REACTOR CONTAINMENT BUILDING
INTEGRATED LEAKAGE RATE TEST

TYPES A, B, AND C
PERIODIC TEST

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION
UNIT NO. 2

OCTOBER 1984

Prepared by
STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

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REFERENCES

1. 10CFR50, Appendix J, Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors, October 22, 1980.

2. 2-PT-61.1, Reactor Containment Building Integrated Leakage Rate Testing, 1984.

3. ANSI N45.4, American National Standard Leakage-Rate Testing of Containment Structures for Nuclear Reactors, March 16, 1982.

4. Vepco, North Anna LER 84-008, Recirculation Spray Cooler Lap Ring Cracking, dated September 27, 1984.

5. Vepco's letter dated October 5, 1984, from W. L. Stewart to H. R. Denton Shorter Duration Type A Testing Requirements.

LIST OF ATTACHMENTS

SECTION 1

PURPOSE

The purpose of this report is to present a description and analysis of the October 1984 Periodic Type A Containment Integrated Leakage Rate Test (CILRT), and a summary of the periodic Type B and C tests conducted since April 1979 on the Virginia Electric and Power Company's North Anna Power Station, Unit No. 2.

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

Stone & Webster Engineering Corporation provided engineering consultation services to Vepco during their performance of these tests.

SECTION 2

SUMMARY

2.1 TYPE A SUMMARY

The recirculation spray cooler lap ring cracking condition that had been discovered during the Unit No. 1 CILRT was also found, to a lesser extent, on the Unit No. 2 coolers. As reported by Vepco (see Reference 4), these cracks were caused by a crevice corrosion and stress corrosion cracking condition. The repairs to the Unit No. 2 coolers were completed prior to the October 1984 CILRT. Vepco is currently evaluating potential modifications for the recirculation spray coolers to address this condition.

Pressurization for the CILRT was started at 2217 hours on October 12, 1984, and was completed at 1257 hours on October 13, 1984. The "A" containment air recirculation fan tripped at 1410 hours on October 13, 1984. The blades on these fans were adjusted to permit operation during the CILRT. The containment air recirculation system would be isolated by the containment depressurization actuation signal when the containment pressure exceeds 10 psig. The procedural temperature stabilization criterion was achieved at 1800 hours on October 13, 1984.

For the first few hours after stabilization, the mass trend was very erratic. The trend indicated a significant leakage rate of approximately 30 lbm per hour, or just about twice the procedure acceptance criterion of $0.75L_A$.

At 0222 hours on October 14, 1984, a significant leak was observed in the containment air recirculation system chilled water piping. An increasing water level in the chilled water makeup tank followed by venting air from the supply and return header high points confirmed the leakage path. As experienced on the recent North Anna Unit No. 1 CILRT, the throttled chilled water flow for the ILRT lowered the system pressure well below the containment pressure. This leakage path is not a credible design basis loss of coolant accident leakage path as this system would be isolated. It was running for the CILRT to provide minimal cooling flow to offset the fan motor heat input and to stabilize containment air temperature.

By process of elimination, the "B" air recirculation cooler unit was identified as the major leakage path. This cooler was isolated at the penetration. Air was still observed in the supply and return header piping after the isolation so there were leaks, although not as significant as those in the "B" Loop, in the other loop(s). The chilled water headers were periodically vented thereafter, to prevent the system pumps from becoming air bound.

The CILRT was started at 1100 hours on October 14, 1984, and was completed at 0240 hours on October 15, 1984. The shorter duration test was done in accordance with the provisions of Reference 5.

The superimposed leakage verification test was started at 0400 hours and was completed at 1200 hours on October 15, 1984.

2.2 LOCAL LEAKAGE RATE TESTS (TYPES B AND C)

The Local Leakage Rate Tests (LLRTs) of containment isolation valves and primary containment penetrations were conducted as required by station surveillance procedures since the Unit No. 2 preoperational Type A test performed in April 1979.

In accordance with Appendix J, 10CFR50, Paragraph V.B., data for the LLRTs are summarized in Section 4 of this report.

SECTION 3

TYPE A TEST

3.1 EDITED LOG OF EVENTS

This log was edited from the chronological Log of Events.

October 12, 1984

2217 - Commenced containment inspection in accordance with generic procedure 1-PT-61.1A.

October 13, 1984

0040 - Completed containment inspection. No significant evidence of deterioration was observed.

0415 - Commenced pressurization.

1257 - Secured pressurization with peak pressure of 59.787 psia.

1410 - Air Recirculation Fan 1A tripped.

1609 - Completed preliminary leakage investigation. No significant leakage paths were identified.

October 14, 1984

0222 - Observed air in the chilled water to the containment air recirculation cooler unit piping. Isolated "A" cooler chilled water supply and return piping in an attempt to identify which cooler(s) were leaking.

0340 - Restored "A" chilled water flow.

0357 - Isolated "B" chilled water flow.

1030 - Vented air from chilled water header outside of containment (to prevent pumps from tripping.)

1055 - Deleted T1042A moisture element MT-LM-200-2 on the Unit No. 2 computer due to erratic behavior.

1106 - Vented chilled water header outside containment.

1215 - Deleted N0081A (the Unit 1 equivalent of T1042A) on the Unit No. 1 computer. Four remaining dewpoint devices are operating acceptably.

1301 - Vented chilled water header outside containment.

1321 - Added penetration 91 to the list of penetrations not vented for the test. A pressure gage had been installed on the vent connection for leakage determination.

1540 - Vented chilled water header outside containment.

1640 - Vented chilled water header outside containment.

1750 - Vented chilled water header outside containment.

1920 - Vented chilled water header outside containment.

October 15, 1984

0240 - Completed 15.667 hour run with final UCL of 0.074662 percent/day for the total time method and 0.033990 for the mass plot method.

0318 - Initiated superimposed leakage rate of 150 scfh at 41.7 psig.

1200 - Completed 8-hour verification test.

1440 - Started depressurization.

2250 - Containment at 14.570 psia.

3.2 GENERAL TEST DESCRIPTION

3.2.1 Initial Conditions

In accordance with the North Anna Unit No. 2 CILRT Procedure 2-PT-61.1 (Reference 2), the following is a partial listing of the initial conditions completed and documented prior to containment pressurization:

a. General inspection of the accessible interior and exterior surfaces of the containment structure was performed.

b. All test instrumentation calibrated or functionally verified within six months of the test.

c. All required system valve lineups completed.

d. Containment air recirculation system operating to maintain stable conditions.

e. Plant computers were operational and programmed for the CILRT.

f. The official Log of Events was established.

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

h. All required Types B and C leakage testing complete or reviewed by the Test Director.

3.2.2 Equipment and Instrumentation

Pressurization of the containment was achieved by the utilization of ten air compressors. Compressed air was piped through two aftercoolers in parallel and then through a refrigerant air dryer. Adequate instrumentation and valving were installed to maintain control of the compressed air quality throughout the pressurization sequence. The total capacity of the pressurization system was slightly in excess of 10,000 cubic feet per minute.

The various containment parameters were monitored by the Leakage Monitoring System instrumentation. The instrumentation (Attachment 3.2A), consisted of multiple resistance temperature detectors (RTDs), moisture dectectors, and two absolute pressure quartz manometers. The general locations of the temperature and moisture sensors are shown in Attachments 3.2B and 3.2C.

A pair of rotometers were used to perform the superimposed leakage verification test. With the exception of these rotometers, all test instrumentation was monitored by the plant computer.

3.2.3 Data Acquisition System

The data acquisition system used for the North Anna Unit No. 2 CILRT was the Westinghouse Prodac P250 process plant computer.

For the CILRT, the P250 monitored the following instrumentation:

Type	Scan Rate (sec)
18 RTDs	32
5 moisture detectors	32
2 quartz manometers	2

The input to the CILRT program was a P250 calculated 10-minute average. For the October 1984 CILRT, the P250 average program was modified to force an average at 10 minutes, independent of the number of accumulated scans.

The CILRT program performs sensor validity checks on the temperature, moisture, and pressure sensors to identify any aberrant behavior. If all sensors are trending within their CILRT program limits, the program calculates weighted average dewpoint temperature, vapor pressure, weighted average containment temperature, and containment air mass.

Instantaneous values of the CILRT instruments were recorded every 5 minutes during the test period, using the P250 digital trend function on the operator's console.

During the Unit No. 1 August 1984 CILRT, the RTD sensitivity was determined to be causing some data scatter. A three-fold improvement in the RTD sensitivity was realized by changing the range of the computer bridge circuit. This improvement was in place for the Unit No. 2 October 1984 CILRT.

3.2.4 Data Resolution System

Once the P250 has acquired the appropriate data, the reduced parameters are manually input into Vepco's Richmond Computer System for leakage rate calculations. For the North Anna Unit No. 2 CILRT, both Mass Point and Total Time Analysis methods were used to determine the leakage rate (see Reference 5).

Absolute Method of Mass Point Analysis

This method consists of calculating air masses within the containment structure over the test period from pressure, temperature, and dewpoint observations. The air masses are computed using the ideal gas law as follows:

$$\text{Mass} = \frac{144V\ (P-Pv)}{RT} \qquad \text{(Eq.1)}$$

Where:

M = air mass, lbm
P = total pressure, psia
Pv = vapor pressure, psia
R = 53.35 ft-lbf/lbm°R (for air)
T = average containment temperature, °R
V = containment free volume, 1.825×10^6 ft^3

The leakage rate is then determined by plotting the air mass as a function of time, using a least-squares fit to determine the slope, A = dm/dt. The leakage rate is expressed as a percentage of air mass lost in 24 hours or symbolically:

$$\text{Leakage rate} = (A/B)\ (-2400) \qquad \text{(Eq. 2)}$$

Where A is the slope of the least-squares curve and B is the y intercept, the sign convention is such that the leakage out of containment is positive and the units are in percent/day.

A 95-percent confidence interval is calculated using a Student's t distribution. The sum of the Mass Point Analysis leakage rate and the 95-percent confidence interval is the UCL-MP.

Absolute Method of Total Time Analysis

This method consists of calculating a measured leakage rate. The containment air mass is computed using Equation 1. The measured leakage rate at any time (t) is then determined by subtracting the mass at the time (M_t) from the initial mass (M_i) and dividing by the initial mass. The measured leakage rate is expressed as a percentage of the continment mass lost in 24 hours or symbolically:

$$\text{Measured Leakage Rate} = \frac{M_i - M_t}{M_i} \quad \frac{(2400)}{(\Delta t)} \qquad \text{(Eq. 3)}$$

The sign convention is such that an outward leakage rate is positive and the units are in percent/day.

The estimated leakage rate is then determined by performing a linear least-squares fit of the measured leakage rate values, as follows:

$$\text{Estimated leakage rate} = \Delta t + B \qquad \text{(Eq. 4)}$$

where Δ is the slope and B is the y intercept of the least-squares line.

The 95-percent confidence interval is determined using a student's t distribution. The sum of the total time estimated leakage rate and the 95 percent confidence level is the UCL-TT.

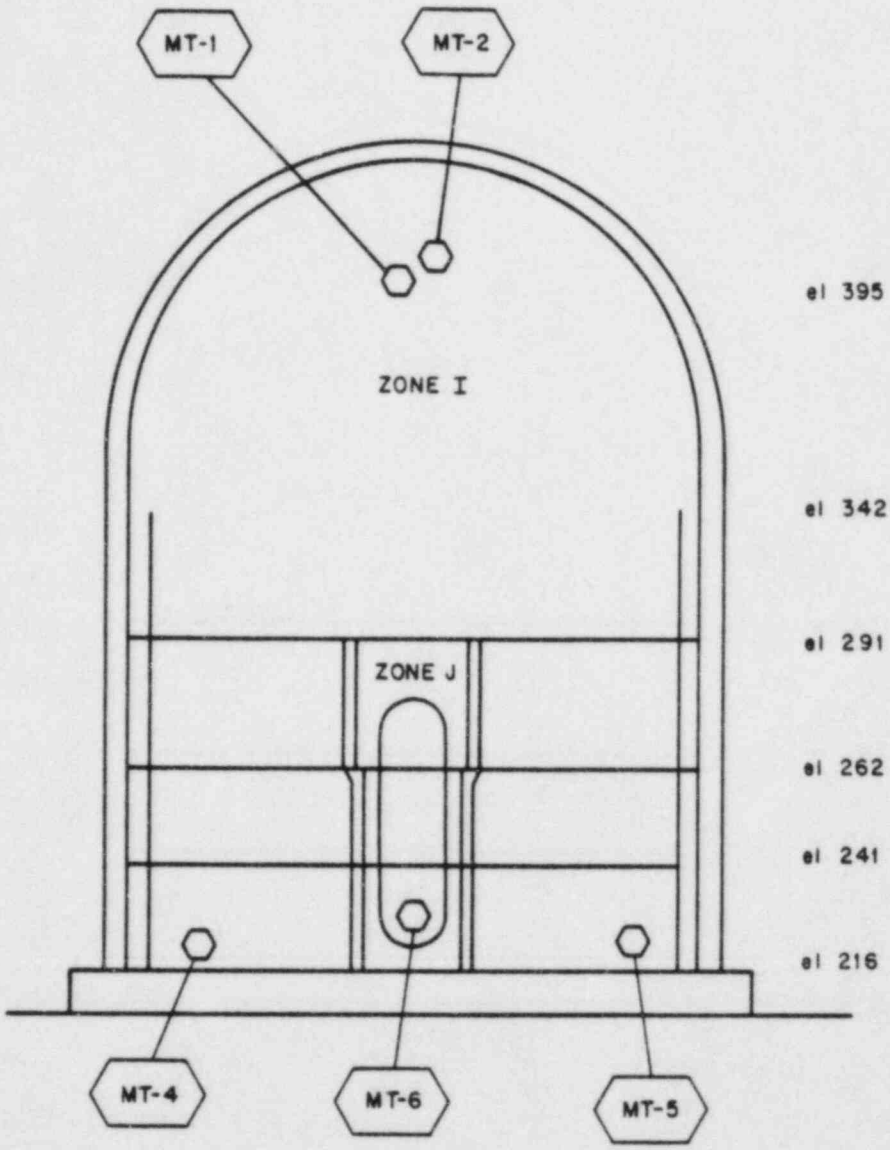
ATTACHMENT 3.2A

INSTRUMENTATION

Instrument	Weight Factor	Computer Point	Range	Zone(1)	Accuracy
TE-LM-200-3	0.03619	T1002A	60-120°F	F	± 0.1°F
TE-LM-200-4	0.02935	T1003A	60-120°F	E	± 0.1°F
TE-LM-200-5	0.09373	T1004A	60-120°F	B	± 0.1°F
TE-LM-200-6	0.09373	T1005A	60-120°F	C	± 0.1°F
TE-LM-200-7	0.09373	T1006A	60-120°F	B	± 0.1°F
TE-LM-200-8	0.09373	T1007A	60-120°F	C	± 0.1°F
TE-LM-200-9	0.04789	T1008A	60-120°F	A	± 0.1°F
TE-LM-200-10	0.04789	T1009A	60-120°F	A	± 0.1°F
TE-LM-200-11	0.04789	T1010A	60-120°F	A	± 0.1°F
TE-LM-200-12	0.02283	T1011A	60-120°F	D	± 0.1°F
TE-LM-200-13	0.02283	T1012A	60-120°F	D	± 0.1°F
TE-LM-200-14	0.02283	T1013A	60-120°F	E	± 0.1°F
TE-LM-200-15	0.02283	T1014A	60-120°F	E	± 0.1°F
TE-LM-200-16	0.08309	T1015A	60-120°F	G	± 0.1°F
TE-LM-200-17	0.08309	T1016A	60-120°F	G	± 0.1°F
TE-LM-200-18	0.08309	T1017A	60-120°F	G	± 0.1°F
TE-LM-200-19	0.03932	T1036A	60-120°F	F	± 0.1°F
TE-LM-200-20	0.03597	T1040A	60-120°F	F	± 0.1°F
MT-LM-200-1	0.12569	Y2020A	32-110°F	H	± 0.5°F
MT-LM-200-2	0.12569	T1042A	32-110°F	H	± 0.5°F
MT-LM-200-4	0.24954	T1044A	32-110°F	I	± 0.5°F
MT-LM-200-5	0.24954	T1045A	32-110°F	I	± 0.5°F
MT-LM-200-6	0.24954	T1041A	32-110°F	I	± 0.5°F
PIT-LM-202	--	U2173	0-100 psia	-	± 0.02 psia
PIT-LM-207	--	U2174	0-100 psia	-	± 0.02 psia

NOTES

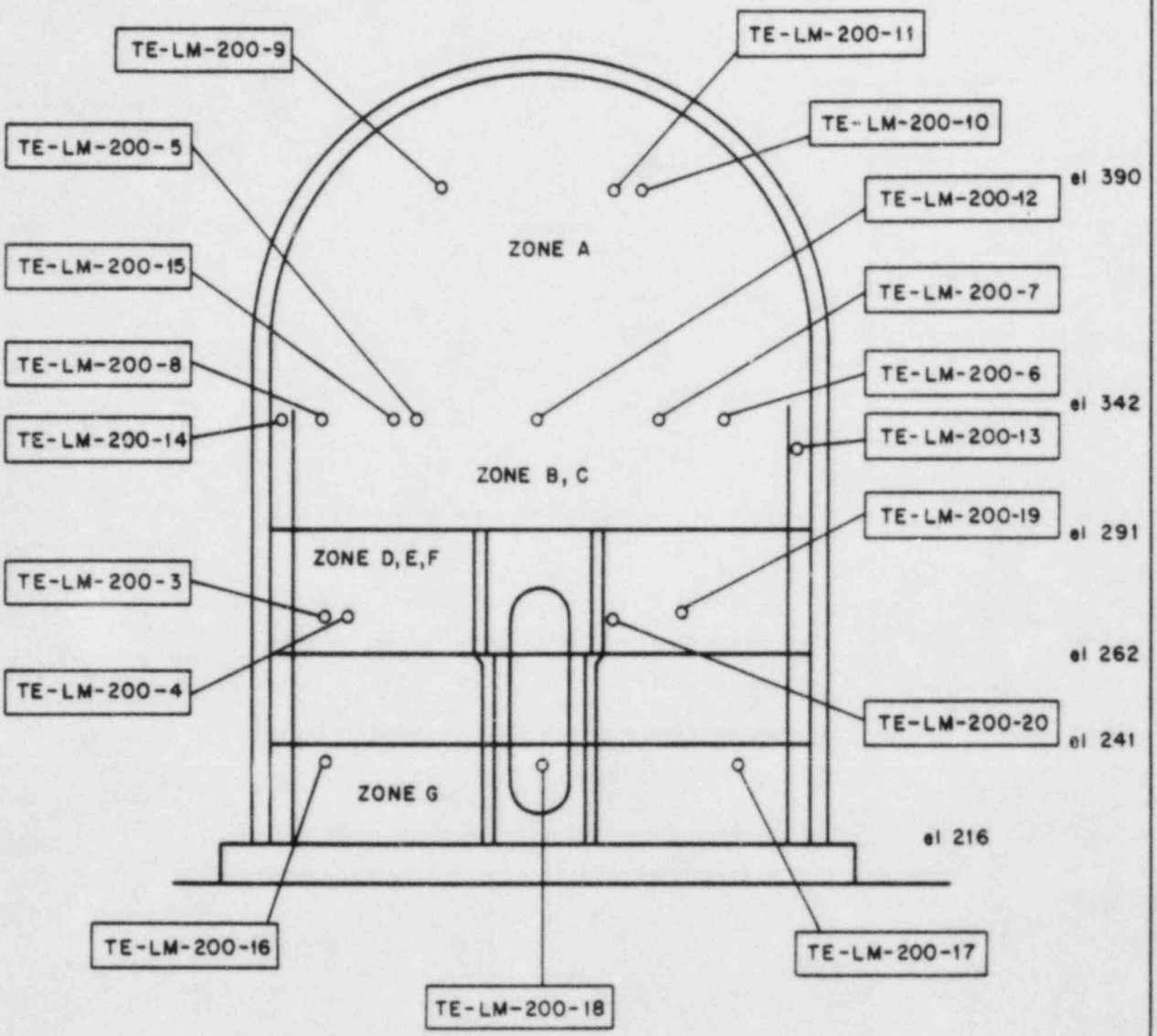
(1) Zone used for sensor validity checking purposes only.



PROFILE VIEW

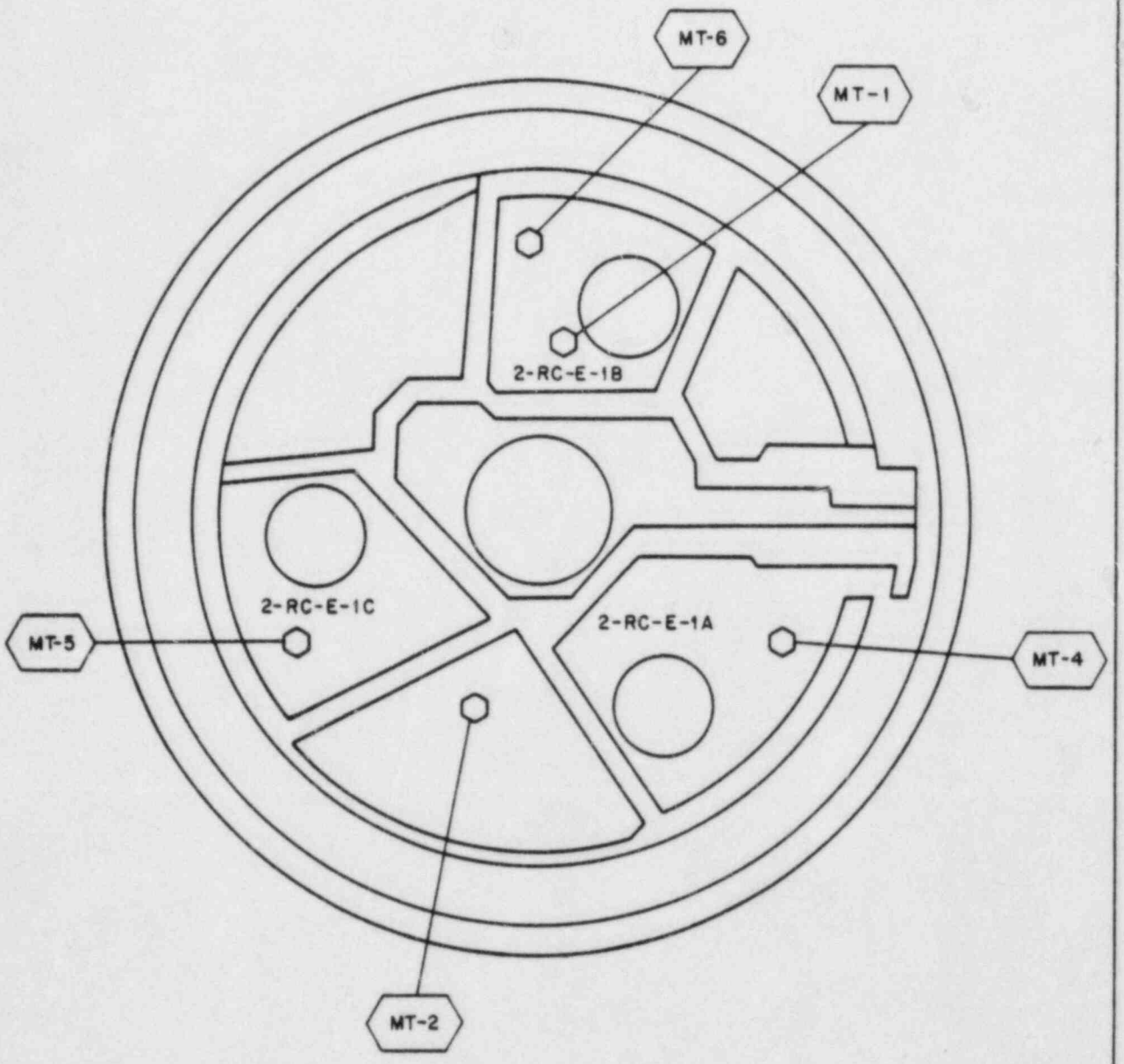
NOTE:
MT-1 MT-LM-200-1 (typ)

ATTACHMENT 3.2B
INSTRUMENTATION LOCATION
MOISTURE DETECTORS
NORTH ANNA POWER STATION-UNIT 2
INTEGRATED LEAK RATE TEST



PROFILE VIEW

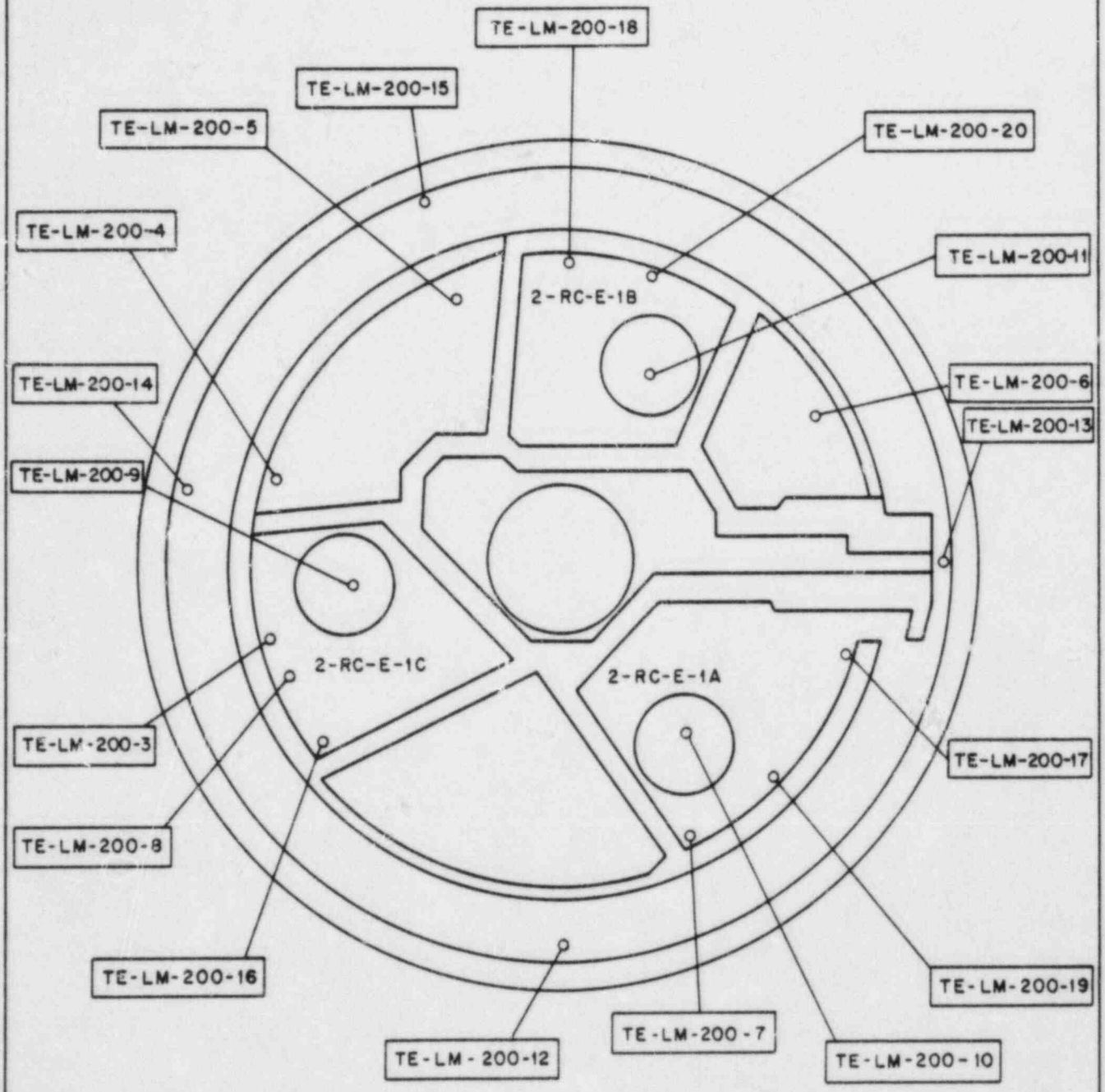
ATTACHMENT 3.2B
INSTRUMENTATION LOCATION
RESISTANCE TEMPERATURE
DETECTORS (RTD)
NORTH ANNA POWER STATION-UNIT 2
INTEGRATED LEAK RATE TEST



PLAN VIEW

NOTE:
MT-1 MT-LM-200-1 (typ)

ATTACHMENT 3.2C
INSTRUMENTATION LOCATION
MOISTURE DETECTORS
NORTH ANNA POWER STATION-UNIT 2
INTEGRATED LEAK RATE TEST



PLAN VIEW

ATTACHMENT 3.2C
INSTRUMENTATION LOCATION
RESISTANCE TEMPERATURE
DETECTORS (RTD)
NORTH ANNA POWER STATION-UNIT 2
INTEGRATED LEAK RATE TEST

3.3 TEST RESULTS

3.3.1 Presentation of Test Results

The test data for the October 1984 CILRT is based on a 15.667 hr period starting at 1,100 hr on October 14, 1984. The final test results were determined using Vepco's Richmond CILRT computer program. The reduced input data, Mass Point Analysis test results, and the total time analysis test results are contained in Attachments 3.3A through 3.3I.

Both the total time and Mass Point Analysis test results satisfied the procedural acceptance criteria.

The type test instrumentation was verified by the superimposed leakage method. Both the total time and Mass Point Analysis test results for the superimposed leakage test satisfied the procedural acceptance criteria.

3.3.2 CILRT Results

The CILRT was conducted in accordance with the North Anna 2-PT-61.1 Surveillance test procedure. The results for the CILRT and for the superimposed leakage test are shown below:

3.3.2.1 Total Time Analysis Results

	Item	(Percent/day)
1.	Leakage rate	0.023230
2.	Confidence level	0.051204
3.	Type C Penalty	0.003412
4.	Total	0.077846

3.3.2.2 Mass Point Analysis Results

	Item	(Percent/day)
1.	Leakage rate	0.032394
2.	Confidence level	0.001706
3.	Type C Penalty	0.003412
4.	Total	0.037512

3.3.2.3 Superimposed Leakage Test Results

1. Calculate superimposed leakage, L_o

   a. Corrected flow for 150 scfh at 41.7 psig

   $$L_o = 150 \left(\frac{41.7 + 14.696}{14.696} \right)^{\frac{1}{2}} = 293.84 \text{ scfh}$$

   b. L_o, in percent/day

   $$L = \frac{293.84 \text{ scfh}}{286.12 \text{ scfh}} = \frac{X}{0.1\%/\text{day}}$$

or L_o = 0.102698%/day

2. Total Time Analysis Test Results

1. Composite Leakage Rate, L_c

i. L_c = 0.109845%/day

2. $L_{AM} + L_o \pm 0.25L_A$

i. 0.023230 + 0.102698 + 0.025 = 0.150928
ii. 0.023230 + 0.102698 + 0.025 = 0.150928
0.100928 < 0.109845 < 0.150928

3. Mass Point Analysis Test Results

1. Composite Leakage Rate, L_c

i. L_c = 0.122204%/day

2. $L_{AM} + L_o \pm 0.25L_A$

i. 0.032394 + 0.102698 + 0.025 = 0.160092
ii. 0.032394 + 0.102698 - 0.025 = 0.110092
0/110092 < 0.122204 < 0.160092

3.3.2.4 Types B and C Penetration Leakage to be added since these penetrations were not vented and drained.

The leakage assigned is the Types B and C recorded valve (maximum pathway analysis) when only minimum pathway analysis is required.

Penetration No.	Leakage (scfh)
1	0.35
9	0.91
12	1.02
25	1.6
38	0.28
30	0.17
56B	0.56
56C	0.17
91	4.1
112	0.6

Total 9.76 scfh or 0.003412

$$\frac{9.76}{286.12} = \frac{X}{0.1\%/\text{day}}$$

ATTACHMENT 3.3A

CONTAINMENT INTEGRATED LEAKAGE RATE TEST
FROM 1100 HOURS 10/14/84 TO 0240 HOURS 10/15/84

REDUCED INPUT VARIABLES

Time (hr)	Absolute Temperature (°R)	Dewpoint (°F)	Absolute Pressure (psia)
0.000	535.90	64.610	59.035
0.333	535.88	64.590	59.031
0.667	535.86	64.520	59.029
1.000	535.84	64.560	59.026
1.333	535.82	64.480	59.024
1.667	535.80	64.440	59.020
2.000	535.78	64.390	59.018
2.333	535.76	64.340	59.015
2.667	535.75	64.270	59.012
3.000	535.73	64.220	59.010
3.333	535.71	64.240	59.006
3.667	535.69	64.120	59.004
4.000	535.67	64.110	59.001
4.333	535.65	64.020	58.999
4.667	535.64	63.960	58.995
5.000	535.61	63.940	58.993
5.333	535.60	63.850	58.990
5.667	535.57	63.810	58.987
6.000	535.56	63.730	58.984
6.333	535.53	63.730	58.981
6.667	535.51	63.600	58.978
7.000	535.49	63.660	58.975
7.333	535.48	63.560	58.973
7.667	535.46	63.530	58.969
8.000	535.43	63.510	58.966
8.333	535.42	63.400	58.964
8.667	535.40	63.440	58.961
9.000	535.37	63.290	58.958

ATTACHMENT 3.3A (Cont)

Time (hr)	Absolute Temperature (°R)	Dewpoint (°F)	Absolute Pressure (psia)
9.333	535.36	63.260	58.955
9.667	535.34	63.230	58.953
10.000	535.32	63.200	58.949
10.333	535.31	63.170	58.946
10.667	535.29	63.110	58.944
11.000	535.27	63.060	58.941
11.333	535.26	63.030	58.939
11.667	535.24	62.900	58.936
12.000	535.22	62.930	58.934
12.667	535.19	62.800	58.928
13.000	535.17	62.730	58.925
13.333	535.16	62.670	58.923
13.667	535.14	62.580	58.921
14.000	535.14	62.610	58.919
14.333	535.13	62.620	58.918
14.667	535.12	62.510	58.916
15.000	535.10	62.470	58.914
15.333	535.09	62.630	58.913
15.667	535.08	62.600	58.912

ATTACHMENT 3.3B

CONTAINMENT INTEGRATED LEAKAGE RATE TEST
FROM 1100 HOURS ON 10/14/84 to 0240 HOURS ON 10/15/84

ABSOLUTE TEST METHOD, TOTAL TIME ANALYSIS

Time (hr)	Mass (lbm)	Mea Leakage (pct/day)	Est Leakage (pct/day)	Confidence (pct/day)	UCL (pct/day)
0.000	539882.02	0.000000	0.000000	0.000000	0.000000
0.333	539867.34	0.196061	0.000000	0.000000	0.000000
0.667	539875.86	0.041085	0.000000	0.000000	0.000000
1.000	539864.57	0.077587	0.045656	0.756473	0.802129
1.333	539874.05	0.026590	0.014536	0.288091	0.302627
1.667	539861.28	0.055322	0.020103	0.220259	0.240362
2.000	539867.85	0.031504	0.011991	0.172498	0.184489
2.333	539865.22	0.032019	0.008574	0.147891	0.156465
2.667	539854.42	0.046009	0.013038	0.136772	0.149810
3.000	539860.97	0.031201	0.010980	0.123838	0.134818
3.333	539842.43	0.052809	0.017459	0.119116	0.136576
3.667	539855.65	0.031973	0.015768	0.110438	0.126206
4.000	539849.17	0.036511	0.016139	0.104148	0.120287
4.333	539859.50	0.023110	0.012948	0.097762	0.110710
4.667	539838.49	0.041471	0.015384	0.094478	0.109862
5.000	539852.22	0.026493	0.013841	0.089983	0.103824
5.333	539843.23	0.032336	0.014074	0.086626	0.100700
5.667	539849.66	0.025390	0.012867	0.083205	0.096072
6.000	539839.69	0.031367	0.013215	0.080640	0.093855
6.333	539842.33	0.027860	0.012906	0.078099	0.091005
6.667	539847.12	0.023273	0.011866	0.075605	0.087472
7.000	539834.05	0.030465	0.012345	0.073797	0.086142
7.333	539835.12	0.028434	0.012468	0.072002	0.084470
7.667	539821.29	0.035212	0.013728	0.070787	0.084515
8.000	539825.81	0.031235	0.014245	0.069340	0.083585
8.333	539827.77	0.028943	0.014391	0.067868	0.082259
8.667	539816.60	0.033556	0.015222	0.066732	0.081953
9.000	539833.22	0.024105	0.014665	0.065254	0.079919
9.333	539818.49	0.030263	0.015041	0.064116	0.079157
9.667	539823.04	0.027125	0.014986	0.062921	0.077908
10.000	539809.18	0.032382	0.015637	0.062010	0.077647

Time (hr)	Mass (lbm)	Mea Leakage (pct/day)	Est Leakage (pct/day)	Confidence (pct/day)	UCL (pct/day)
10.333	539794.44	0.037681	0.016892	0.061385	0.078277
10.667	539801.75	0.033453	0.017529	0.060540	0.078069
11.000	539798.93	0.033579	0.018139	0.059722	0.077861
11.333	539793.38	0.034771	0.018840	0.058972	0.077812
11.667	539797.91	0.032051	0.019188	0.058146	0.077334
12.000	539796.91	0.031530	0.019467	0.057336	0.076803
12.667	539783.88	0.034445	0.019181	0.056883	0.076063
13.000	539782.84	0.033917	0.019855	0.056184	0.076039
13.333	539779.99	0.034018	0.020473	0.055506	0.075979
13.667	539789.96	0.029946	0.020620	0.054747	0.075366
14.000	539768.82	0.035947	0.021346	0.054173	0.075518
14.333	539768.79	0.035121	0.021930	0.053581	0.075512
14.667	539770.47	0.033812	0.022344	0.052970	0.075314
15.000	539775.86	0.031463	0.022516	0.052328	0.074844
15.333	539762.20	0.034741	0.022966	0.051778	0.074743
15.667	539765.81	0.032975	0.023230	0.051204	0.074434

ATTACHMENT 3.3C

CONTAINMENT INTEGRATED LEAKAGE RATE TEST
FROM 1100 HOURS 10/14/84 TO 0240 HOURS 10/15/84

ABSOLUTE TEST METHOD, MASS POINT ANALYSIS

Time (hr)	Mass (lbm)	Leakage (pct/day)	Confidence (pct/day)	UCL (pct/day)
0.000	539876.43	0.000000	0.000000	0.000000
0.333	539861.74	0.000000	0.000000	0.000000
0.667	539870.26	0.041106	0.453757	0.494863
1.000	539858.98	0.058463	0.118180	0.176642
1.333	539868.46	0.024956	0.072100	0.097056
1.667	539855.68	0.036151	0.045004	0.081155
2.000	539862.26	0.026886	0.031952	0.058838
2.333	539859.63	0.023708	0.023233	0.046941
2.667	539848.83	0.030245	0.018944	0.049189
3.000	539855.37	0.027161	0.015194	0.042356
3.333	539836.84	0.035483	0.015069	0.050552
3.667	539850.06	0.032138	0.012881	0.045018
4.000	539843.58	0.031905	0.010789	0.042694
4.333	539853.90	0.026912	0.010510	0.037422
4.667	539832.89	0.029999	0.009579	0.039578
5.000	539846.63	0.027361	0.008752	0.036113
5.333	539837.64	0.027366	0.007682	0.035049
5.667	539844.06	0.025386	0.007085	0.032472
6.000	539834.09	0.025668	0.006321	0.031988
6.333	539836.74	0.025002	0.005708	0.030710
6.667	539841.53	0.023355	0.005405	0.028760
7.000	539828.46	0.023908	0.004931	0.028839
7.333	539829.53	0.023914	0.004491	0.028405
7.667	539815.70	0.025524	0.004407	0.029930
8.000	539820.22	0.025985	0.004071	0.030056
8.333	539822.18	0.025902	0.003752	0.029654
8.667	539811.01	0.026813	0.003583	0.030396
9.000	539827.63	0.025706	0.003496	0.029202
9.333	539812.89	0.025991	0.003262	0.029254
9.667	539817.44	0.025664	0.003058	0.028721
10.000	539803.59	0.026358	0.002937	0.029295
10.333	539788.84	0.027897	0.003137	0.031034
10.667	539796.16	0.028502	0.003003	0.031505

Time (hr)	Mass (lbm)	Leakage (pct/day)	Confidence (pct/day)	UCL (pct/day)
11.000	539793.34	0.029053	0.002874	0.031927
11.333	539787.79	0.029728	0.002787	0.032515
11.667	539792.31	0.029891	0.002635	0.032526
12.000	539791.32	0.029959	0.002491	0.032450
12.667	539778.28	0.030500	0.002401	0.032901
13.000	539777.25	0.030887	0.002297	0.033184
13.333	539774.40	0.031241	0.002199	0.033440
13.667	539784.36	0.030959	0.002102	0.033062
14.000	539763.22	0.031562	0.002077	0.033639
14.333	539763.19	0.031981	0.002015	0.033995
14.667	539764.87	0.032176	0.001928	0.034105
15.000	539770.27	0.032045	0.001844	0.033889
15.333	539756.60	0.032345	0.001784	0.034129
15.667	539760.22	0.032395	0.001707	0.034101

ATTACHMENT 3.3D

SUPERIMPOSED LEAKAGE RATE TEST
FROM 0400 HOURS ON 10/15/84 TO 1200 HOURS ON 10/15/84

REDUCED INPUT VARIABLES

Time (hr)	Absolute Temperature (°R)	Dewpoint (°F)	(psia) Absolute Pressure
0.0	535.03	62.590	58.904
0.333	535.02	62.600	58.901
0.667	535.00	62.540	58.898
1.0	534.99	62.520	58.895
1.333	534.98	62.480	58.893
1.667	534.96	62.450	58.890
2.0	534.95	62.390	58.888
2.333	534.94	62.310	58.885
2.667	534.92	62.370	58.882
3.0	534.92	62.360	58.880
3.333	534.91	62.300	58.878
3.667	534.90	62.340	58.876
4.0	534.89	62.390	58.875
4.333	534.89	62.410	58.872
4.667	534.87	62.370	58.870
5.0	534.86	62.360	58.868
5.333	534.85	62.290	58.865
5.667	534.83	62.340	58.863
6.0	534.82	62.300	58.860
6.333	534.81	62.330	58.858
6.667	534.82	62.290	58.856
7.0	534.79	62.270	58.854
7.333	534.79	62.300	58.852
7.667	534.77	62.180	58.849
8.000	534.75	62.260	58.846

ATTACHMENT 3.3E

SUPERIMPOSED LEAKAGE RATE TEST
FROM 0400 HOURS 10/15/84 to 1200 HOURS 10/15/84

ABSOLUTE TEST METHOD, TOTAL TIME ANALYSIS

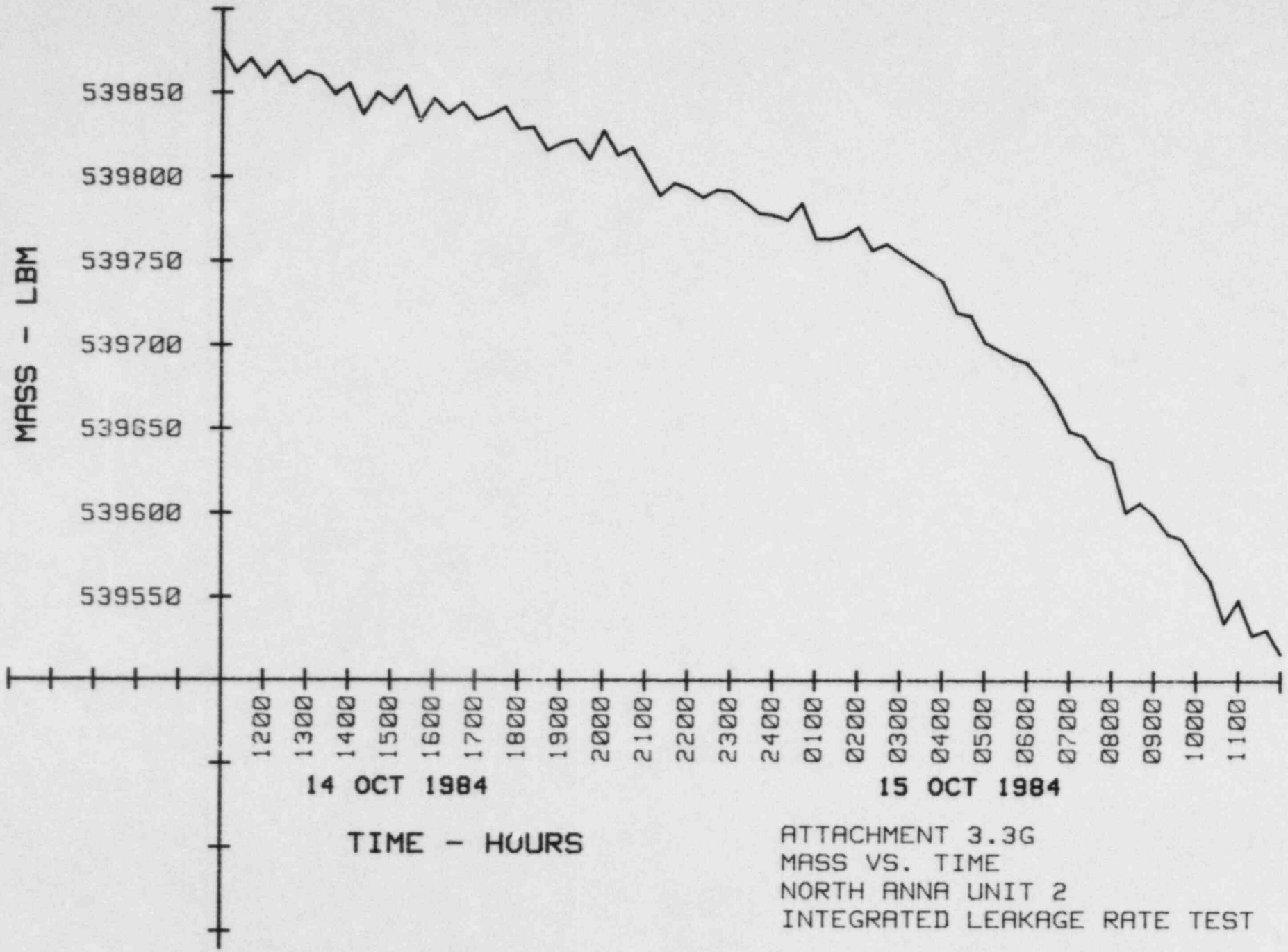
Time (hr)	Mass (lbm)	Mea. Leakage (pct/day)	Est Leakage (pct/day)	Confidence (pct/day)	UCL (pct/day)
0.000	539743.51	0.00000	0.000000	0.000000	0.000000
0.333	539725.06	0.246278	0.000000	0.000000	0.000000
0.667	539713.97	0.197184	0.000000	0.000000	0.000000
1.000	539707.36	0.160735	0.158610	0.050523	0.209133
1.333	539702.66	0.136247	0.130141	0.043691	0.173832
1.667	539697.94	0.121556	0.110309	0.048408	0.158717
2.000	539695.04	0.107752	0.094209	0.049197	0.143406
2.333	539684.73	0.112017	0.088039	0.060489	0.148528
2.667	539671.86	0.119445	0.088171	0.070983	0.159154
3.000	539654.35	0.132145	0.093776	0.080764	0.174540
3.333	539651.44	0.122825	0.094918	0.079819	0.174737
3.667	539639.50	0.126118	0.097149	0.079164	0.176313
4.000	539635.86	0.119666	0.097210	0.076407	0.173618
4.333	539606.42	0.140680	0.103271	0.078626	0.181897
4.667	539611.80	0.125488	0.104212	0.076040	0.180252
5.000	539604.37	0.123736	0.104691	0.073465	0.178156
5.333	539593.15	0.125364	0.105572	0.071347	0.176919
5.667	539590.39	0.120139	0.105255	0.068922	0.174177
6.000	539576.46	0.123795	0.105848	0.067102	0.172951
6.333	539565.42	0.125038	0.106662	0.065532	0.172194
6.667	539540.52	0.135380	0.109325	0.065070	0.174396
7.000	539554.17	0.120270	0.108954	0.063214	0.172168
7.333	539533.04	0.127620	0.109939	0.061988	0.171927
7.667	539536.40	0.120115	0.109599	0.060396	0.169995
8.000	539521.74	0.123263	0.109845	0.059093	0.168939

ATTACHMENT 3.3F

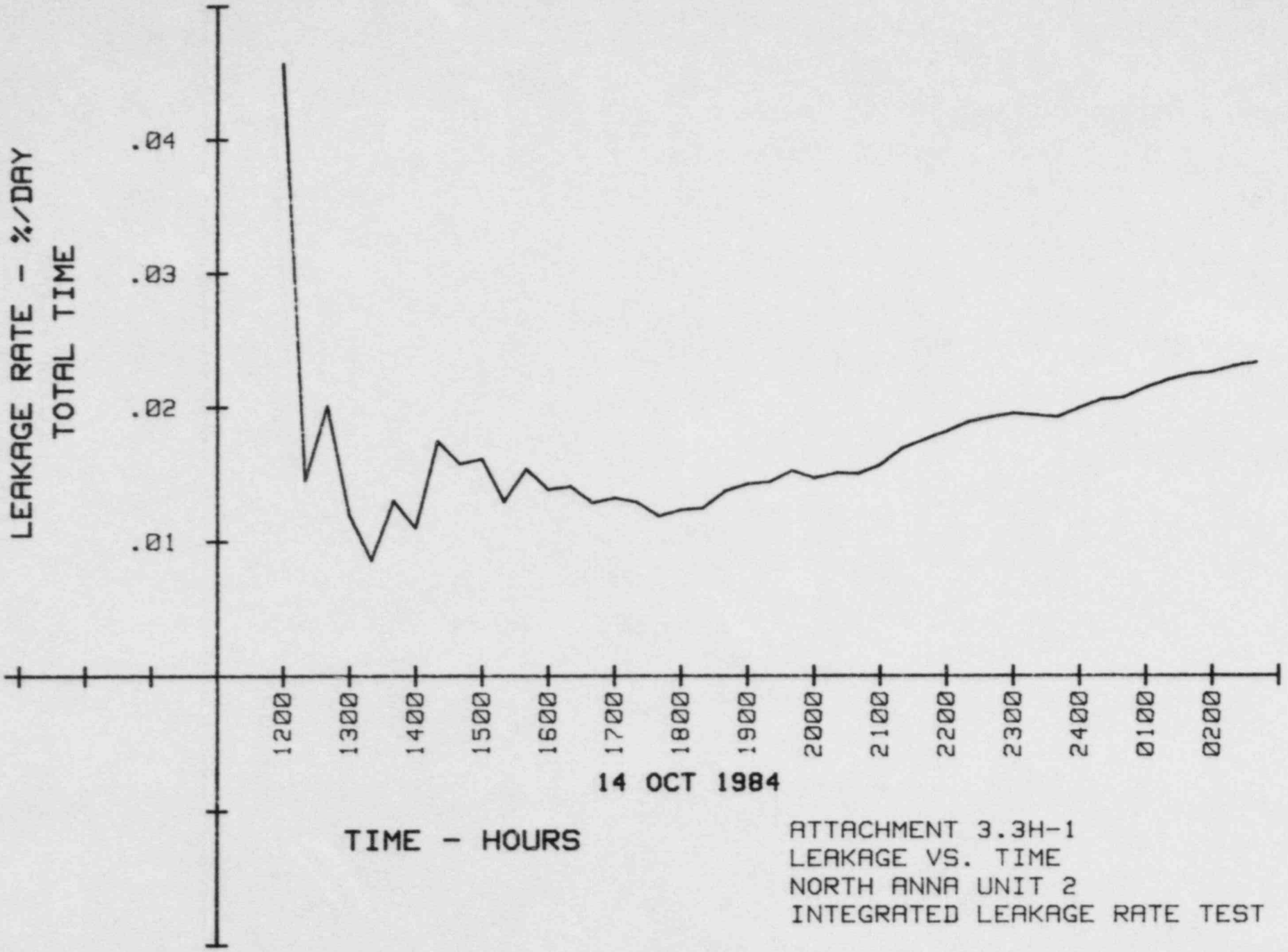
SUPERIMPOSED LEAKAGE RATE TEST
FROM 0400 HOURS 10/15/84 TO 1200 HOURS 10/15/84

ABSOLUTE TEST METHOD, MASS POINT ANALYSIS

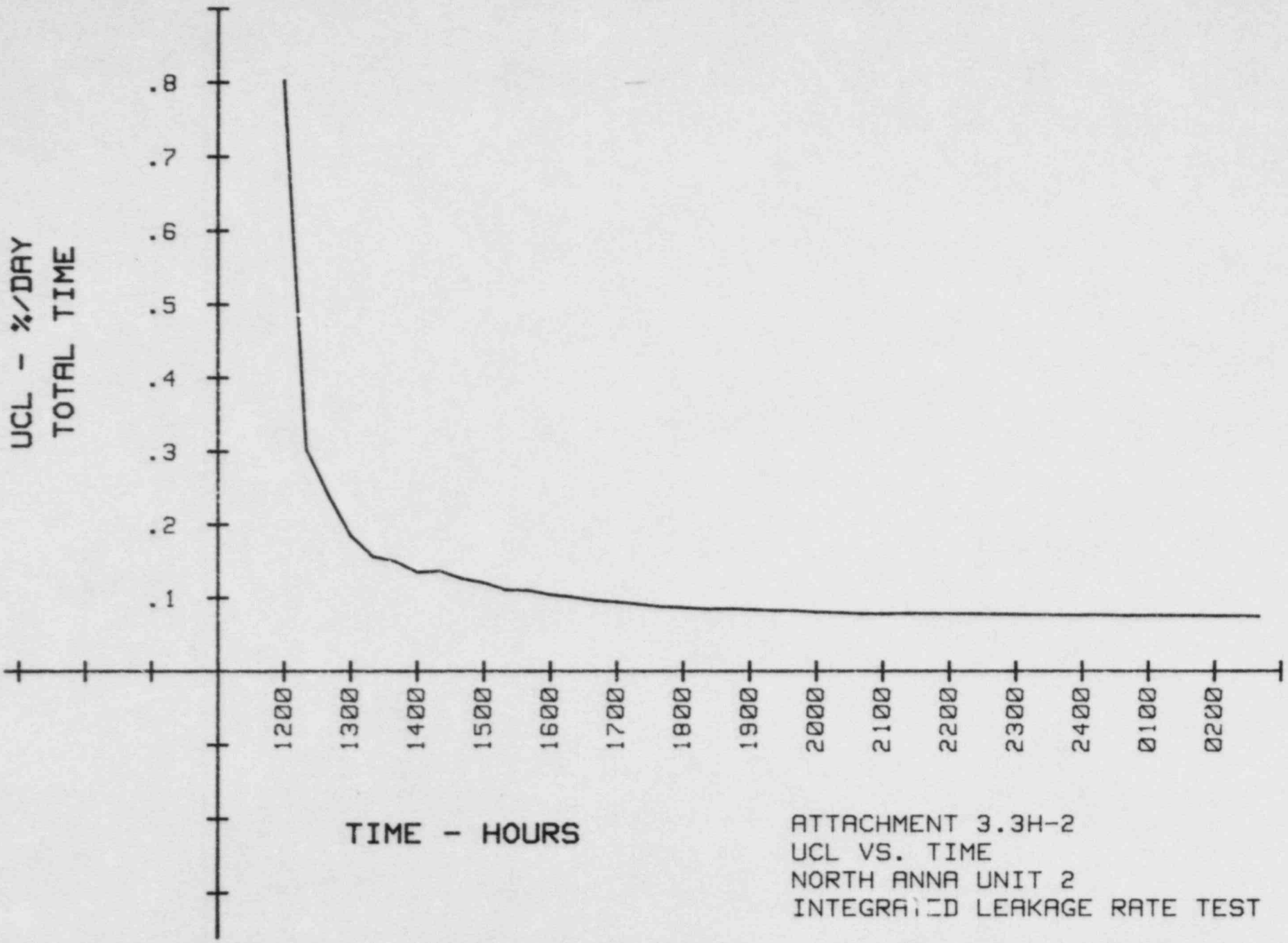
Time (hr)	Mass (lbm)	Leakage (pct/day)	Confidence (pct/day)	UCL (pct/day
0.000	539737.91	0.000000	0.000000	0.000000
0.333	539719.47	0.000000	0.000000	0.000000
0.667	539717.48	0.136272	0.321816	0.458089
1.000	539701.77	0.147314	0.083330	0.230644
1.333	539697.07	0.132588	0.044218	0.176807
1.667	539692.34	0.118448	0.031526	0.149974
2.000	539689.45	0.104844	0.026361	0.131204
2.333	539679.14	0.101896	0.019227	0.121123
2.667	539666.27	0.105172	0.014952	0.120125
3.000	539648.76	0.113847	0.014959	0.128805
3.333	539645.85	0.115168	0.012119	0.127287
3.667	539633.91	0.117627	0.010296	0.127924
4.000	539630.27	0.116838	0.008661	0.125498
4.333	539600.83	0.124222	0.010579	0.134801
4.667	539606.21	0.124124	0.009104	0.133228
5.000	539598.78	0.123506	0.007943	0.131448
5.333	539587.56	0.123594	0.006972	0.130567
5.667	539584.80	0.122133	0.006343	0.128477
6.000	539570.87	0.122093	0.005654	0.127747
6.333	539559.83	0.122424	0.005081	0.127505
6.667	539534.93	0.125392	0.005458	0.130850
7.000	539548.58	0.123976	0.005145	0.129121
7.333	539527.45	0.124614	0.004729	0.129343
7.667	539530.81	0.123412	0.004486	0.127898
8.000	539516.15	0.123142	0.004128	0.127270



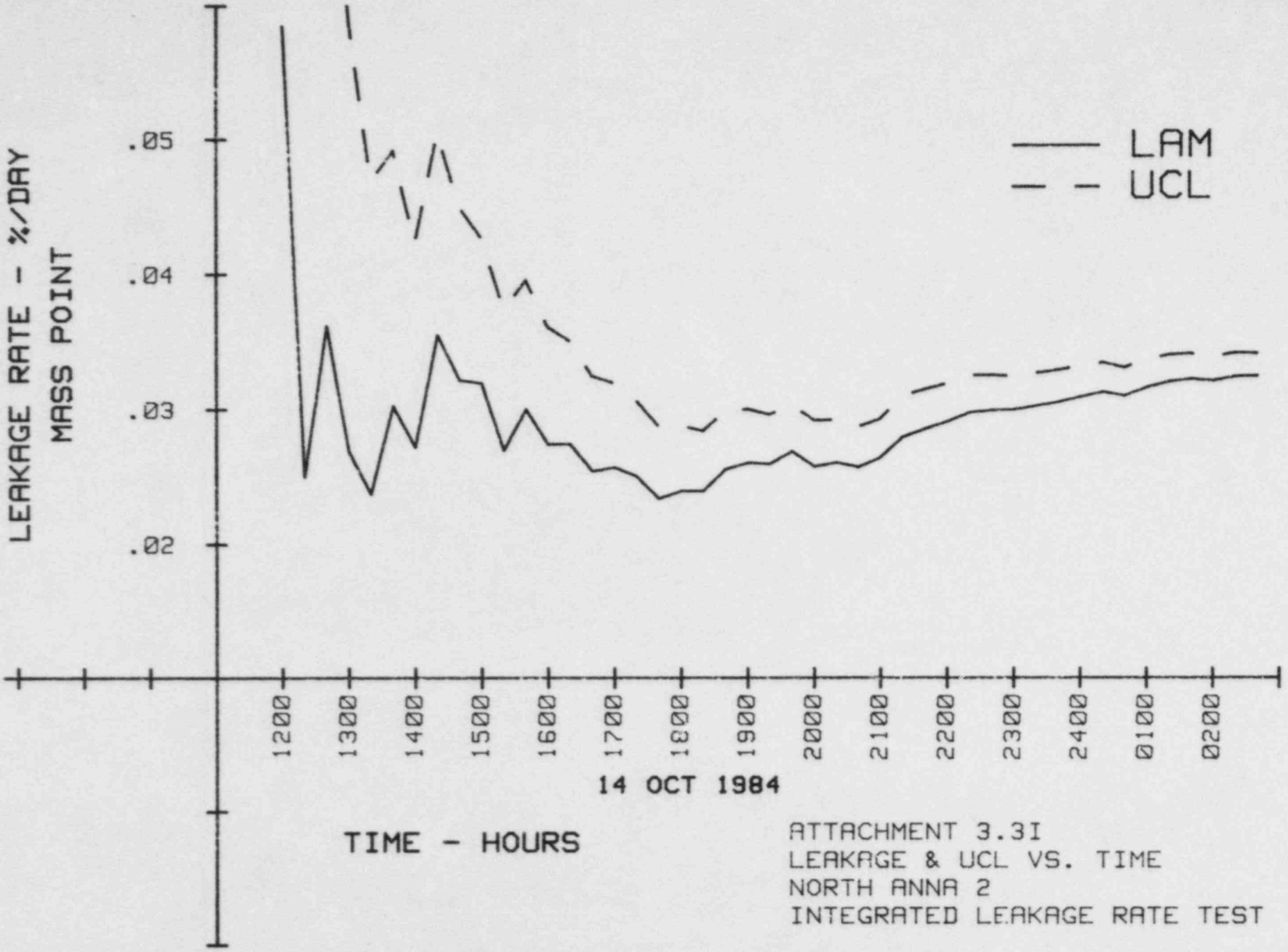
ATTACHMENT 3.3G
MASS VS. TIME
NORTH ANNA UNIT 2
INTEGRATED LEAKAGE RATE TEST



ATTACHMENT 3.3H-1
LEAKAGE VS. TIME
NORTH ANNA UNIT 2
INTEGRATED LEAKAGE RATE TEST



ATTACHMENT 3.3H-2
UCL VS. TIME
NORTH ANNA UNIT 2
INTEGRATED LEAKAGE RATE TEST



ATTACHMENT 3.3I
LEAKAGE & UCL VS. TIME
NORTH ANNA 2
INTEGRATED LEAKAGE RATE TEST

SECTION 4

LOCAL LEAKAGE RATE TESTS (TYPES B AND C)

Section 4 contains the LLRT data performed since the April 1979 Type A Test. The data contained in this section is summarized below:

Attachment 4A	1984 LLRT Data (Later)
Attachment 4B	1982 LLRT Data (Later)
Attachment 4C	1979/1980 LLRT Data

The combined "as-left" leakage rate for all the valves and penetrations is well below the acceptance criteria of less than $0.60L_A$. Reference the applicable surveillance procedures for the actual totals.

The 1982 and 1984 LLRT Data are not included in this report. When the information becomes available, an addendum to this report will be issued.

ATTACHMENT 4C

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
1	Component Cooling	C	TC-CC-203B	0	0	
2	Component Cooling	C	2-CC-194	0.7	0.7	
4	Component Cooling	C	TV-CC-198	0	0	
5	Component Cooling	C	TV-CC-203A	0	0	
7B	Safety Injection	C	2-SI-93	0.25	0.35	
			MOV-2867C	0	0	
			MOV-2867D	0	0	
			2-SI-83	0	0	
8	Component Cooling	C	TV-CC-201A	0	0	
			TV-CC-201B	0	0	
9	Air Recirculation Cooling Water	C	2-CC-302	0	0	
10	Air Recirculation Cooling Water	C	2-CC-302	0	0	
11	Air Recirculation Cooling Water	C	2-CC-276	>12	0.18	MR-N2-79-08291010

ATTACHMENT 4C (Cont)

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
12B	Air Recirculation Cooling	C	TV-CC-200B	0	0	
			TV-CC-205B	0	0	
13B	Air Recirculation Cooling Water	C	TV-CC-200C	1.46	1.46	
			TV-CC-205C	0	0	
14B	Air Recirculation Cooling Water	C	TV-CC-200A	2.1	2.1	
			TV-CC-205A	0	0	
15	Charging	C	2-CH-335	0	0	
			MOV-2289A	0	0	
16	Component Cooling	C	2-CC-254	7.7	0.9	MR-79-09040939
			TV-CC-204C	0	0	
17	Component Cooling	C	2-CC-115	0	0	
			TV-CC-204B	0.475	0.475	
18	Component Cooling	C	2-CC-78	0	0	
			TV-CC-204A	0	0	
19B	RCP Seal Water	C	2-CH-331	excessive	0	MR-79-08290910 New Ikrads int. n.c. ✗
			MOV-2380	excessive	0	
			MOV-2381	1.5	15	MR-79-08290913 New disc ✗
20	Safety Injection	C	2-SI-47	0	0	
			2-SI-136	0	0	

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
22	Safety Injection	C	2-SI-85	0	0.05	
			MOV-2836	0	0	
24B	RHR	C	2-RH-37	0.1	0.1	
			2-RH-38	0	0	
25	Component Cooling	C	TV-CC-202E	0	0	
			TV-CC-202F	0	0	
26	Component Cooling	C	TV-CC-202A	0	0	
			TV-CC-202B	0	0	
27	Component Cooling	C	TV-CC-202C	0	0	
			TV-CC-202D	0	0	
28B	Letdown	C	RV-2203	0	0	
			HCV-2200A,B,C	0.14	0.14	
			HCV-2142	0	0	
			TV-2204	0	0	
31	Containment Atmosphere Cleanup	C	2-HC-15	12	2.45	Cleaned Valve
			2-HC-13	0	0.4 Combination	
			2-HC-29	0		
32	Wet Layup	C	2-WT-446	0	0	
			2-WT-437	0	0	

ATTACHMENT 4C (Cont)

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
33	Primary Drains	C	TV-DG-200A	0	0	
			TV-DG-200B	0	0	
34	Fire Protection	C	2-FP-2	10.8	0.7	
			2-FP-3	0	0	
38	Containment Sump Pump Discharge	C	TV-DA-200A	0	0	
			TV-DA-200B	2.4	2.4	
39	Blowdown	C	TV-BD-200A	0.14	0.14	
			TV-BD-200B	0	0	
40	Blowdown	C	TV-BD-200E	0	0	
			TV-BD-200F	0	0	
41	Blowdown	C	TV-BD-200C	0	0	
			TV-BD-200D	0	0	
42	Service Air	C	2-SA-65	0	0	
			2-SA-67	0	0	
43	Air Sample	C	2-IA	1.2	1.2	
			TV-RM-200A	0	0	
44	Air Sample	C	TV-RM-200B	0	0	
			TV-RM-200C	0.03	0.03	
45	PG Water	C	2-RC-162		1.2	Lapped seat, cleaned
			TV-2519A	0	0	and adjusted spaces
46B	Loopfill	C	2-CH-332	0	0	
			FCV-2160	0	0	

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
47	Instrument Air	C	2-IA-250	0.08	0.08	
			TV-IA-202A	0.3	0.3	
48	Primary Vent Header	C	TV-VG-200A	0.025	0.025	
			TV-VG-200B	0.11	0.11	
50	Safety Injection	C	HCV-2936		0	
			TV-S1-201	0.056	0.056	
53	Safety Injection	C	2-SI-132	0	0	
			TV-SI-200	0.35	0.35	
54	Primary Vent	C	2-DA-7	0	0	
			2-DA-9	0	0	
55	Leakage Monitoring	C	TV-LM-200E	0	0	
			TV-LM-200F	0	0	
55	Sample System	C	TV-SS-204A	0	0	
			TV-SS-204B	0	0	
56	Sample System	C	TV-SS-202A	0	0	
			TV-SS-202B	0	0	
56	Sample System	C	TV-SS-206A	0	0	
			TV-SS-206B	0	0	
56	Sample System	C	TV-SS-200A	0	0	
			TV-SS-200B	0	0	
56	Sample System	C	TV-SS-212A	0	0	
			TV-SS-212B	0	0	

ATTACHMENT 4C (Cont)

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
57B	Leakage Monitoring	C	TV-LM-200G	0	0	
			TV-LM-200H	0	0	
57	Sample System	C	TV-SS-201B	0	0	
			TV-SS-201A	0	0	
60B	Safety Injection	C	2-SI-126	0	0	
			MOV-2890B	0	0	
61B	Safety Injection	C	2-SI-228	0	0	
			MOV-2890A	0	0	
62	Safety Injection	C	MOV-2890C	0	0	
			MOV-2890D	0	0	
			2-SI-91	0	0	
			2-SI-99	0	0	
			2-SI-105	0	0	
63	Quench Spray	C	MOV-QS-201B	1.0	1.0	
			2-QS-22	0	0	
64	Quench Spray	C	MOV-QS-201A	0.1	0	
			2-QS-11	0	0.1	
66B	Recirculation Spray	C	MOV-RS-200A	0	0	
			MOV-RS-201A	1.95	1.95	
67B	Recirculation Spray	C	MOV-RS-200B	0	0	
			MOV-RS-201B	1.9	1.9	
70	Recirculation Spray	C	MOV-RS-256B	0	0	
			2-RS-30	0	0	

ATTACHMENT 4C (Cont)

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
71	Recirculation Spray	C	MOV-RS-256A	0	5.9	WR012196 Adjusted torque switch
			2-RS-20	0	0	
79	Service Water	C	MOV-SW-203D	1.25	1.61	WR11656
80	Service Water	C	MOV-SW-203C	1.65	7.34	
81	Service Water	C	MOV-SW-203B	8.04	8.04	
82	Service Water	C	MOV-SW-203A	0	0	
83	Service Water	C	MOV-SW-204D	0.42	0	WR
84	Service Water	C	MOV-SW-204C	1.89	1.89	
85	Service Water	C	MOV-SW-204B	0	0	
86	Service Water	C	MOV-SW-204A	0	0	
89	Air Ejector	C	2-VP-24	3.5	0.7	
			TV-SV-103	0	0	
90	Purge	C	MOV-HV-100C		0	MR-79-N209081632
			MOV-HV-200D			MR-79-N209081633
			MOV-HV-201			MR-79-N209081634
91	Purge	C	MOV-HV-200A		1.8	MR-79-N209081630
			MOV-HV-200B		Combination	MR-79-N209081631
			MOV-HV-202			MR-79-N209081635

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
92	Containment Atmosphere Cleanup	C	TV-CU-250C	0	0	
			TV-CU-250D	0	0	
93	Containment Atmosphere Cleanup	C	TV-CU-250A	0	0	
			TV-CU-250B	0	0	
94	Containment Vacuum	C	TV-CU-200	0	0	
			2-CU-4	0	0	
97A	Pressurizer Dead Weight Calibrator	C	2-RC-143	0	0	
			2-RC-145	0	0	
97B	Leakage Monitoring	C	TV-LM-200B	0	0	
			TV-LM-200A	0	0	
97C	Sample System	C	TV-SS-203	0	0	
100	Wet Layup	C	2-WT-438	0	0	
			1-WT-447	0	0	
103	Reactor Cavity Purification	C	2-RP-7	0	0	
			1-RP-84	0	0	
104	Reactor Cavity Purification	C	2-RP-6	0	0	
			2-RP-50	0	0	
105A	Leakage Monitoring	C	TV-LM-200D	0	0	
			TV-LM-200C	0	0	

ATTACHMENT 4C (Cont)

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration		Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
105B	Leakage Monitoring	C	TV-LM-201B	0	0	
			TV-LM-201C	0	0	
105C	Leakage Monitoring	C	TV-LM-201D	0	0	
			TV-LM-201A	0	0	
106B	Safety Injection	C	TV-2842	0	0	
			TV-2859	0	0	
108	Wet Layup	C	2-WT-445	0	0	
			2-WT-437	0	0	
109	Containment Atmosphere	C	2-HC-20		0	Clean prior to test
			2-HC-18	0	0	
			2-HC-33	0	0	
112	Instrument Air	C	TV-IA-201A	0	0	
			TV-IA-201B	0	0	
113B	Safety Injection	C	2-SI-119	0	0	
			MOV-2869B	0	0	
114B	Safety Injection	C	2-SI-107	0	0	
			MOV-2869A	0	0	
	Electrical Penetrations	B		>0.054(0) <0.054(129)	1.49	
	Equipment Hatch	B			0	

1979/1980 LOCAL LEAKAGE RATE TEST PENETRATION DATA

Penetration	Type Test	Equipment/Valves Tested	Prerepair Leakage (scfh)	Postrepair Leakage (scfh)	Repair/Notes
Fuel Transfer Tube	B			0	
Personnel Air Lock	B			4.8	
Emergency Escape Lock	B				Included with personnel airlock test