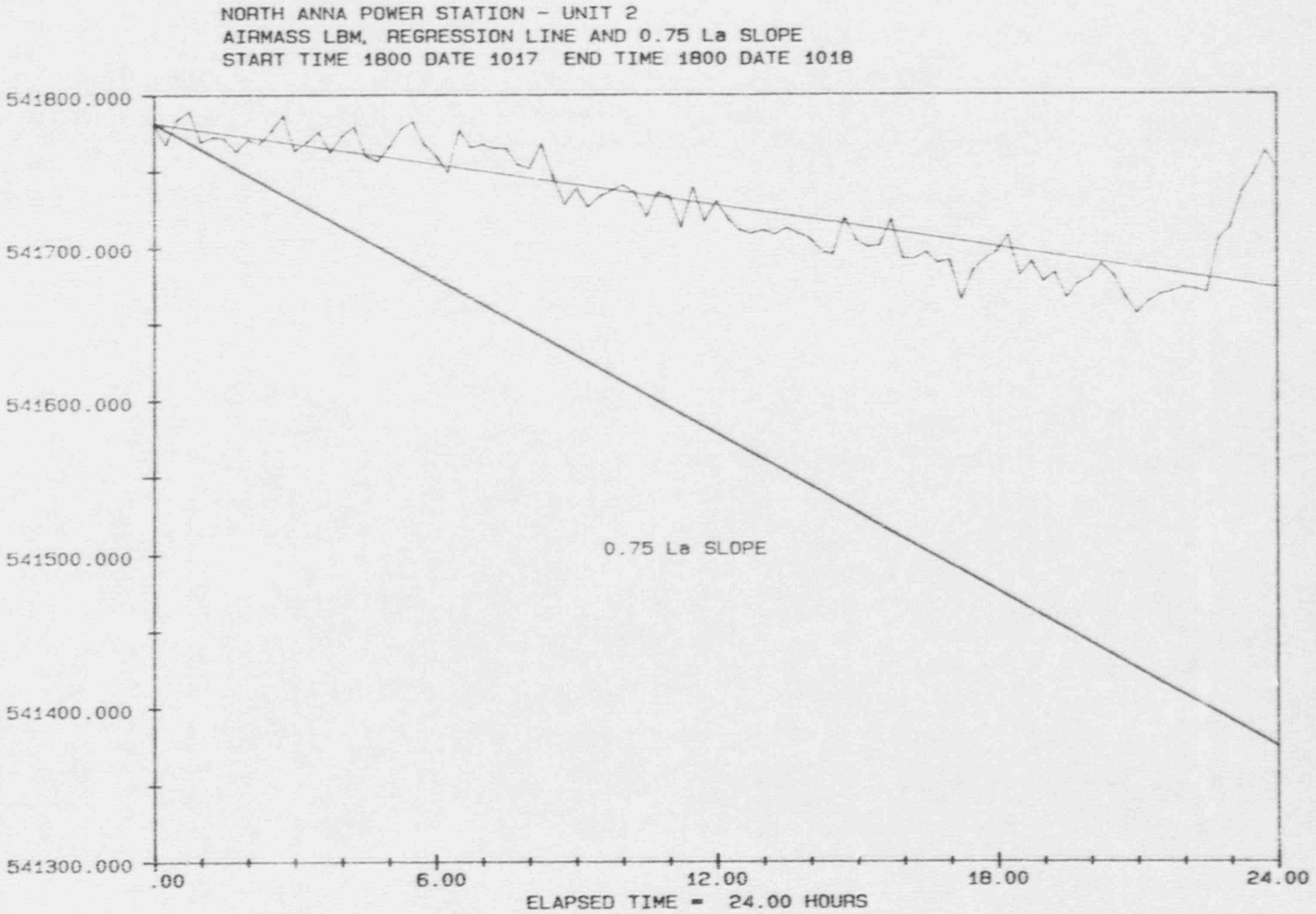
SECTION C.4: REGRESSION LINE OF VERIFICATION TEST CONTAINMENT AIR MASS

SECTION C.5: VERIFICATION TEST MASS POINT LEAKAGE RATE

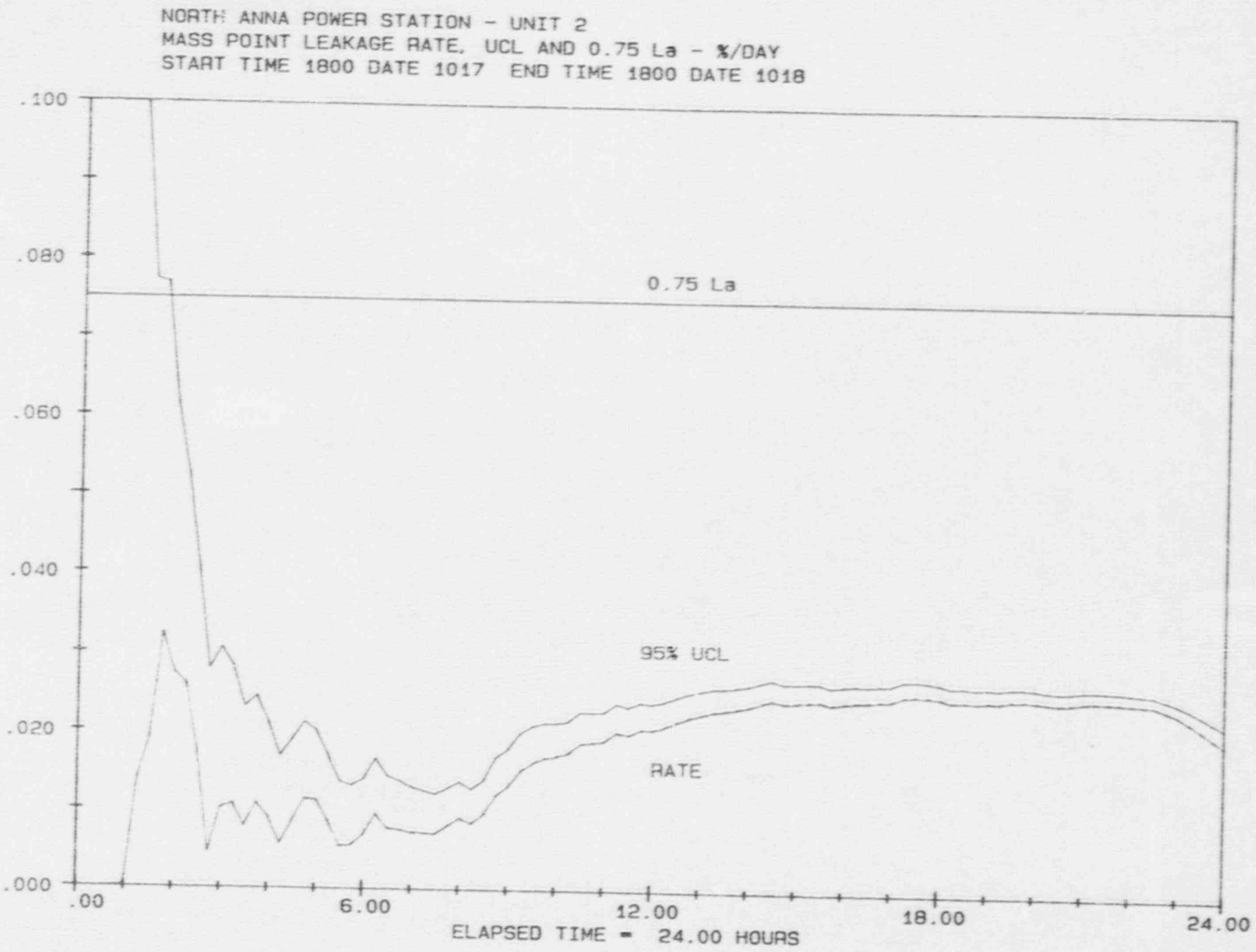
SECTION C.1: Containment Air Mass Plot For Test Duration


NORTH ANNA POWER STATION - UNIT 2
AIRMASS LBM
START TIME 400 DATE 1017 END TIME 400 DATE 1019
542160.000
542040.000
541920.000
541800.000
541680.000
541560.000
STABILIZATION
ILRT
VERIFICATION
FAN TRIP
ELAPSED TIME = 48.00 HOURS

SECTION C.2: Regression Line Of ILRT Containment Air Mass

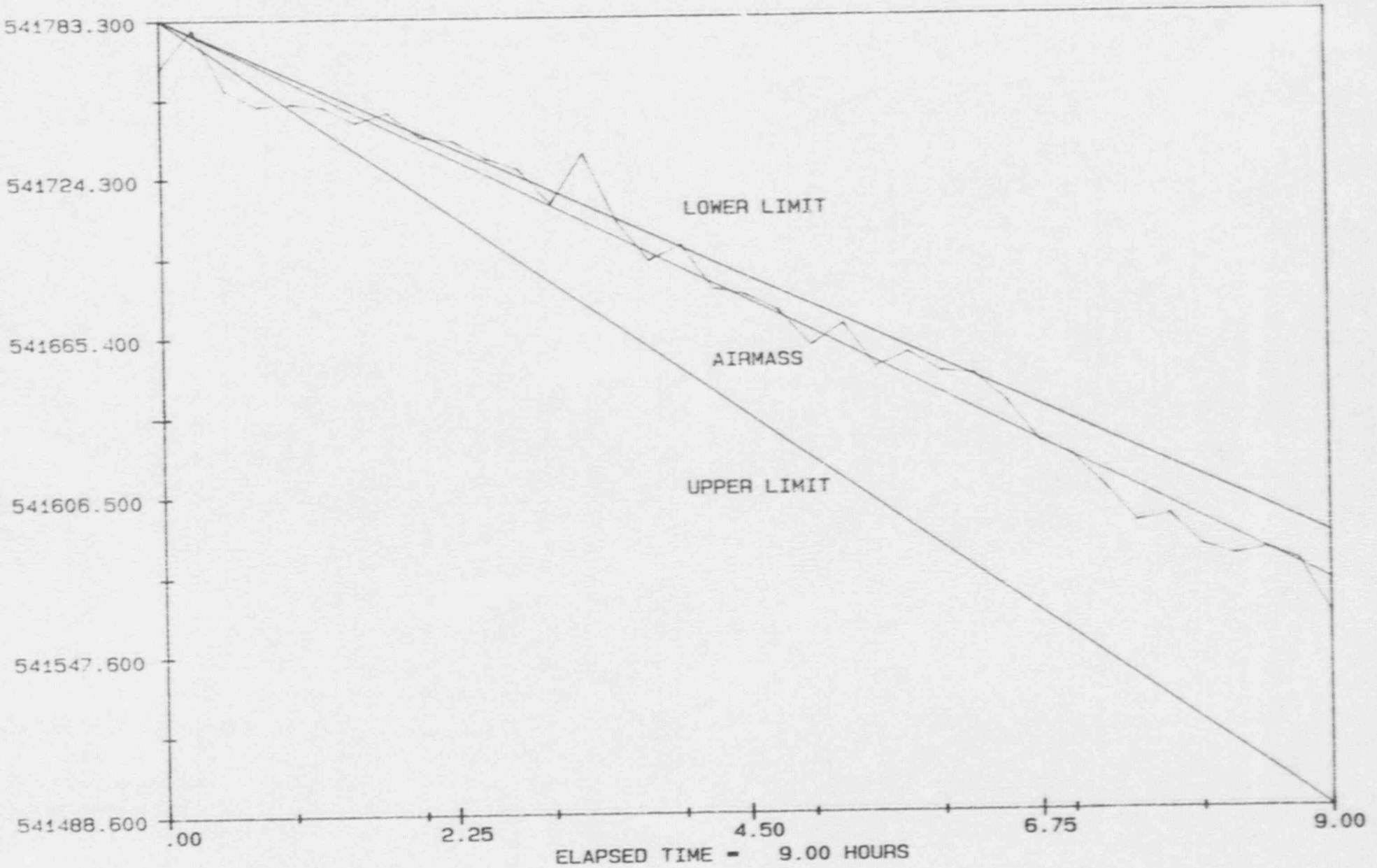

NORTH ANNA POWER STATION - UNIT 2
AIRMASS LBM, REGRESSION LINE AND 0.75 La SLOPE
START TIME 1800 DATE 1017 END TIME 1800 DATE 1018
541800.000
541700.000
541600.000
541500.000
541400.000
541300.000
0.75 La SLOPE
.00
6.00
12.00
18.00
24.00
ELAPSED TIME = 24.00 HOURS

SECTION C.3: ILRT Mass Point Leakage Rate And UCL


NORTH ANNA POWER STATION - UNIT 2
MASS POINT LEAKAGE RATE, UCL AND 0.75 La - %/DAY
START TIME 1800 DATE 1017 END TIME 1800 DATE 1018
.100
.080
.060
.040
.020
.000
0.75 La
95% UCL
RATE
.00
6.00
12.00
18.00
24.00
ELAPSED TIME = 24.00 HOURS

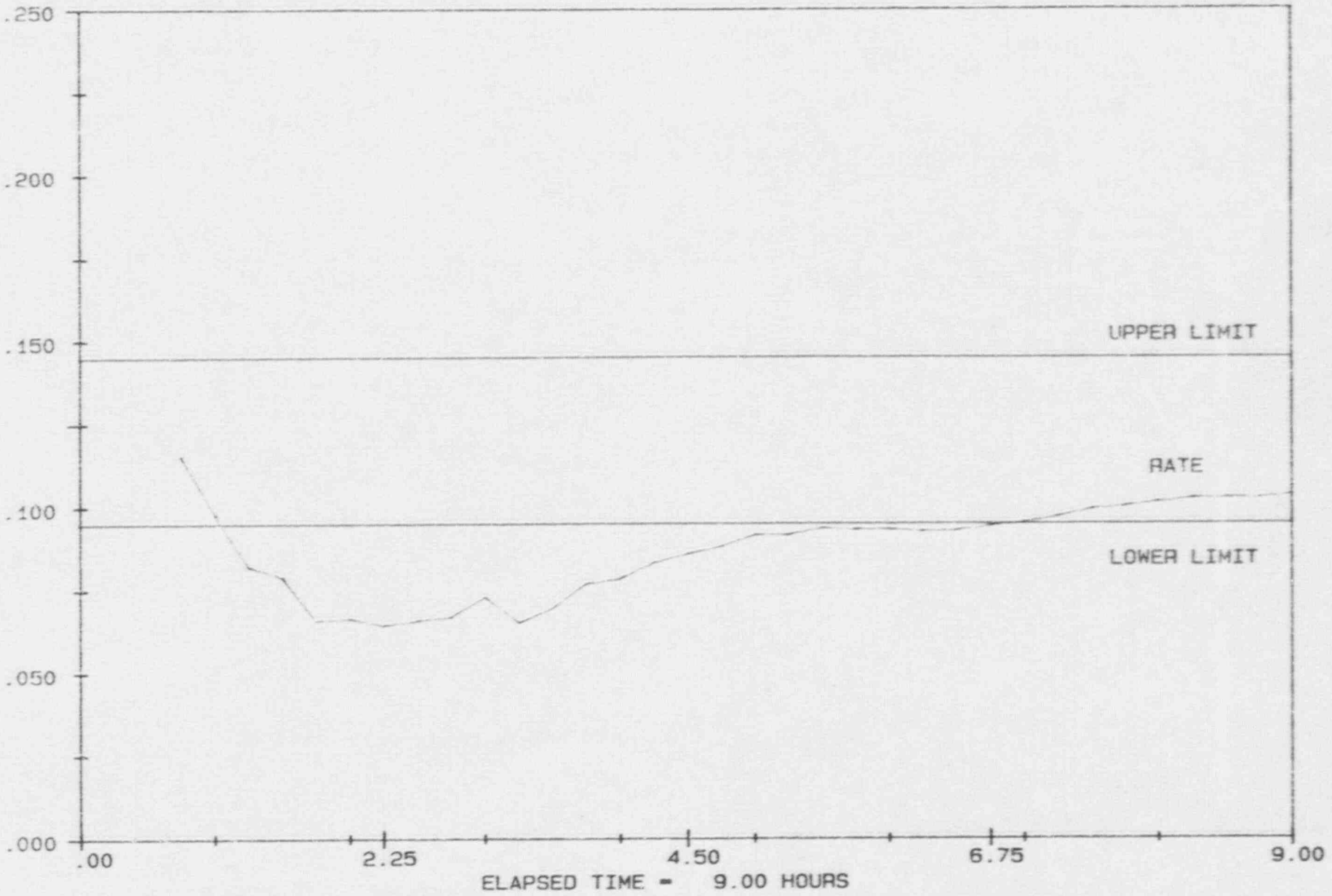
SECTION C.4: Regression Line Of Verification Test Containment Air Mass

NORTH ANNA POWER STATION - UNIT 2
AIRMASS LBM, REGRESSION LINE AND VERIFICATION TEST LIMITS
START TIME 1900 DATE 1018 END TIME 400 DATE 1019



SECTION C.5: Verification Test Mass Point Leakage Rate

NORTH ANNA POWER STATION - UNIT 2
MASS POINT LEAKAGE RATE AND VERIFICATION TEST LIMITS - %/DAY
START TIME 1900 DATE 1018 END TIME 400 DATE 1019



APPENDIX D

LOCAL LEAKAGE RATE TESTING SUMMARY

SECTION D.1: TYPE B TESTING SUMMARY

SECTION D.2: TYPE C TESTING SUMMARY

SECTION D.3: TYPE B AND TYPE C INSTRUMENT ERROR ANALYSIS

SECTION D.1: Type B Testing Summary

SECTION D.1: Type B Testing Summary

The following charts summarize the Type B leakage testing performed on Unit 2 components from April 1989 to the November 1990 Unit 2 startup.

All Type B leakage testing for the outage was performed at a pressure range of 44.1 psig to 45.0 psig.

Electrical Penetration Type B Testing Summary

Outage	Total Leakage (SCFH)
Spring 1989	4.84 3.03
Fall 1990	1.89 1.02

Containment Fuel Transfer Tube Type B Testing Summary

Outage	Total Leakage (SCFH)
Spring 1989	-0-
Fall 1990	-0-

Containment Air Locks Type B Testing Summary

Leakages (SCFH) and Test Dates

	Personnel Air Lock	Emergency Escape Air Lock In Equipment Hatch
May 1989	3.10 ± 0.23	0.14 ± 0.14
October 1989	11.0 ± 0.23	7.50 ± 0.23
April 1990	5.50 ± 0.23	3.10 ± 0.23
October 1990	6.40 ± 0.16	2.30 ± 0.16

SECTION D.2: Type C Testing Summary

SECTION D.2: Type C Testing Summary

The following chart summarizes the Type C leakage testing performed on Unit 2 components from April 1989 to the November 1990 Unit 2 startup. The leakages in the chart represent the maximum pathway leakages for the penetrations.

All Type C leakage testing for the outage was performed at a pressure range of 44.1 psig to 45.0 psig.

Containment Piping Penetrations Type C Testing Summary

Leakages (SCFH)

Penetration Number	SPRING 1989 Outage	INTERIM	FALL 1990 Outage
1	0.07 ± 0.07		3.90 ± 0.23
2	0.07 ± 0.07		0.90 ± 0.23
4	0.07 ± 0.07		2.00 ± 0.23
5	0.07 ± 0.07		2.60 ± 0.23
7	0.07 ± 0.07 0.49 ± 0.07		0 ± 0.16
8	0.14 ± 0.14		0 ± 0.16
9	>241 0.07 ± 0.07		0 ± 0.16
10	>241 0.60 ± 0.07		0 ± 0.07
11	>241 0.07 ± 0.07		0 ± 0.04
12	0.07 ± 0.07		1.10 ± 0.04
13	0.07 ± 0.07		0.30 ± 0.04
14	0.07 ± 0.07		1.40 ± 0.07
15	0.07 ± 0.07		0 ± 0.16
16	>241 0.07 ± 0.07		0 ± 0.16

NOTES:). For outages, the second figure is "As Left," when different than "As Found".

2. The Spring 1989 outage data is included for reference.

Containment Piping Penetrations Type C Testing Summary (cont)

Leakages (SCFH)

Penetration Number	SPRING 1989 Outage	INTERIM	FALL 1990 Outage
17	>241 2.40 ± 0.07		0 ± 0.16
18	0.07 ± 0.07		0 ± 0.16
19	0.07 ± 0.07		74.0 ± 5.14 2.80 ± 0.07
20	0.07 ± 0.07		0 ± 0.04
22	0.07 ± 0.07		0.20 ± 0.04
24	2.50 ± 0.23		0 ± 0.07 0.90 ± 0.16
25	0.14 ± 0.14		0 ± 0.16
26	0.14 ± 0.14		0 ± 0.04
27	0.14 ± 0.14		0 ± 0.04
28	0.07 ± 0.07		0.1 ± 0.16
31	6.30 ± 0.70 0.04 ± 0.04		34.0 ± 0.70 0.30 ± 0.16
32	0.85 ± 0.07		0.50 ± 0.07
33	0.56 ± 0.07		0 ± 0.16
34	35.0 ± 0.70 0.35 ± 0.07		0 ± 0.04
38	0.50 ± 0.07 0.04 ± 0.04		2.90 ± 0.07 0 ± 0.16

Containment Piping Penetrations Type C Testing Summary (cont)

Leakages (SCFH)

Penetration Number	SPRING 1989 Outage	INTERIM	FALL 1990 Outage
39	0.14 ± 0.14		9.80 ± 0.70 0 ± 0.16
40	1.28 ± 0.07 0.35 ± 0.07		7.00 ± 0.70 0 ± 0.16
41	1.58 ± 0.07		1.10 ± 0.07 0 ± 0.07
42	0.07 ± 0.07 0.04 ± 0.04		0 ± 0.16
43	0.07 ± 0.07		0 ± 0.04
44	0.07 ± 0.07		0 ± 0.04
45	>241 0.60 ± 0.07		0 ± 0.16
46	>241 0.07 ± 0.07		>257 0.40 ± 0.04
47	0.40 ± 0.07		0.20 ± 0.04
48	0.07 ± 0.07		0 ± 0.16
50	0.07 ± 0.07		0.20 ± 0.07
53	0.07 ± 0.07		1.60 ± 0.07 0.10 ± 0.04
54	0.07 ± 0.07		0 ± 0.04
55D	0.04 ± 0.008		0 ± 0.04
56A	1.20 ± 0.07 0.40 ± 0.07		1.50 ± 0.07 0.05 ± 0.04

Containment Piping Penetrations Type C Testing Summary (cont)

Leakages (SCFH)

Penetration Number	SPRING 1989 Outage	INTERIM	FALL 1990 Outage
56B	6.00 ± 0.70 0.04 ± 0.04		0 ± 0.07
56C	1.20 ± 0.07		0.30 ± 0.07 0 ± 0.16
56D	0.07 ± 0.07		0 ± 0.07
57A	0.008 ± 0.008		0 ± 0.04
57B	0.04 ± 0.04		0 ± 0.04
57C	0.04 ± 0.04		0 ± 0.04
60	0.50 ± 0.07		1.50 ± 0.07
61	0.07 ± 0.07		7.50 ± 0.07
62	0.53 ± 0.07		0.30 ± 0.07 0 ± 0.07
63	0.35 ± 0.07 0.50 ± 0.07		0 ± 0.16
64	0.07 ± 0.07		0.40 ± 0.04
66	0.14 ± 0.14		0 ± 0.04
67	0.14 ± 0.14		0 ± 0.04
70	0.07 ± 0.07		1.60 ± 0.04
71	0.07 ± 0.07		>257 1.20 ± 0.04
79	0.006 ± 0.006		0 ± 0.07

Containment Piping Penetrations Type C Testing Summary (cont)

Leakages (SCFH)

Penetration Number	SPRING 1989 Outage	INTERIM	FALL 1990 Outage
80	0.006 ± 0.006		0 ± 0.07
81	>206 0.07 ± 0.07		0 ± 0.07
82	0.006 ± 0.006		0 ± 0.07
83	0.006 ± 0.006		0 ± 0.07
84	0.006 ± 0.006		16.0 ± 0.70 0 ± 0.07
85	>206 13.0 ± 0.70		12.0 ± 0.70 0 ± 0.07
86	>206 0.07 ± 0.07		0 ± 0.07
89	3.20 ± 0.07 1.60 ± 0.035		1.10 ± 0.16 0.70 ± 0.23
90	3.40 ± 0.70 4.35 ± 0.14		2.1 ± 0.70 5.7 ± 0.16
91	81.2 ± 4.82 8.58 ± 1.40		5.0 ± 0.70 6.5 ± 0.16
92	1.30 ± 0.07	1.30 ± 0.07 (8/89)	0 ± 0.04
93	0.78 ± 0.07 0.07 ± 0.07		0.3 ± 0.04

Containment Piping Penetrations Type C Testing Summary (cont)

Leakages (SCFH)

Penetration Number	SPRING 1989 Outage	INTERIM	FALL 1990 Outage
94	0.71 ± 0.07 1.70 ± 0.23		30.0 ± 0.70 0 ± 0.07
97A	0.04 ± 0.04		0 ± 0.04
97B	0.04 ± 0.04		0 ± 0.04
97C	0.07 ± 0.07		0 ± 0.04
98A	0.08 ± 0.07		0 ± 0.16
98B	0.07 ± 0.07		0 ± 0.04
100	10.0 ± 0.70 0.07 ± 0.07		0 ± 0.16
103	0.07 ± 0.07		0 ± 0.04
104	0.07 ± 0.07		0 ± 0.04
105A	0.008 ± 0.008 0.04 ± 0.04		0 ± 0.04
105B	0.04 ± 0.04		0 ± 0.04
105C	0.07 ± 0.07		0 ± 0.04
105D	0.07 ± 0.07		0 ± 0.04
106	0.14 ± 0.14 0.04 ± 0.04		0 ± 0.16
108	0.07 ± 0.07		0 ± 0.16
109	0.07 ± 0.07		131.6 ± 3.14 0 ± 0.16
111	0.07 ± 0.07		1.0 ± 0.07 0 ± 0.16
112	0.55 ± 0.14		0.3 ± 0.16
113	0.07 ± 0.07		0 ± 0.16
114	0.07 ± 0.07		0 ± 0.16

SECTION D.3: Type B and Type C Instrument Error Analysis

SECTION D.3: Type B and Type C Instrument Error Analysis

Instrument error analyses were performed for the Type B and C testing results. The Type B testing on the electrical penetrations and the fuel transfer tube are performed using a bubbler rig in which the number of bubbles per unit time are counted. The conversion from number of bubbles to SCFH is sufficiently conservative so that no additional error penalty needs to be incorporated. As is shown in the charts in Section D.1 and Section D.2, the reported leakages for the air lock Type B tests and the Type C tests reflect the instrument error analyses performed for the Fall 1990 Unit 2 leakage testing results.

APPENDIX E

LOCAL LEAKAGE RATE TESTING FAILURE SUMMARY

SECTION E.1: TYPE B TESTING FAILURE SUMMARY

SECTION E.2: TYPE C TESTING FAILURE SUMMARY

SECTION E.1: Type B Testing Failure Summary

SECTION E.1: Type B Testing Failure Summary

During the time period of April 1989 to the November 1990 Unit 2 Cycle 8 start-up, there have been no Type B testing failures of equal to or greater than $0.60L_a$.

SECTION E.2: Type C Testing Failure Summary

SECTION E.2: Type C Testing Failure Summary

The following chart summarizes the Type C testing results for the Unit 2 containment isolation valves which have recorded Type C leakages of at least $0.60L_a$ during the time period from April 1989 to the November 1990 Unit 2 start-up.

Penetration Number	Valve #	Test Date	Recorded Leakage (SCFH)	Work Order Number	Description of Repair
46	2-CH-FCV-2160	08/29/90	>257	094282	Replaced plug and stem assembly and seat ring.
71	2-RS-20	09/03/90	>257	116059	Replaced rubber seat.