REACTOR CONTAINMENT BUILDING

INTEGRATED LEAK RATE TEST

QUAD-CITIES NUCLEAR POWER STATION

UNIT TWO

MAY 26-28, 1985

0188H/0078Z

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INTRODUCTION

This report presents the test method and results of the Integrated Primary Containment Leak Rate Test (IPCLRT) successfully performed on May 26-28, 1985 at Quad-Cities Nuclear Power Station, Unit Two. The test was performed in accordance with 10 CFR 50, Appendix J, and the Quad-Cities Unit Two Technical Specifications.

This test was conducted using the ANS/ANSI N45.4-1972, 24 hour Mass Plot method. The calculated leak rate, statistically averaged leak rate, and the statistical upper confidence limit were computed in a manner consistent with the ANSI/ANS 56.8-1981 standard.

Simultaneously with the above method, calculations were performed using the Total Time Leak Rate method of BN-TOP-1, Rev. 1, a Bechtel Corporation Topical report approved by the Commission for short duration testing. The test duration criteria of BN-TOP-1 were easily satisfied for terminating the test in 8 hours. Because of the present regulatory uncertainty due to the ongoing revision to Appendix J and technical uncertainty due to ANSI/ANS standard changes, a full 24 hour test was performed and is the basis of this report. The BN-TOP-1 calculations are presented in Appendix E of this report to further demonstrate the conservative results given by this method of short duration testing.

SECTION A - TEST PREPARATIONS

A.1 Type A Test Procedure

The IPCLRT was performed in accordance with Quad-Cities Temporary Procedure 2552, a change to QTS 150-1, Rev. 12. The temporary procedure included a provision to run the reactor clean-up system continuously to obtain reactor water temperature data and use the RHR shutdown cooling loop for water temperature control. Other clarifications of the test procedure, including the induced test acceptance criteria and method for depressurization, were made in Temporary Procedure 2552.

In addition to the procedure, checklists QTS 150-S1, S2, S3, S4, S7, S9, S10, S11, S12, and S13, and subsections T1, T2, T3, and T8 were used to document the test activities. Temporary Procedure 2562 documented changes to QTS 150-S2 to show changes in the plant systems due to out-of-services. Temporary Procedure 2557 documented changes to QTS 150-S4 to increase the quantity of data plotted to include all individual sensors (hourly), to document the method of securing the personnel interlock, to clarify the shift turnover required by Test Directors, and to allow the test prior to final repairs to some primary containment isolation valves (certain subsystems were out-of-service for the test). Temporary Procedure 2554 added a clarification to a maintenance checklist QTS 150-S1, requiring Technical Staff notification prior to making any repairs to the personnel interlock (if they had been necessary). Temporary Procedure 2564 made changes to QTS 150-S7, the pre-test valve checklist, to document actual plant systems' status during the test. Temporary Procedure 2556 documented the method for connection of the induced phase flowmeter in QTS 150-S3.

These procedures were written to comply with 10 CFR 50 Appendix J, ANS/ANSI N45.4-1972, and Quad-Cities Unit Two Technical Specifications. The methods for calculating the containment leakage and upper confidence limit are in compliance with the ANSI/ANS 56.8-1981 standard. Compliance with all features of the ANSI/ANS 56.8-1981 standard was not possible, because the Commission has not approved the standard for use.

A.2 Type A Test Instrumentation

Table One shows the specifications for the instrumentation utilized in the IPCLRT. Table Two lists the physical locations of the temperature and humidity sensors within the primary containment. Figure 1 is an idealized view of the drywell and suppression chamber used to calculate the primary containment free air volumes used for weighting the sensor readings. Plant personnel performed all test instrumentation calibrations using NBS traceable standards.

TABLE ONE
INSTRUMENT SPECIFICATIONS

INSTRUMENT	MANUFACTURER	MODEL NO.	RANGE	ACCURACY	REPEATABILITY
Precision Pressure Gages (2)	Volumetrics		0-100 PSIA	±.015 PSI	±.001 PSI
RTD's (30)	Burns Engineering	SP1A1-5 1/2-3A	50-200°F	±05°F	±.1°F
Dewcells (10)	Volumetrics (Foxboro)	Lithium Chloride	-50-+140°F	±1.0°F	±.5°F
Thermocouple	Pall Trinity Micro	14-T-2H	0-600°F	±2.0°F	±.1°F
Flowmeter	Fischer & Porter	10A3555A	1.1-11.1 scfm	±.111 scfm	
Level Indicator LT 1-646B	GEMAC	555111BCAA 3AAA	0-60" H_2O		

TABLE TWO
SENSOR PHYSICAL LOCATIONS

RTD NUMBER	SUBVOLUME	ELEVATION	AZIMUTH*
1	1	670'0"	180°
2	1	670'0"	0°
3	2	657'0"	20°
4	2	657'0"	200°
5	3	634'0"	70°
6	3	634'0"	265°
7	4(Annular Ring)	643'0"	45°
8	4	615'0"	225°
9	5	620'0"	5°
10	5	620'0"	100°
11	5	620'0"	220°
12	6	608'0"	40°
13	6	608'0"	130°
14	6	608'0"	220°
15	6	608'0"	310°
16	7	598'0"	70°
17	7	598'0"	160°
18	7	598'0"	250°
19	7	598'0"	340°
20	8	587'0"	10°
21	8	587'0"	100°
22	8	587'0"	190°
23	8	587'0"	280°
24	9(CRD Space)	586'0"	0°
25	10(Torus)	578'0"	0°
26	10(Torus)	578'0"	60°
27	10(Torus)	578'0"	120°
28	10(Torus)	578'0"	180°
29	10(Torus)	578'0"	240°
30	10(Torus)	578'0"	300°
Thermocouple	11(Rx Vessel)	(Inlet to CU Hx)	

DEWCELL NO.	SUBVOLUME	ELEVATION	AZIMUTH
1	1	670'	180°
2	2,3,4	653'	90°
3	2,3,4	653'	270°
4	5	620'	0°
5	6,7	600'	45°
6	6,7	600'	225°
7	8,9	586'	0°
8	8,9	586'	180°
9	10	578'	90°
10	10	578'	270°
Thermocouple (Saturated)	11	---	---

*WEST = 0° AZIMUTH

Idealized View of Drywell and Torus
Used to Calculate Free Volumes

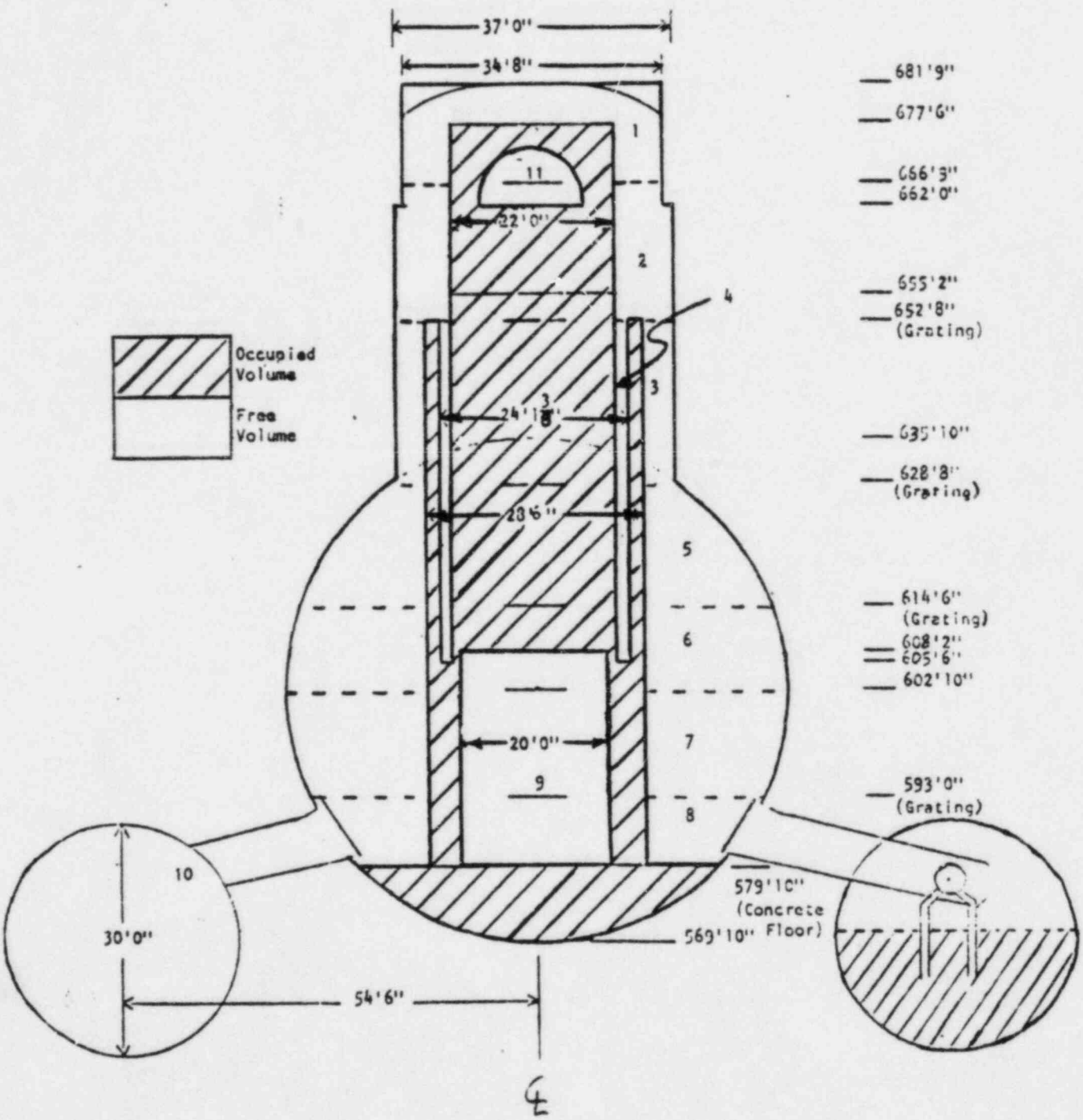


FIGURE 1

A.2.a. Temperature

The location of the 30 platinum RTD's was chosen to avoid conflict with local temperature variations and thermal influence from metal structures.

The RTD's were manufactured by Burns Engineering Inc. and are Model SP 1A1-5 1/2-3A. Each RTD and its associated bridge network was calibrated to yield an output of approximately 0-100 mV over a temperature range of 50-150°F. Each RTD was calibrated by comparing the bridge output to the true temperature as indicated by the temperature standard. Three temperatures were used for the calibration. Two calibration constants (a slope and intercept of the regression line) were computed for each RTD by performing a least squares fit of the RTD bridge output to the reference standard's indicated true temperature.

The temperature standard used for all calibrations was a Volumetrics RTD Model VMC 701-B used with a Dewcell/RTD Calibrator Model 07782. The standard was calibrated by Volumetrics on April 16, 1985 to standards traceable to the NBS. The sensors used during the test were calibrated within 6 months of the calibration date for the standard.

The plant process computer was used to scan the output of each RTD-bridge network. These digital inputs were then transferred to the PRIME computer and converted to engineering units for use in the leak rate calculations.

A.2.b. Pressure

Two precision quartz bourdon tube, absolute pressure gauges were utilized to measure total containment pressure. Each gauge had a local digital readout and a Binary Coded Decimal (BCD) output to the process computer. Primary containment pressure was sensed by the pressure gauges in parallel through a 3/8" tygon tube connection to a special one inch pipe penetration to the containment.

Each precision pressure gauge was calibrated from 62.6-65.0 PSIA using a third precision pressure gauge (Volumetrics Model 07726) that had been sent to Volumetrics for calibration. The pressure standard was calibrated on April 16, 1985 using NBS traceable reference standards. The pressure instruments used during the test were calibrated within 6 months of the standard's calibration.

The digital readout of the instruments were in "counts" or arbitrary units. Calibration constants (a slope and intercept of a regression line) were entered into the computer program to convert "counts" into true atmospheric pressure as read by the third, reference gauge. No mechanical calibration of the gauges was performed to bring their digital displays into agreement with true pressure.

A.2.c. Vapor Pressure

Ten lithium chloride dewcells were used to determine the partial pressure due to water vapor in the containment. The dewcells were calibrated using the Volumetrics standard described in section A.2.a. and a chilled mirror dewcell standard (Volumetrics S/N 1263) calibrated on April 16, 1985 by Volumetrics.

The calibration constants (the slope and intercept of a regression line) for each dewcell were computed relating the 0-100 mV output of the signal conditioning cards to the actual dewpoint indicated by the reference standard.

A.2.d. Flow

A rotameter flowmeter, Fischer-Porter serial number 8405A0348A1, was used for the flow measurement during the induced leakage phase of the IPCLRT. The flowmeter was calibrated on April 3, 1985 by Fischer-Porter to within ±1% of full scale (1.1-11.1 SCFM) using NBS traceable standards.

Plant personnel continuously monitored the flow during the induced leakage phase and corrected any minor deviations from the induced flow rate of 7.75 SCFM by adjusting a 3/8" needle valve on the flowmeter inlet. The outlet of the flowmeter was unrestricted and vented to atmosphere.

A.2.e Instrument Failures During the Test

Prior to the start of data taking, Dewcell number 2 and RTD number 20 were failed and removed from the computer data base. The reason for removal was that both sensors gave outputs that were not consistent with surrounding instrumentation and known temperature and humidity profiles within the containment. An inspection of the instrumentation following the test and post test calibrations did not reveal the reason for the failure of the dewcell. The probable reasons for the erroneous reading was a partial ground or cable noise. The reason for the RTD number 20 giving inconsistent results was that it was placed in the wrong location. RTD's 19 and 20 were in reverse locations. The final calculation for leakage will not include RTD 19, 20 and Dewcell 2.

The impact of these failed sensors was minimal. Dewcell numbers 2 and 3 were in the same subvolumes. Therefore, the loss of Dewcell number 2 did not change the volume fractions associated with the vapor pressure sensors. RTD's 19 and 20 were from subvolumes with three (3) other temperature sensors in each subvolume. Changing the number of dewcells from 10 to 9 and RTD's from 30 to 28 has minimal impact on the test accuracy.

A.3 Type A Test Measurement

The IPCLRT was performed utilizing a direct interface with the station process computer. This system consists of a hard-wired installation of temperature, dewpoint, and pressure inputs for the IPCLRT to the process computer. The interface allows the process computer to scan the inputs and send the data, still as a millivolt signal or BCD in the case of pressure, to the PRIME computer with minimal manual inputs and without the disadvantages of multiplexers or positioning sensitive electronic hardware inside the containment during the test.

The PRIME computer was used to compute and print the leak rate data using the ANSI/ANS mass plot method and the BN-TOP-1 method. Key parameters, such as total time measured leak rate, volume weighted dry air pressure and temperature, and absolute pressure were plotted on a Ramtek color terminal. Plant personnel also plotted a large number of other parameters, including reactor water level and temperature, dry air mass, volume weighted partial pressures and temperature, total time leak rate, statistically averaged leak rate and UCL, and all sensor outputs in engineering units. In all cases, data was plotted hourly and computer summaries were obtained at 10 minute time intervals. The plotting of data and the computer printed summaries of data allowed rapid identification of any problems as they might develop. Figure 2 shows a schematic of the data acquisition system.

A.4 Type A Test Pressurization

A 3000 SCFM, 600 hp, 4 kV electric oil-free air compressor was used to pressurize the primary containment. An identical compressor was available in standby during the IPCLRT. The compressors were physically located on a single, enclosed truck trailer located outside the Reactor Building. The compressed air was piped using flexible metal hose to the Reactor Building, through an existing four inch fire header penetration, and piped to a temporary spool piece that, when installed, allowed the pressurization of the drywell through the "A" containment spray header. The inboard, containment spray isolation valve, MO-2-1001-26A was open during pressurization. Once the containment was pressurized, the MO-2-1001-26A valve was closed and the spool piece was removed and replaced with a blind flange.

Measurement System Schematic Arrangement

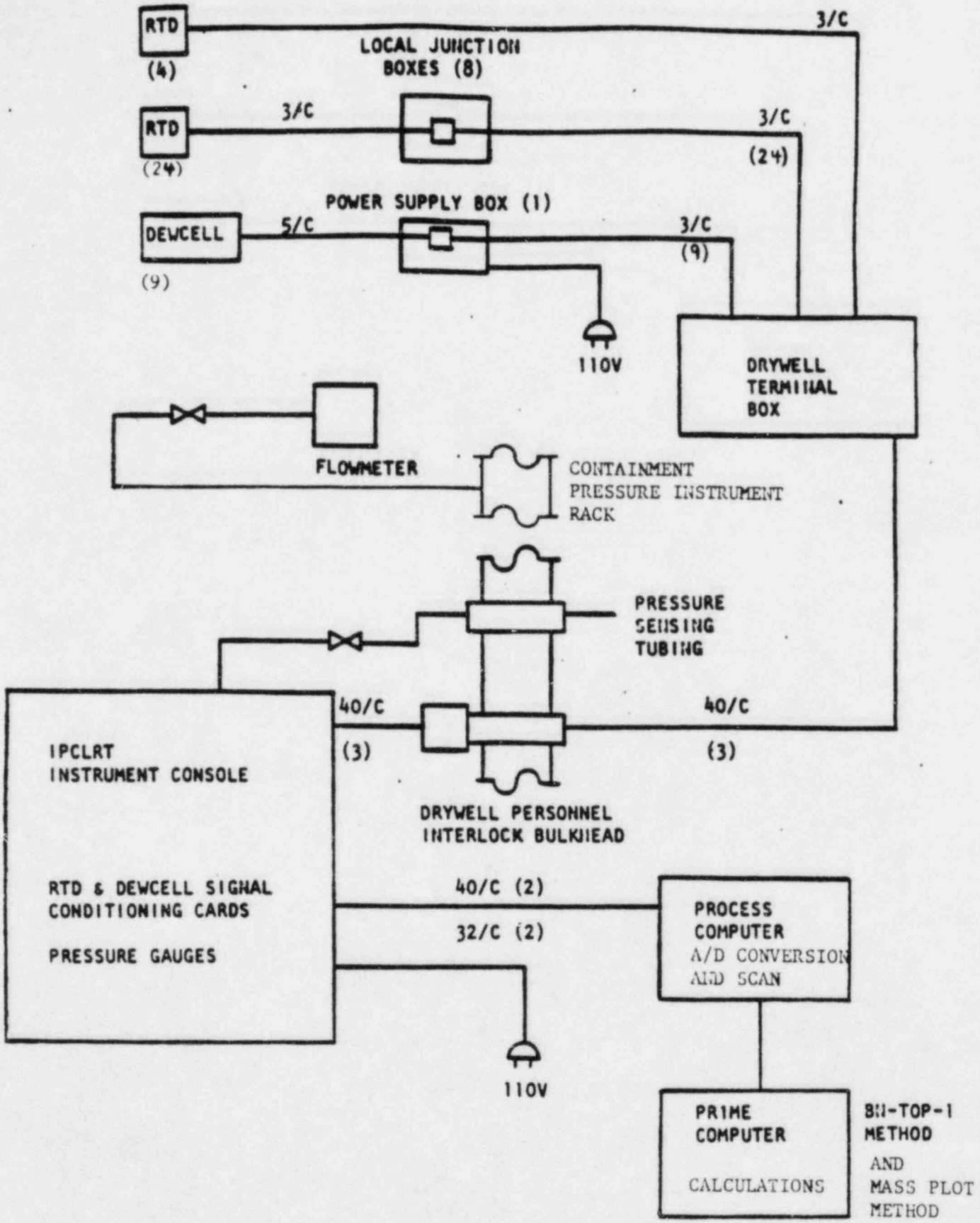


FIGURE 2

SECTION B - TEST METHOD

B.1 Basic Technique

The absolute method of leak rate determination was used. The absolute method uses the ideal gas laws to calculate the measured leak rate, as defined in ANS/ANSI N45.4-1972. The inputs to the total containment dry air mass calculation include subvolume weighted containment temperature, subvolume weighted vapor pressure, total absolute air pressure, and a total containment volume correction for reactor water level. As the data sets are collected over time a regression line is computed for the measured dry air mass as a function of time. The slope divided by the "y-intercept" of the regression line gives the statistically averaged leak rate. The upper confidence limit is defined as the statistically averaged leak rate plus the product of the one-sided 95% T-distribution and the standard deviation of the regression line slope. The mathematical expressions for these calculations are found in Appendix C.

B.2 Supplemental Verification Test

The supplemental verification test superimposes a known leak of approximately the same magnitude as L_A (8.16 SCFM or 1.0 wt %/day as defined in the Technical Specifications). The degree of detectability of the combined leak rate (containment calculated leak rate plus the superimposed, induced leak rate) provides a basis for resolving any uncertainty associated with the measured leak rate phase of the test. The allowed error band is $\pm$ 25% of L_A.

There are no references to the use of upper confidence limits to evaluate the acceptability of the induced leakage phase of the IPCLRT in the ANS/ANSI standards or in BN-TOP-1, Rev. 1. The induced leak used for this test was 7.75 SCFM or 0.950 wt %/day.

B.3 Instrument Error Analysis

An instrument error analysis was performed prior to the test to demonstrate the adequacy of the data acquisition system. The instrument system error was calculated in two parts. The first was to determine the system accuracy uncertainty. The second and more important calculation (since the leak rate is impacted most by changes in the containment parameters) was performed to determine the system repeatability uncertainty. The results were 0.0833 wt %/day and 0.0169 wt %/day for a 24-hour test, respectively. These results are inversely proportional to the test duration. With a dewcell and two RTD's failed for the test, the values were re-calculated giving 0.0851 wt %/day and 0.0173 wt %/day for a 24-hour test.

The instrumentation uncertainty is used only to illustrate the system's ability to measure the required parameters to calculate the primary containment leak rate. The mathematical derivation of the above values can be found in Appendix D.

SECTION C - SEQUENCE OF EVENTS

C.1 Test Preparation Chronology

The pretest preparation phase and containment inspection was completed on May 26, 1985 with no apparent structural deterioration being observed. Major preliminary steps included:

1) Completion of all Type B and C tests, component repairs and modifications where appropriate, and retests as required, except for the "B" loop of RHR, HPCI, and "B" feedwater line. These subsystems were out of service for the Type A test.

2) Blocking open three pairs of drywell to suppression chamber vacuum breakers.

3) Installation of all IPCLRT test equipment including the sensors, associated wiring, and data acquisition system.

4) In situ test of data acquisition system and computer programs for data processing.

5) Dewcell number 2 and RTD number 20 were removed from the computer data due to readings being inconsistent with other sensors.

6) Completion of all repairs and installations in the containment.

7) Completion of the pre-test valve line-up.

C.2 Test Pressurization and Stabilization Chronology

DATE	TIME	EVENT
05-26-85	0428	Began pressurizing the Unit Two containment.
	0500	Stopped pressurization due to failure of pressure sensors to respond to the increase in pressure.
	0530	Resumed pressurization. Sensing line was connected to wrong fitting on ILRT Instrument Console.
	1120	Pressurization complete at 65.3 psia.
	1120	Stabilization phase beginning.
	1520	Stabilization phase ending (Temperature change = 0.25°F/hr)

C.3 Measured Leak Rate Phase Chronology

DATE	TIME	EVENT
05-26-85	1527	24 hour leakage rate phase begun.
05-27-85	0615	Reactor water level has steadily dropped .5 inch/hr and has not been problem for the test. Careful attention has been focused on maintaining reactor water temperature. Temperature has fluctuated in a 6°F band.
	1527	End of 24 hour leak rate phase. Total containment pressure is 63.8 PSIA. Statistically averaged leak rate is 0.4083 wt %/day.

C.4 Induced Leakage Phase Chronology

DATE	TIME	EVENT
05-27-85	1530	Attempted to start the induced phase by valving in the flowmeter. Dirty water in lines blew into flowmeter.
	1640	Cleaned flowmeter and installed a moisture trap in the line. Started the induced leak.
	1740	Radiation Protection completed taking containment air sample from the discharge of ILRT flowmeter.
	1749	One hour stabilization complete and took 1st data set for the induced phase.
	2150	Induced phase complete. Leak rate is 1.2126 wt %/day. The acceptance band is from 1.1083 to 1.6083 wt %/day.

C.5 Depressurization Phase Chronology

DATE	TIME	EVENT
05-27-85	2340	Started depressurization phase through 2" bypass around 1601-23 valve. Throttling fixture for 1601-63 valve needs modification.
05-28-85	0030	Throttling fixture has been modified to accelerate the blowdown.
	0240	1601-63 is full OPEN.
	0400	Depressurization is complete.

SECTION D - TYPE A TEST DATA

D.1 Measured Leak Rate Phase Data

A summary of the computed data using the ANSI N45.4 test method can be found in Table 3. Shown in the table are data set number, time since the start of the test (after pressurization and stabilization complete), volume weighted containment temperature in degrees R, dry air pressure in PSIA, reactor water level in inches, total time measured leak rate, point-to-point leak rate, statistically averaged leak rate, and the ANSI calculation of the upper confidence limit.

Graphic results for the test are found in Figures 3-6.

D.2 Induced Leakage Phase Data

A summary of the computed data using the ANSI N45.4 test method can be found in Table 4. Graphic results for the test are found in Figures 7-10.

Measured Leak Rate Data

**** SUMMARY OF DATA SETS 31 THRU 174 ****

DATA SET	TAPE TIME	TEST DURATION (HRS)	TEMP (R)	DRY AIR PRESSURE (PSIA)	RX WATER LEVEL (IN)	MEASURED MASS	CALCULATED MASS T = 0	MEAS LEAK RATE TOTAL % / DAY	MEAS LEAK RATE POINT % / DAY	CALC LEAK RATE % / DAY	95% UPPER CONFIDENCE LIMIT
31	001 1923:154	0.000000	556.55408	63.44731	48.59700	8.96701E+04	0.00000E-01	0.0000	0.0000	0.0000	0.0000
32	001 1933:598	0.166672	556.52063	63.49085	48.26179	8.96675E+04	0.00000E-01	0.4240	0.4240	0.0000	0.0000
33	001 1946:259	0.333618	556.49866	63.49501	48.18800	8.96634E+04	8.96703E+04	0.5378	0.6513	0.5378	0.8561
34	001 1957:000	0.500565	556.46631	63.49039	48.11400	8.96627E+04	8.96699E+04	0.3968	0.1152	0.4223	0.6277
35	001 2008:101	0.667503	556.44495	63.47585	48.03799	8.96593E+04	8.96696E+04	0.4361	0.5537	0.4255	0.6237
36	001 2017:201	0.833617	556.42017	63.47117	47.92799	8.96587E+04	8.96689E+04	0.3680	0.0954	0.3793	0.4609
37	001 2027:305	1.001453	556.39455	63.46601	47.85000	8.96562E+04	8.96687E+04	0.3731	0.3987	0.3649	0.4219
38	001 2037:307	1.168167	556.37463	63.46179	47.75600	8.96542E+04	8.96693E+04	0.3659	0.3227	0.3554	0.3977
39	001 2047:311	1.336952	556.35364	63.45762	47.68500	8.96529E+04	8.96690E+04	0.3468	0.2069	0.3410	0.3766
40	001 2057:317	1.503891	556.33618	63.45281	47.55299	8.96493E+04	8.96690E+04	0.3704	0.5663	0.3459	0.3743
41	001 2107:317	1.671944	556.31824	63.44824	47.45900	8.96465E+04	8.96693E+04	0.3779	0.4455	0.3532	0.3773
42	001 2117:319	1.839172	556.29150	63.44441	47.38100	8.96461E+04	8.96690E+04	0.3504	0.0750	0.3467	0.3676
43	001 2127:319	2.005936	556.27832	63.44114	47.30900	8.96442E+04	8.96689E+04	0.3465	0.3037	0.3413	0.3597
44	001 2137:320	2.172783	556.26233	63.43646	47.19399	8.96410E+04	8.96689E+04	0.3584	0.5811	0.3425	0.3582
45	001 2147:321	2.339729	556.24707	63.43308	47.12019	8.96395E+04	8.96688E+04	0.3525	0.2756	0.3416	0.3552
46	001 2157:323	2.506450	556.23401	63.42937	47.00600	8.96357E+04	8.96690E+04	0.3675	0.5779	0.3462	0.3589
47	001 2207:324	2.673889	556.21265	63.42526	46.94900	8.96352E+04	8.96689E+04	0.3496	0.0882	0.3442	0.3555
48	001 2217:324	2.840561	556.19958	63.42138	46.84060	8.96327E+04	8.96688E+04	0.3526	0.4016	0.3437	0.3538
49	001 2227:325	3.007507	556.18127	63.41668	46.76599	8.96298E+04	8.96690E+04	0.3588	0.4636	0.3463	0.3544
50	001 2237:327	3.174774	556.16760	63.41210	46.66800	8.96262E+04	8.96691E+04	0.3708	0.5880	0.3499	0.3593
51	001 2247:329	3.508614	556.13904	63.40439	46.48000	8.96214E+04	8.96693E+04	0.3719	0.3822	0.3545	0.3637
52	001 2307:329	3.675278	556.12732	63.40195	46.38699	8.96206E+04	8.96693E+04	0.3610	0.1331	0.3550	0.3633
53	001 2317:330	3.842232	556.11145	63.39823	46.33400	8.96183E+04	8.96694E+04	0.3609	0.3584	0.3554	0.3629
54	001 2327:331	4.009171	556.09853	63.39487	46.16299	8.96170E+04	8.96693E+04	0.3548	0.2131	0.3542	0.3612
55	001 2337:331	4.175835	556.08521	63.39075	46.10500	8.96138E+04	8.96693E+04	0.3609	0.5097	0.3548	0.3612
56	001 2347:333	4.343063	556.06995	63.38706	46.03200	8.96117E+04	8.96693E+04	0.3604	0.3478	0.3552	0.3611
57	001 2357:334	4.510002	556.05550	63.38201	45.95900	8.96075E+04	8.96694E+04	0.3718	0.6493	0.3579	0.3639
58	001 2007:335	4.676949	556.02917	63.37847	45.88100	8.96035E+04	8.96694E+04	0.3595	0.0251	0.3577	0.3633
59	001 2017:335	4.843620	556.01733	63.37448	45.77200	8.96045E+04	8.96693E+04	0.3629	0.4595	0.3581	0.3634
60	001 2027:338	5.011116	556.00731	63.37014	45.71500	8.96005E+04	8.96694E+04	0.3714	0.6172	0.3601	0.3654
61	001 2037:338	5.177780	555.98120	63.36511	45.60000	8.95985E+04	8.96695E+04	0.3706	0.3465	0.3617	0.3668
62	001 2047:339	5.344727	555.96045	63.36102	45.50600	8.95962E+04	8.96694E+04	0.3673	0.2657	0.3625	0.3673
63	001 2057:339	5.511391	555.95349	63.35730	45.54300	8.95924E+04	8.96696E+04	0.3776	0.7082	0.3648	0.3700
64	001 2107:340	5.678337	555.95552	63.35375	45.50600	8.95874E+04	8.96698E+04	0.3900	0.7998	0.3689	0.3752
65	001 2117:340	5.845009	555.94702	63.35068	45.50600	8.95844E+04	8.96701E+04	0.3926	0.4822	0.3728	0.3799
66	001 2127:341	6.011788	555.94690	63.34770	45.59700	8.95811E+04	8.96704E+04	0.3964	0.5291	0.3768	0.3845
67	001 2137:342	6.178896	555.94040	63.34400	45.43400	8.95794E+04	8.96706E+04	0.3930	0.2708	0.3797	0.3876
68	001 2147:344	6.346115	555.94580	63.34271	45.39700	8.95745E+04	8.96710E+04	0.4044	0.8261	0.3860	0.3929
69	001 2157:345	6.513062	555.94727	63.33969	45.39700	8.95695E+04	8.96714E+04	0.4134	0.7598	0.3889	0.3984
70	001 2207:345	6.679726	555.94641	63.33727	45.26199	8.95675E+04	8.96717E+04	0.4111	0.3190	0.3933	0.4028
71	001 2217:346	6.846672	555.94312	63.33533	45.26199	8.95654E+04	8.96719E+04	0.4095	0.3486	0.3963	0.4062
72	001 2227:348	7.013893	555.94165	63.33285	45.15199	8.95630E+04	8.96722E+04	0.4089	0.3831	0.3992	0.4090
73	001 2237:348	7.180857	555.93884	63.32882	45.13100	8.95575E+04	8.96725E+04	0.4204	0.9069	0.4032	0.4134
74	001 2247:348	7.347229	555.93384	63.32654	45.02200	8.95564E+04	8.96727E+04	0.4145	0.1543	0.4059	0.4161
75	001 2257:349	7.514175	555.93567	63.32305	44.98000	8.95515E+04	8.96731E+04	0.4225	0.7775	0.4094	0.4197
76	001 2307:350	7.681114	555.93103	63.32158	44.94399	8.95502E+04	8.96733E+04	0.4180	0.2132	0.4119	0.4220
77	001 2317:351	7.848061	555.92981	63.31919	44.87099	8.95478E+04	8.96734E+04	0.4171	0.3763	0.4140	0.4240
78	001 2327:351	8.014725	555.93140	63.31592	44.83400	8.95429E+04	8.96736E+04	0.4254	0.8191	0.4169	0.4268
79	001 2337:353	8.181946	555.93018	63.31272	44.74100	8.95397E+04	8.96738E+04	0.4257	0.4884	0.4196	0.4295
80	001 2347:354	8.348900	555.92261	63.30917	44.71999	8.95361E+04	8.96741E+04	0.4297	0.5770	0.4223	0.4322
81	001 2357:354	8.515569	555.92322	63.30718	44.64700	8.95339E+04	8.96743E+04	0.4286	0.3744	0.4247	0.4344
82	002 0007:355	8.682503	555.92151	63.30439	44.55299	8.95309E+04	8.96746E+04	0.4293	0.4692	0.4268	0.4364
83	002 0017:357	8.849731	555.92163	63.30174	44.55200	8.95273E+04	8.96748E+04	0.4320	0.5711	0.4291	0.4386
84	002 0027:358	9.016670	555.92578	63.29907	44.41800	8.95237E+04	8.96750E+04	0.4346	0.5721	0.4313	0.4408
85	002 0037:359	9.183617	555.91846	63.29581	44.38100	8.95205E+04	8.96753E+04	0.4357	0.4993	0.4335	0.4428
86	002 0047:359	9.350538	555.91724	63.29337	44.27200	8.95182E+04	8.96755E+04	0.4348	0.3845	0.4353	0.4445
87	002 0057:400	9.517727	555.90857	63.29104	44.19399	8.95169E+04	8.96756E+04	0.4388	0.2083	0.4366	0.4456
88	002 0107:401	9.684174	555.89519	63.28806	44.04300	8.95160E+04	8.96756E+04	0.4259	0.1430	0.4373	0.4459

TABLE 3

Measured Leak Rate Data (cont'd)

**** SUMMARY OF DATA SETS 51 THRU 174 ****

DATA SET	TAPE TIME	TEST DURATION (HRS)	TEMP (R)	DRY AIR PRESSURE (PSIA)	XX WATER LEVEL (IN)	MEASURED MASS	CALCULATED MASS T = 0	MEAS LEAK RATE TOTAL % / DAY	MEAS LEAK RATE POINT % / DAY	CALC LEAK RATE % / DAY	95% UPPER CONFIDENCE LIMIT
89	002 01:18:09	9.855000	555.07471	63.60394	43.93400	8.95141E+04	8.96757E+04	0.4238	0.3891	0.4376	0.4440
90	002 01:29:11	10.020750	555.05585	63.60869	43.78200	8.95141E+04	8.96756E+04	0.4169	0.4075	0.4373	0.4434
91	002 01:39:13	10.187225	555.03260	63.67645	43.68800	8.95126E+04	8.96755E+04	0.4130	0.2384	0.4366	0.4445
92	002 01:49:14	10.354444	555.01152	63.67380	43.53799	8.95123E+04	8.96754E+04	0.4080	0.4476	0.4355	0.4432
93	002 01:59:16	10.521667	555.79431	63.66819	43.40780	8.95093E+04	8.96753E+04	0.4091	0.4760	0.4345	0.4428
94	002 02:09:18	10.688996	555.77698	63.66371	43.25600	8.95078E+04	8.96750E+04	0.4086	0.3783	0.4335	0.4409
95	002 02:19:19	10.855835	555.75073	63.66087	43.12600	8.95064E+04	8.96749E+04	0.4027	0.0251	0.4321	0.4393
96	002 02:29:20	11.022781	555.73071	63.65809	42.99599	8.95043E+04	8.96747E+04	0.4026	0.3998	0.4307	0.4379
97	002 02:39:20	11.189453	555.70837	63.65094	42.90199	8.95028E+04	8.96745E+04	0.4002	0.2438	0.4292	0.4363
98	002 02:49:21	11.356392	555.68586	63.64669	42.78749	8.95015E+04	8.96743E+04	0.3975	0.2158	0.4276	0.4347
99	002 02:59:22	11.523331	555.66553	63.64194	42.67799	8.94988E+04	8.96740E+04	0.3980	0.4342	0.4261	0.4331
100	002 03:09:25	11.690842	555.63477	63.63661	42.52699	8.94974E+04	8.96738E+04	0.3995	0.2201	0.4245	0.4315
101	002 03:19:28	11.858337	555.61511	63.63265	42.39700	8.94960E+04	8.96735E+04	0.3938	0.2201	0.4228	0.4298
102	002 03:29:29	12.025276	555.60883	63.62818	42.30849	8.94915E+04	8.96734E+04	0.3976	0.7279	0.4216	0.4285
103	002 03:39:30	12.192238	555.58362	63.62353	42.18800	8.94899E+04	8.96732E+04	0.3957	0.2585	0.4202	0.4271
104	002 03:49:31	12.359169	555.56494	63.61885	42.10100	8.94867E+04	8.96730E+04	0.3972	0.5845	0.4191	0.4259
105	002 03:59:31	12.525833	555.54126	63.61512	41.98000	8.94865E+04	8.96728E+04	0.3925	0.8427	0.4177	0.4244
106	002 04:09:33	12.693062	555.52283	63.61049	41.87019	8.94838E+04	8.96726E+04	0.3938	0.4360	0.4164	0.4230
107	002 04:19:34	12.860001	555.51233	63.60588	41.79100	8.94808E+04	8.96724E+04	0.3958	0.6875	0.4154	0.4219
108	002 04:29:35	13.026947	555.49377	63.60098	41.64700	8.94767E+04	8.96722E+04	0.3975	0.5297	0.4145	0.4210
109	002 04:39:37	13.194176	555.47693	63.59684	41.53200	8.94746E+04	8.96721E+04	0.3967	0.3333	0.4137	0.4200
110	002 04:49:38	13.361115	555.45886	63.59323	41.41800	8.94733E+04	8.96719E+04	0.3943	0.2884	0.4127	0.4190
111	002 04:59:38	13.527779	555.44543	63.58928	41.34499	8.94705E+04	8.96718E+04	0.3991	0.4577	0.4119	0.4180
112	002 05:09:38	13.694458	555.42773	63.58561	41.21500	8.94692E+04	8.96715E+04	0.3928	0.2887	0.4109	0.4169
113	002 05:19:39	13.861389	555.40747	63.58143	41.17799	8.94664E+04	8.96714E+04	0.3926	0.3791	0.4099	0.4159
114	002 05:29:39	14.028053	555.39832	63.57678	41.02699	8.94629E+04	8.96712E+04	0.3954	0.6235	0.4092	0.4151
115	002 05:39:40	14.195087	555.38354	63.57232	40.93400	8.94597E+04	8.96711E+04	0.3967	0.5122	0.4087	0.4144
116	002 05:49:41	14.361946	555.37122	63.56988	40.80219	8.94593E+04	8.96709E+04	0.3929	0.8678	0.4079	0.4136
117	002 05:59:43	14.529167	555.36072	63.56636	40.74599	8.94565E+04	8.96708E+04	0.3936	0.4562	0.4072	0.4128
118	002 06:09:44	14.696114	555.35242	63.56208	40.61680	8.94552E+04	8.96707E+04	0.3958	0.5876	0.4066	0.4121
119	002 06:19:45	14.863060	555.34229	63.55782	40.53799	8.94491E+04	8.96706E+04	0.3981	0.6827	0.4063	0.4117
120	002 06:29:45	15.029724	555.34180	63.55556	40.50100	8.94462E+04	8.96706E+04	0.3988	0.4578	0.4068	0.4115
121	002 06:39:46	15.197223	555.32935	63.55188	40.37899	8.94440E+04	8.96705E+04	0.3983	0.3604	0.4057	0.4108
122	002 06:49:46	15.363892	555.32471	63.54811	40.33400	8.94398E+04	8.96705E+04	0.4613	0.6742	0.4056	0.4106
123	002 06:59:47	15.530838	555.31936	63.54536	40.21999	8.94377E+04	8.96703E+04	0.4006	0.3398	0.4054	0.4104
124	002 07:09:5	15.697784	555.30648	63.54181	40.12600	8.94354E+04	8.96703E+04	0.4002	0.3642	0.4053	0.4101
125	002 07:19:50	15.864449	555.30648	63.53864	40.05299	8.94316E+04	8.96703E+04	0.4025	0.6189	0.4052	0.4100
126	002 07:29:51	16.031387	555.30615	63.53603	39.99599	8.94284E+04	8.96703E+04	0.4036	0.5124	0.4053	0.4099
127	002 07:39:52	16.198341	555.29211	63.53257	39.90199	8.94265E+04	8.96703E+04	0.4026	0.3814	0.4053	0.4098
128	002 07:49:54	16.365562	555.28198	63.52950	39.78799	8.94247E+04	8.96703E+04	0.4014	0.2989	0.4052	0.4097
129	002 07:59:54	16.532227	555.28027	63.52663	39.69399	8.94217E+04	8.96702E+04	0.4023	0.4881	0.4052	0.4095
130	002 08:09:55	16.699173	555.24088	63.52353	39.65700	8.94172E+04	8.96702E+04	0.4054	0.7184	0.4053	0.4096
131	002 08:19:55	16.865837	555.27881	63.52025	39.68000	8.94136E+04	8.96701E+04	0.4071	0.5737	0.4056	0.4098
132	002 08:29:57	17.033058	555.26929	63.51756	39.49100	8.94127E+04	8.96702E+04	0.4053	0.2257	0.4057	0.4098
133	002 08:39:58	17.200085	555.26282	63.51439	39.39700	8.94095E+04	8.96702E+04	0.4056	0.4366	0.4058	0.4099
134	002 08:49:58	17.366669	555.25513	63.51096	39.31899	8.94065E+04	8.96703E+04	0.4563	0.4887	0.4060	0.4099
135	002 08:59:59	17.533615	555.24939	63.50828	39.28900	8.94045E+04	8.96702E+04	0.4054	0.3216	0.4061	0.4100
136	002 09:09:00	17.700562	555.23975	63.50417	39.13100	8.94009E+04	8.96703E+04	0.4071	0.5829	0.4063	0.4101
137	002 09:19:01	17.867508	555.23169	63.50095	39.02200	8.93985E+04	8.96703E+04	0.4069	0.3844	0.4065	0.4102
138	002 09:29:04	18.035004	555.22961	63.49846	39.00100	8.93955E+04	8.96703E+04	0.4076	0.4884	0.4067	0.4104
139	002 09:39:06	18.202225	555.22883	63.49501	38.88699	8.93929E+04	8.96703E+04	0.4076	0.4087	0.4069	0.4105
140	002 09:49:10	18.370018	555.21375	63.49143	38.83400	8.93894E+04	8.96703E+04	0.4090	0.5575	0.4071	0.4107
141	002 09:59:11	18.536949	555.19587	63.48858	38.68400	8.93895E+04	8.96703E+04	0.4052	-0.0101	0.4072	0.4107
142	002 10:09:11	18.703613	555.18848	63.48418	38.60500	8.93851E+04	8.96703E+04	0.4079	0.7123	0.4073	0.4108
143	002 10:19:13	18.870842	555.17725	63.48196	38.53200	8.93843E+04	8.96703E+04	0.4054	0.1204	0.4074	0.4108
144	002 10:29:14	19.037781	555.17090	63.47823	38.47500	8.93805E+04	8.96704E+04	0.4071	0.6082	0.4075	0.4108
145	002 10:39:14	19.204445	555.16345	63.47457	38.36600	8.93774E+04	8.96703E+04	0.4080	0.5060	0.4077	0.4109
146	002 10:49:14	19.371117	555.14685	63.47169	38.28799	8.93766E+04	8.96703E+04	0.4055	0.1233	0.4077	0.4109
147	002 10:59:17	19.538612	555.14258	63.46774	38.23000	8.93722E+04	8.96703E+04	0.4082	0.7164	0.4079	0.4110
148	002 11:09:18	19.705559	555.12866	63.46518	38.13699	8.93715E+04	8.96704E+04	0.4056	0.1805	0.4079	0.4110
149	002 11:19:19	19.872505	555.11975	63.46159	38.00600	8.93690E+04	8.96703E+04	0.4056	0.4172	0.4079	0.4110
150	002 11:29:19	20.039169	555.11414	63.45856	37.87600	8.93666E+04	8.96703E+04	0.4054	0.3827	0.4079	0.4109
151	002 11:39:20	20.206116	555.09717	63.45445	37.81899	8.93640E+04	8.96703E+04	0.4055	0.4172	0.4080	0.4109
152	002 11:49:21	20.373062	555.09160	63.45175	37.72500	8.93618E+04	8.96703E+04	0.4051	0.3569	0.4079	0.4109
153	002 11:59:21	20.539726	555.08447	63.44814	37.65199	8.93584E+04	8.96702E+04	0.4062	0.5363	0.4080	0.4109

TABLE 3

Measured Leak Rate Data

**** SUMMARY OF DATA SETS 31 THRU 174 ****

DATA SET	TAPE TIME	TEST DURATION (HRS)	TEMP (R)	DRY AIR PRESSURE (PSIA)	RX WATER LEVEL (IN)	MEASURED MASS	CALCULATED MASS T = 0	MEAS LEAK RATE TOTAL % / DAY	MEAS LEAK RATE POINT % / DAY	CALC LEAK RATE % / DAY	95% UPPER CONFIDENCE LIMIT
154	002 12:09:24	20.707022	555.87312	63.44434	37.53799	8.93558E+04	8.96703E+04	0.4063	0.4259	0.4080	0.4189
155	002 12:19:24	20.873894	555.86559	63.44113	37.42799	8.93533E+04	8.96702E+04	0.4062	0.3928	0.4081	0.4186
156	002 12:29:25	21.040848	555.85420	63.43813	37.35000	8.93515E+04	8.96702E+04	0.4053	0.2941	0.4081	0.4186
157	002 12:39:26	21.207779	555.83479	63.43423	37.27699	8.93497E+04	8.96702E+04	0.4044	0.2916	0.4080	0.4187
158	002 12:49:28	21.375008	555.82930	63.43014	37.16299	8.93457E+04	8.96701E+04	0.4062	0.6400	0.4081	0.4187
159	002 12:59:28	21.541672	555.81453	63.42722	37.06899	8.93447E+04	8.96700E+04	0.4043	0.1637	0.4080	0.4186
160	002 13:09:29	21.708611	554.99927	63.42365	36.99599	8.93427E+04	8.96700E+04	0.4037	0.3193	0.4079	0.4185
161	002 13:19:30	21.875565	554.98767	63.41853	36.93800	8.93378E+04	8.96700E+04	0.4066	0.7919	0.4080	0.4185
162	002 13:29:30	22.042229	554.97595	63.41632	36.77200	8.93379E+04	8.96698E+04	0.4035	-0.0126	0.4079	0.4184
163	002 13:39:31	22.209167	554.97913	63.41322	36.73000	8.93333E+04	8.96698E+04	0.4059	0.7367	0.4079	0.4184
164	002 13:49:32	22.376122	554.96973	63.41008	36.63699	8.93311E+04	8.96698E+04	0.4055	0.3528	0.4079	0.4183
165	002 13:59:34	22.543335	554.95850	63.40678	36.56300	8.93288E+04	8.96698E+04	0.4052	0.3640	0.4079	0.4183
166	002 14:09:35	22.710281	554.94702	63.40283	36.49100	8.93257E+04	8.96697E+04	0.4060	0.5105	0.4079	0.4183
167	002 14:19:36	22.877785	554.93616	63.40071	36.37600	8.93253E+04	8.96697E+04	0.4034	0.0526	0.4079	0.4182
168	002 14:29:39	23.044724	554.92212	63.39634	36.30299	8.93220E+04	8.96697E+04	0.4044	0.5407	0.4078	0.4181
169	002 14:39:40	23.211670	554.92078	63.39333	36.18800	8.93188E+04	8.96697E+04	0.4051	0.5855	0.4078	0.4180
170	002 14:49:42	23.378899	554.90283	63.39002	36.16800	8.93172E+04	8.96696E+04	0.4040	0.2586	0.4077	0.4099
171	002 14:59:43	23.545837	554.88748	63.38742	36.02200	8.93168E+04	8.96696E+04	0.4016	0.0629	0.4076	0.4097
172	002 15:09:44	23.712776	554.87842	63.38440	35.94399	8.93155E+04	8.96696E+04	0.4002	0.2087	0.4074	0.4095
173	002 15:19:45	23.879730	554.87317	63.38089	35.85000	8.93116E+04	8.96695E+04	0.4019	0.6362	0.4072	0.4093
174	002 15:29:46	24.046669	554.86841	63.37786	35.71999	8.93091E+04	8.96695E+04	0.4019	0.4849	0.4071	0.4092

TABLE 3

QUAD-CITIES UNIT 2
Mass Plot Leak Rate vs. Time

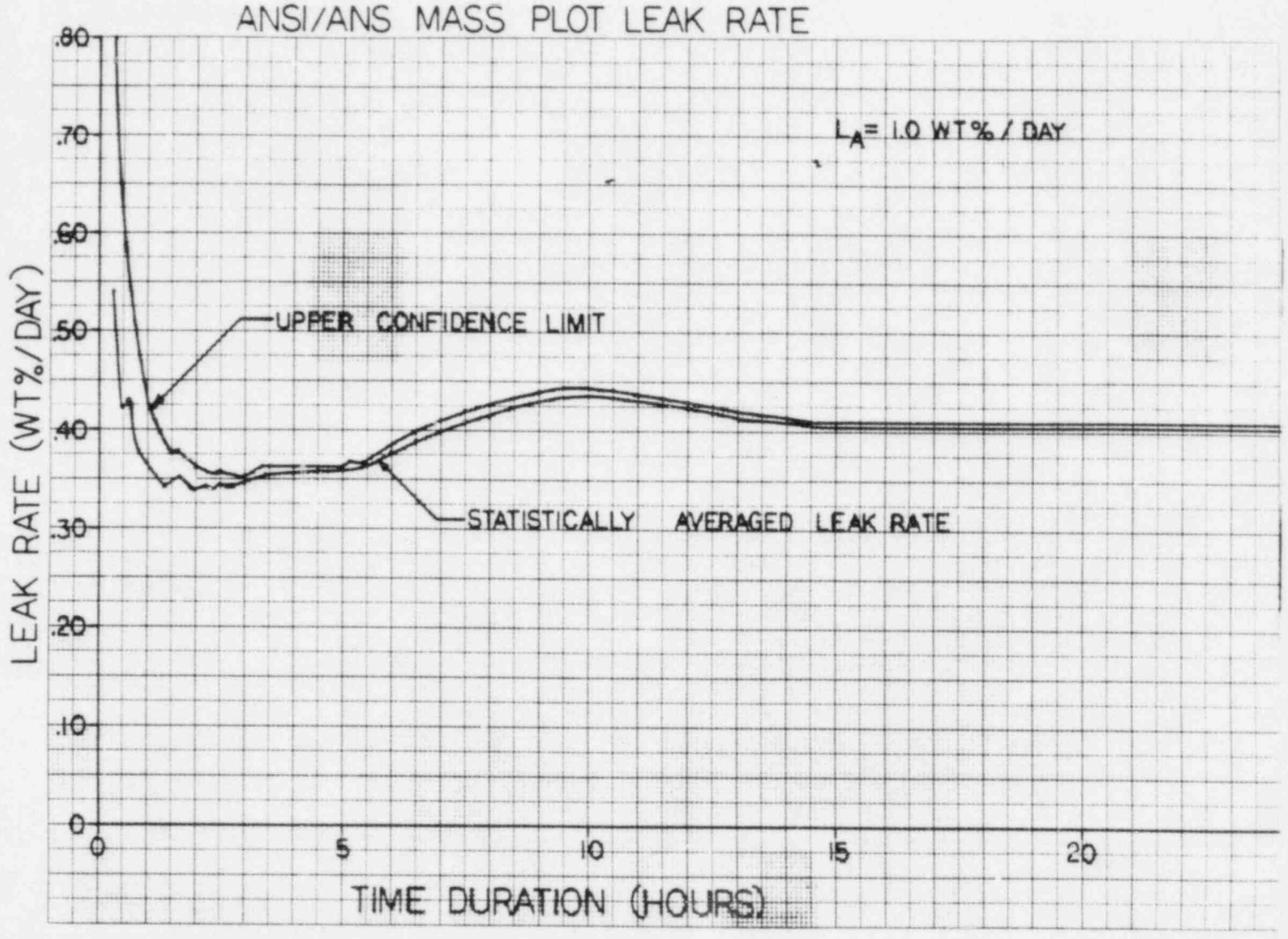


FIGURE 3

QUAD-CITIES UNIT 2
Containment Dry Air Pressure vs. Time

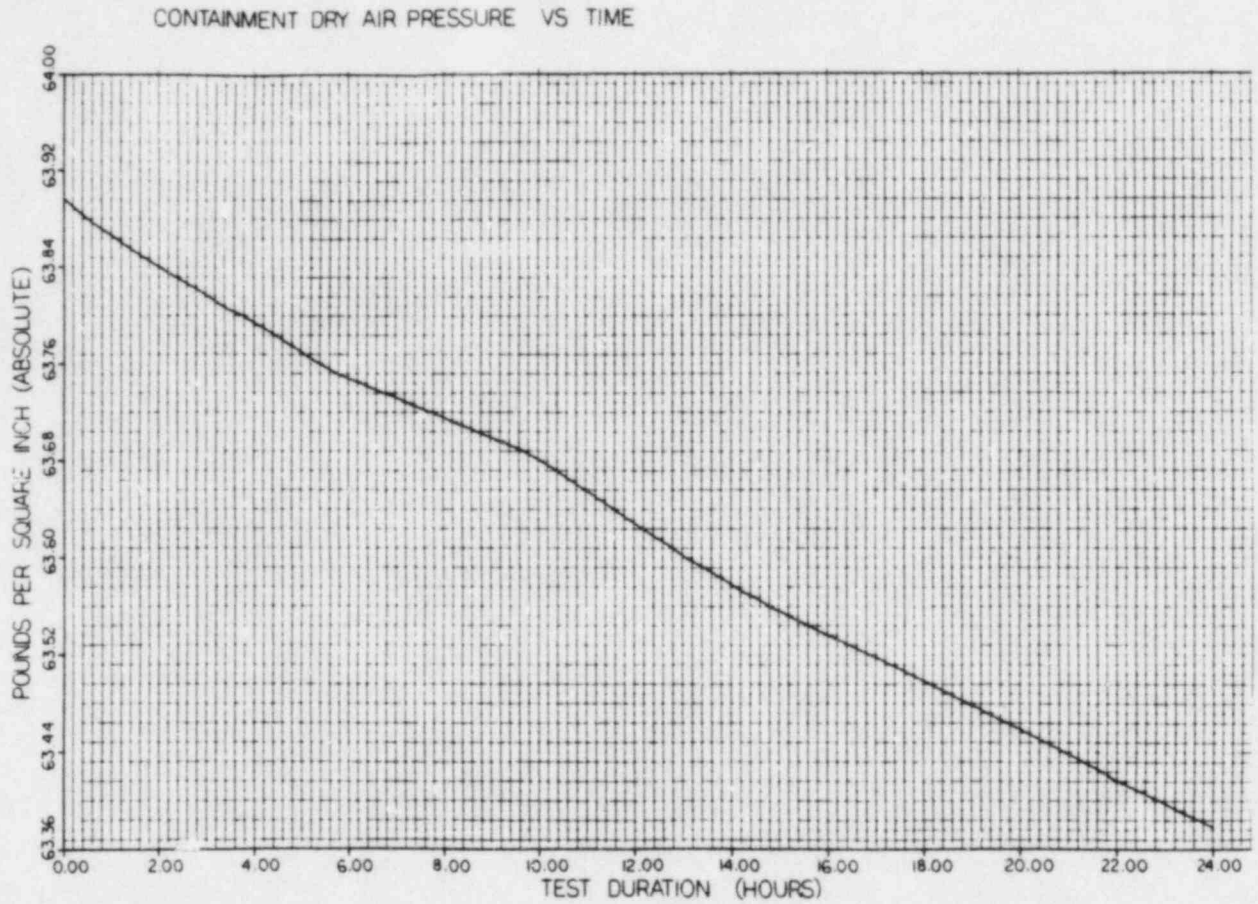


FIGURE 4

QUAD-CITIES UNIT 2
Total Containment Pressure vs. Time

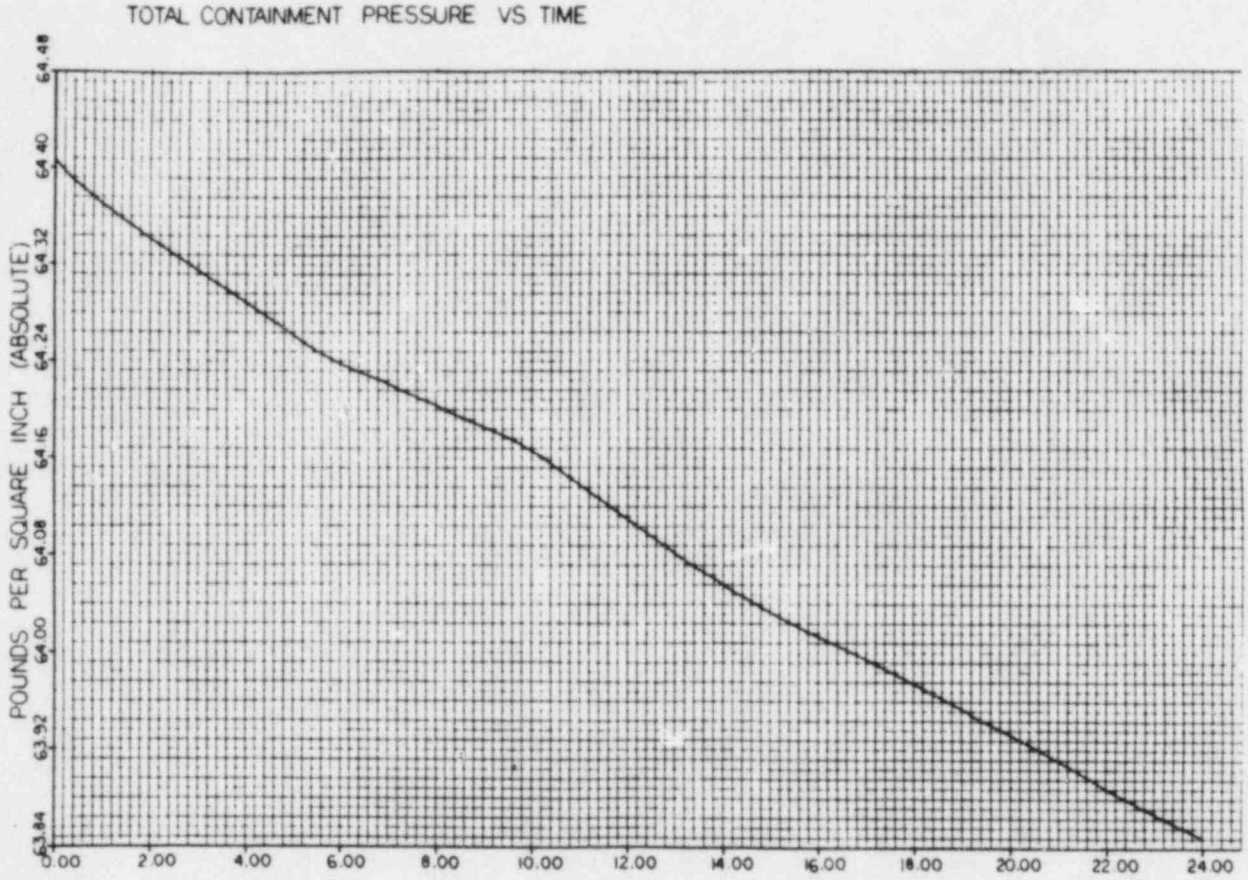


FIGURE 5

QUAD-CITIES UNIT 2
Dry-Bulb Temperature vs. Time

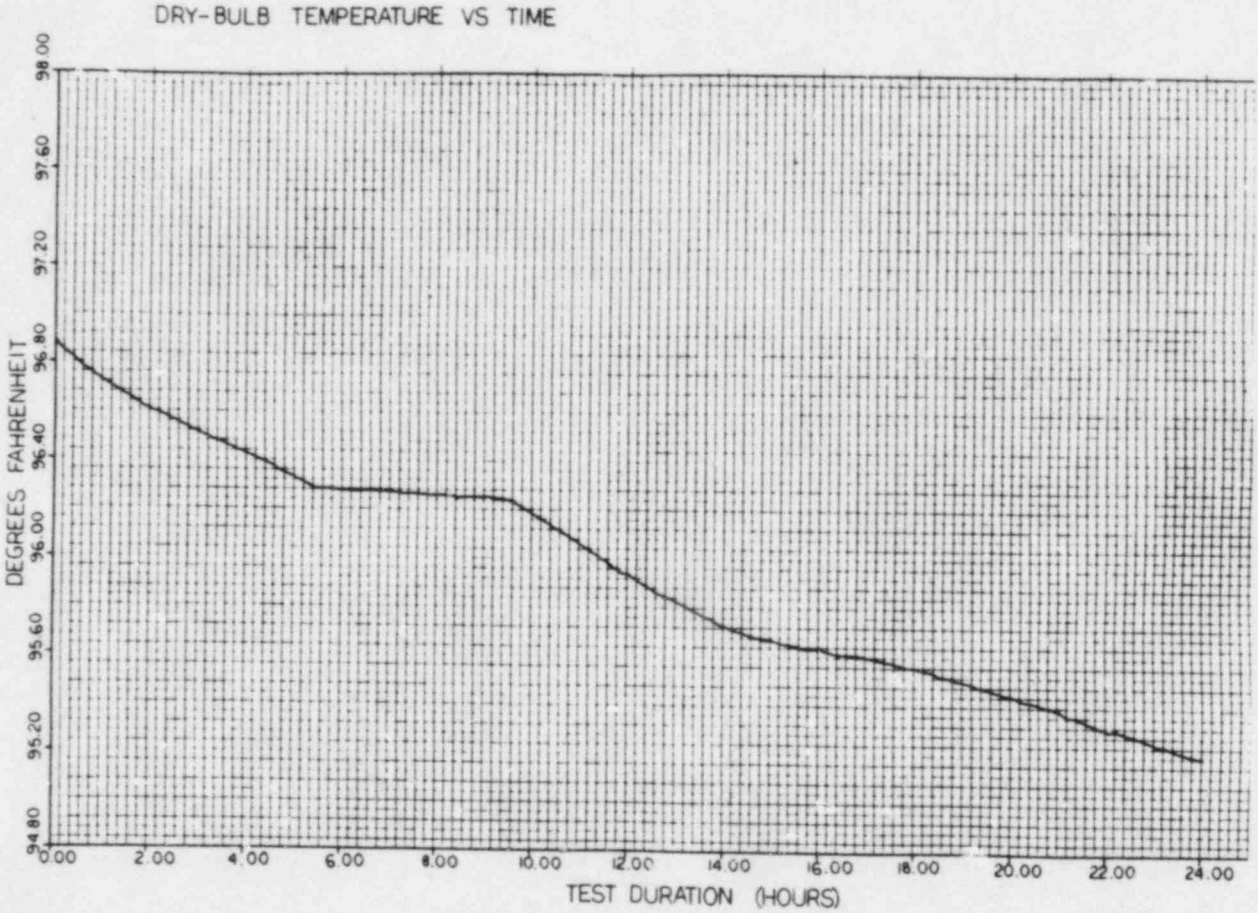


FIGURE 6

INDUCED LEAKAGE PHASE DATA

**** SUMMARY OF DATA SETS 188 THRU 212 ****

DATA SET	TAPE TIME	TEST DURATION (HRS)	TEMP (R)	DRY AIR PRESSURE (PSIA)	RX WATER LEVEL (IN)	MEASURED MASS	CALCULATED MASS T = 0	MEAS LEAK RATE TOTAL % / DAY	MEAS LEAK RATE POINT % / DAY	CALC LEAK RATE % / DAY	95% UPPER CONFIDENCE LIMIT
188	002 17:40:58	0.000000	554.71338	63.29704	34.44399	8.92308E+04	0.00000E-01	0.0000	0.0000	0.0000	0.0000
189	002 17:50:59	0.166946	554.70178	63.28938	34.38699	8.92215E+04	0.00000E-01	1.3669	1.3669	0.0000	0.0000
190	002 18:10:00	0.333893	554.69360	63.28207	34.25600	8.92135E+04	8.92298E+04	1.3266	1.2865	1.3266	1.4394
191	002 18:20:01	0.500839	554.68506	63.27512	34.16239	8.92058E+04	8.92297E+04	1.2998	1.2438	1.2977	1.3532
192	002 18:30:01	0.667511	554.67908	63.26832	34.09000	8.91977E+04	8.92297E+04	1.2989	1.2989	1.2921	1.3196
193	002 18:40:05	0.835281	554.67053	63.26101	34.05299	8.91891E+04	8.92298E+04	1.3167	1.3883	1.3042	1.3264
194	002 18:50:06	1.003052	554.65698	63.25363	33.95900	8.91816E+04	8.92297E+04	1.2972	1.2004	1.2973	1.3141
195	002 19:00:10	1.170313	554.65039	63.24697	33.82400	8.91743E+04	8.92295E+04	1.2805	1.1812	1.2847	1.3053
196	002 19:10:11	1.336945	554.64648	63.23931	33.73000	8.91648E+04	8.92297E+04	1.3105	1.5216	1.2946	1.3122
197	002 19:20:13	1.504166	554.63708	63.23161	33.67799	8.91559E+04	8.92300E+04	1.3246	1.4386	1.3074	1.3268
198	002 19:30:14	1.671112	554.62292	63.22547	33.54300	8.91505E+04	8.92297E+04	1.2783	0.8616	1.2941	1.3151
199	002 19:40:14	1.837759	554.62903	63.21892	33.46999	8.91409E+04	8.92297E+04	1.3035	1.5573	1.2965	1.3139
200	002 19:50:17	2.005286	554.61462	63.21203	33.41219	8.91339E+04	8.92296E+04	1.2881	1.1201	1.2928	1.3074
201	002 20:00:18	2.172276	554.60657	63.20642	33.26199	8.91285E+04	8.92292E+04	1.2566	0.8795	1.2775	1.2973
202	002 20:10:18	2.338882	554.59265	63.20001	33.20900	8.91221E+04	8.92288E+04	1.2407	1.0351	1.2619	1.2853
203	002 20:20:19	2.505829	554.58813	63.19352	33.09499	8.91145E+04	8.92285E+04	1.2391	1.2174	1.2505	1.2739
204	002 20:30:20	2.672791	554.58301	63.18744	33.00100	8.91075E+04	8.92281E+04	1.2323	1.1317	1.2403	1.2633
205	002 20:40:20	2.839447	554.57642	63.18065	32.92799	8.90995E+04	8.92279E+04	1.2354	1.2878	1.2340	1.2553
206	002 20:50:21	3.006393	554.56067	63.17379	32.83400	8.90931E+04	8.92277E+04	1.2243	1.0361	1.2263	1.2468
207	002 21:00:21	3.173065	554.55981	63.16742	32.74100	8.90850E+04	8.92275E+04	1.2290	1.3157	1.2219	1.2408
208	002 21:10:24	3.340546	554.55627	63.16063	32.62600	8.90768E+04	8.92275E+04	1.2328	1.3070	1.2198	1.2369
209	002 21:20:24	3.507217	554.54602	63.15357	32.56899	8.90698E+04	8.92274E+04	1.2343	1.2680	1.2187	1.2343
210	002 21:30:25	3.674179	554.53333	63.14813	32.51139	8.90639E+04	8.92272E+04	1.2157	0.8246	1.2136	1.2287
211	002 21:40:26	3.841118	554.52820	63.14117	32.39100	8.90558E+04	8.92270E+04	1.2194	1.3040	1.2105	1.2247
212	002 21:50:27	4.008057	554.52808	63.13363	32.28799	8.90459E+04	8.92270E+04	1.2350	1.5966	1.2117	1.2247

TABLE 4

QUAD-CITIES UNIT 2
Mass Plot Leak Rate vs. Time

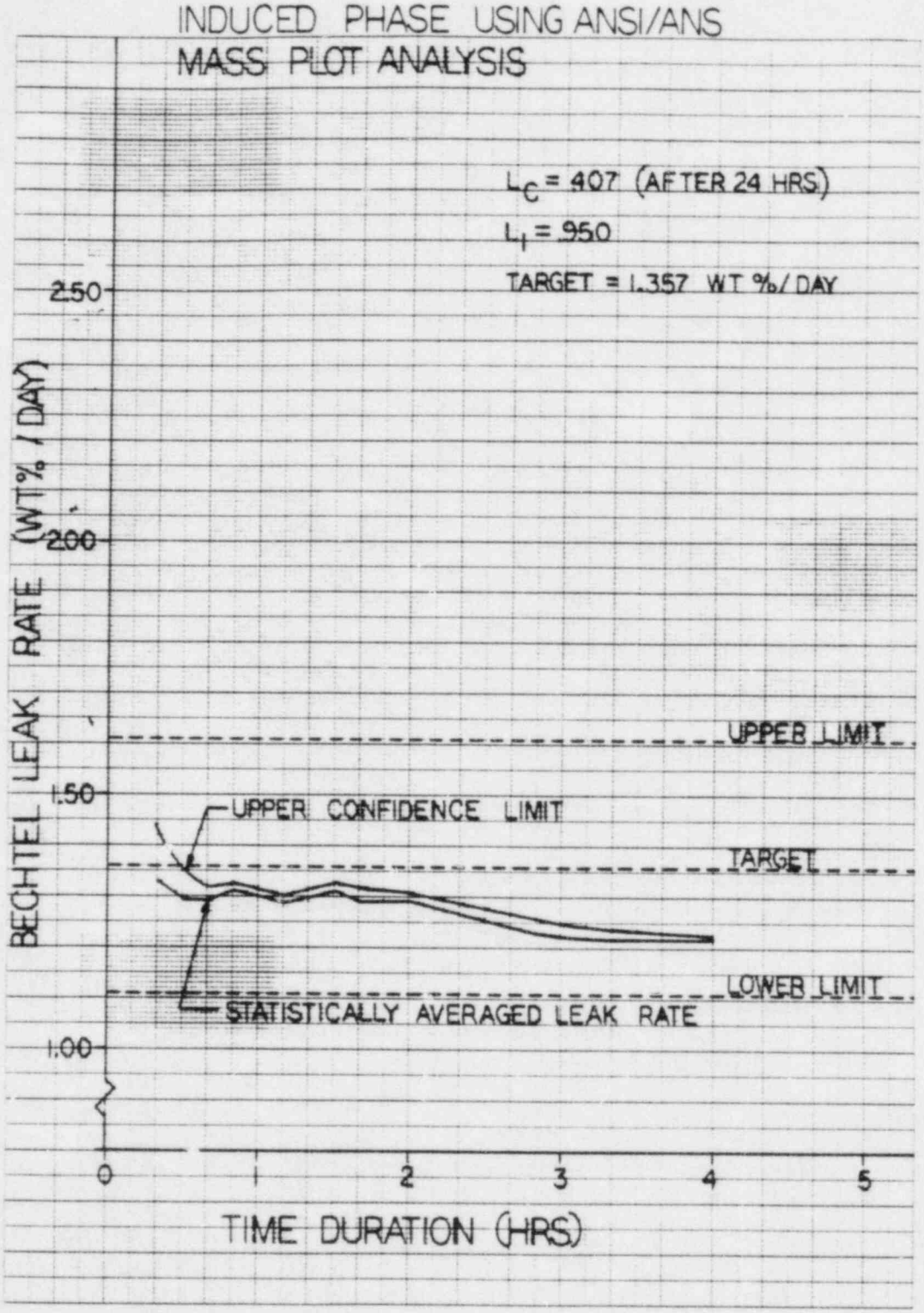


FIGURE 7

QUAD-CITIES UNIT 2
Dry Bulb Temperature vs. Time

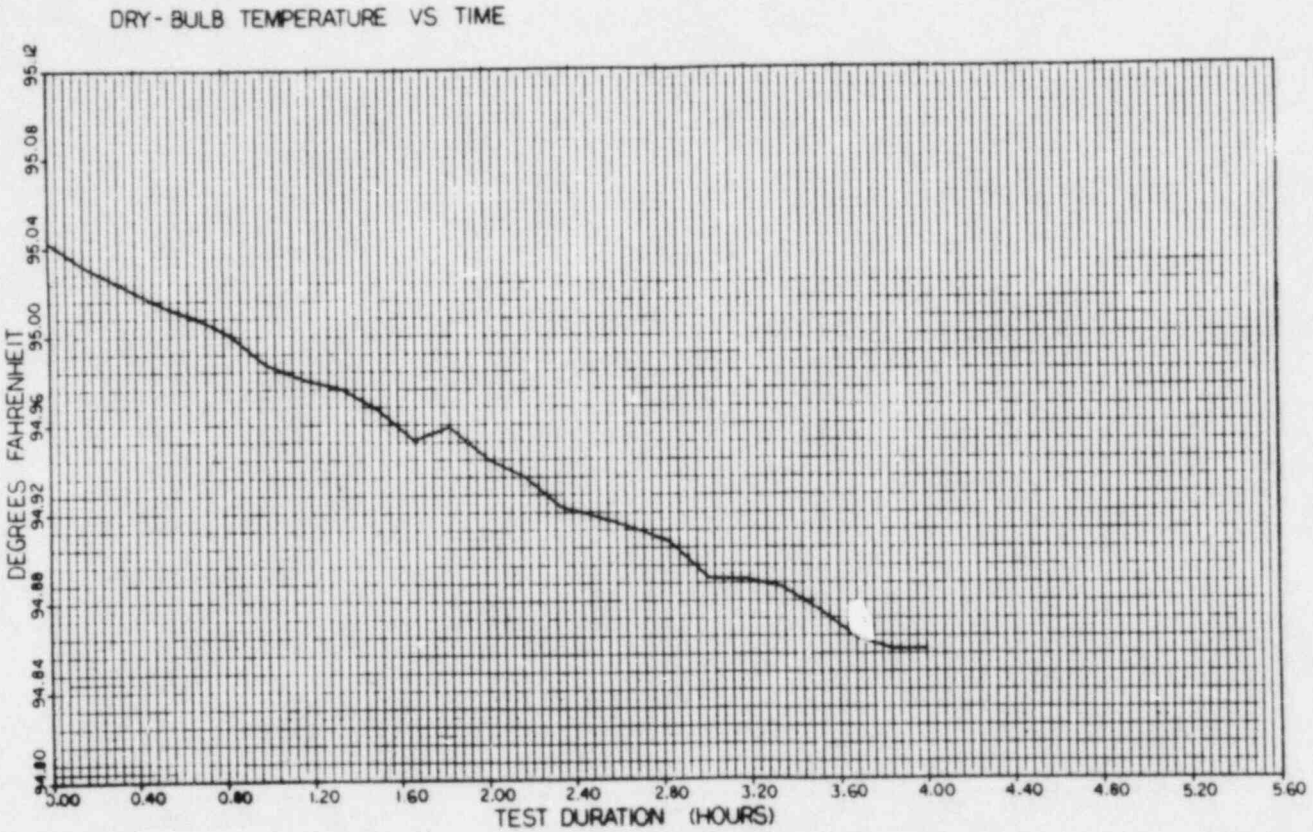


FIGURE 8

QUAD-CITIES UNIT 2
Total Containment Pressure vs. Time

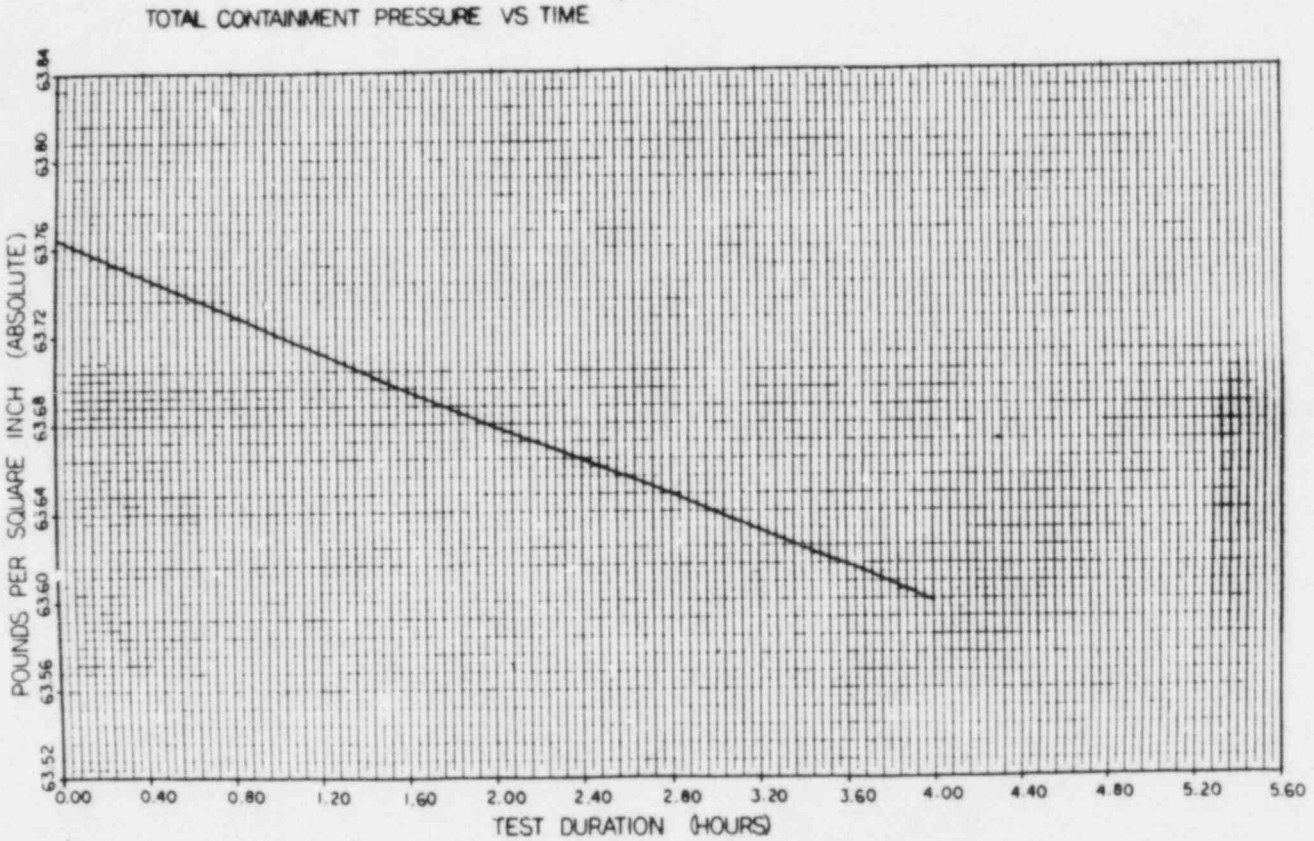


FIGURE 9

QUAD-CITIES UNIT 2
Containment Dry Air Pressure vs. Time

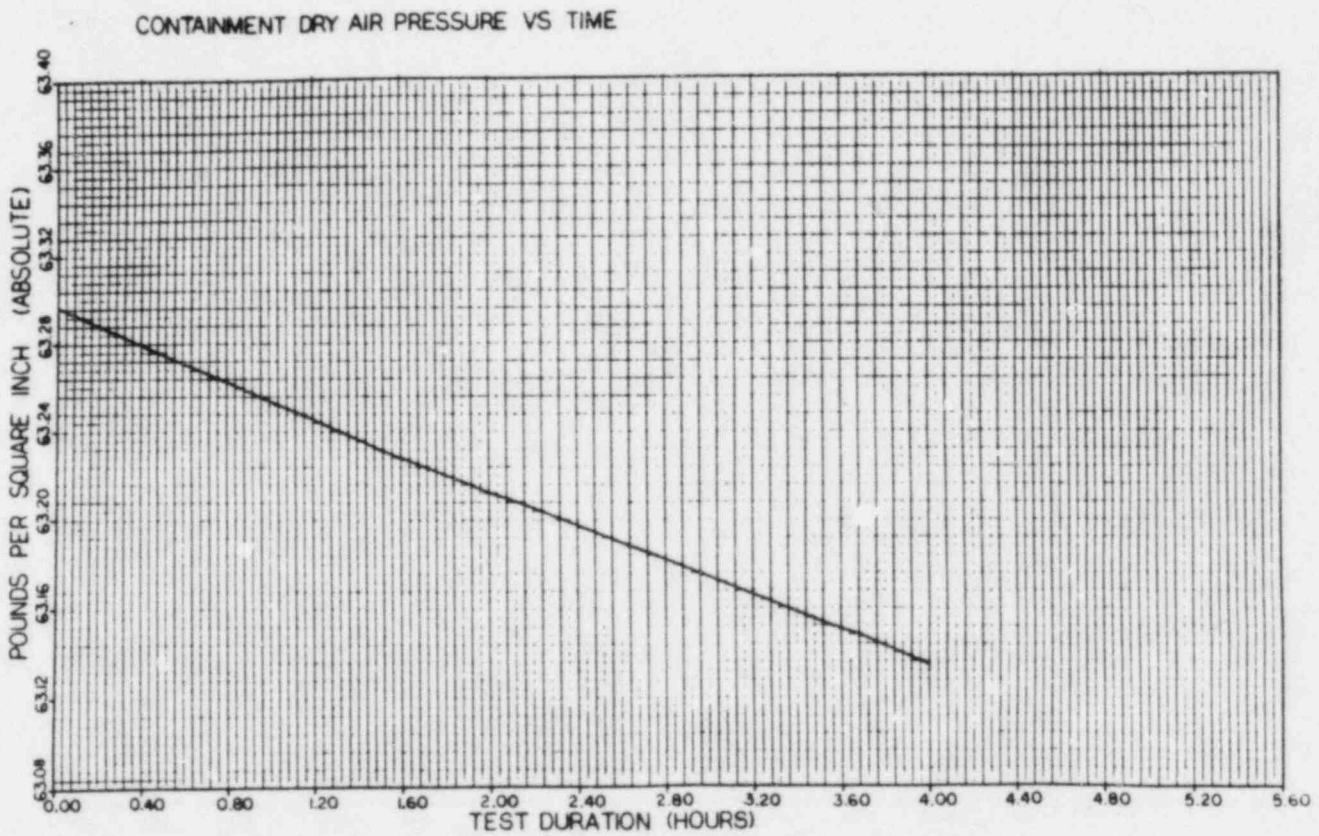


FIGURE 10

SECTION E - TEST CALCULATIONS

Calculations for the IPCLRT using the ANSI method are found in Quad-Cities procedures QTS 150-T3. A summary of this document can be found in Appendix B. The ANSI N45-4-1972 standard is the reference document for conducting the type A test, as required by 10CFR50 Appendix J and Quad-Cities Technical Specifications.

SECTION F - TYPE A TEST RESULTS

F.1 Measured Leak Rate Test Results

Based on the data collected over 24 hours on approximately 10 minute time intervals the statistically averaged leak rate was found to be 0.4071 wt %/day with an upper confidence limit of 0.4092 wt %/day.

These values include a correction for the torus level being at -1.9 inches for the test. This correction was applied to the test program after conducting the test. The values calculated at the time of the test assumed 0.0 inches (normal level) and were 0.4083 and 0.4105 respectively.

F.2 Induced Leakage Test Results

A leak rate of 7.75 SCFM (0.950 wt %/day) was induced from the containment for this phase of the test. The required accuracy for the test is computed below.

Statistically Averaged Leak Rate (Measured Leak Rate Phase)	0.4071	0.4071	
Induced Leak (7.75 SCFM)	0.9500	0.9500	
Allowed Error Band (25% L_a)	+0.2500	-0.2500	
	1.6071	1.1071	(wt%/day)
Statistically Averaged Leak Rate (Induced Leakage Phase)	1.2117 wt %/day		

Therefore, the required test accuracy was satisfied. The verification test result was 10.7% different than the predicted result (.4071 + .9500). The magnitude of the error is less than the predicted error found in Appendix D and demonstrates that the instrumentation and modeling of the containment is adequate to measure a leakage with a magnitude of the allowable limit.

F.3 Leak Rate Compensation For Non-Vented Penetrations

This correction to the Type A test result has historically been reported by Quad-Cities and other stations because of the requirement presented in 10CFR50, Appendix J, Section III.A.1.(d). It is the station's opinion that the penalty to the Type A test result is presently being misinterpreted by many in the industry. The present interpretation of the regulation is that the "as left", "minimum pathway leakage" for every containment penetration where the system is not drained and vented during the Type A test must be added to the Type A test result as a penalty. A portion of the system that must be drained and vented is that which is exterior to the primary containment isolation (PCI) valves in order to challenge all PCI valves to accident D/P's and allow air leakage from the containment during the Type A test.

The above described test procedure and penalty corrections are not what the existing regulation says and simulates a condition that is overly conservative and unrealistic. The intent of the regulation was to simulate conditions as they might exist during a design basis accident (DBA). The above interpretations attempts to simulate a condition where every system is severed (or somehow drained and vented) outside the containment to challenge every PCI valve isolation. This accident scenario goes beyond what can be realistically expected during the worst of accidents.

The station views this penalty as unjustified based on the present regulation because of the following reasons. 1) The regulation never references penalties to the Type A result for not draining and venting systems. In fact, systems that are required for maintaining the unit in a safe mode or would be operating (water filled) during post-accident conditions are exempted by the regulation and require no regulatory review (exemption request). The regulation only requires that PCI valves on the exempted systems be tested (Type C) to the requirements of Section III.C. and that those leakage rates be reported to the Commission. 2) The regulation never requires that systems outside the containment boundary be drained and vented to maximize valve leakages. The regulation refers to draining and venting lines within the containment that might rupture or become part of the containment during a DBA. The regulation never intended for all PCI valves to be tested during the Type A test to the requirements of Section III.A.1.(d) and states that they will be tested separately to the requirements of Section III.C.

The Type A test penalties for failing to drain and vent all containment penetrations has been included in the ANSI/ANS 56.8-1981 standard, Section 3.2.1.5. This standard has not, however, been accepted by the industry and the NRC. No such penalties can be justified based on ANSI N45.4-1972, 10CFR50 Appendix J, or Quad-Cities Technical Specifications.

The above interpretation is not, however, in agreement with present NRC enforcement policy. For that reason, the following values give the historically reported (at Quad-Cities) penalties to the Type A test.

SYSTEM	STATUS	MINIMUM PATHWAY LEAKAGE FROM TYPE B AND C TESTING	
		SCFH	T %/DAY
'A' Rx Feedwater	Isolated, Filled	10.85	0.022
'B' Rx Feedwater	Isolated, OOS*	5.42	0.011
RHR System	Operating for SDC*	37.52	0.077
Rx Water CU*	Operating for Rx Water Temp and SDC	2.51	0.005
ACAD/CAM	Isolated	1.70	0.003
Primary Sample	Isolated	0.04	0.000
Hydrogen Monitor Panel	Isolated	3.80	0.008
HPCI Steam (Supp & Ex's)	Isolated	12.50	0.026
RCIC Steam (Supp & Ex's)	Isolated	15.83	0.032
All Electrical Penetrations	Test Bellows Pressurized with Dry N_2.	0.37	0.001
		90.54	0.185

This correction yields the following adjusted leak rates:

Statistically Averaged Leak Rate (ANSI)	0.592 wt %/day
Upper Confidence Limit (ANSI)	0.594 wt %/day

*OOS = out of service
SDC = shutdown cooling
CV = reactor water clean up system

F.4 Pre-Operational Results vs. Test Results

The result of the pre-operational IPCLRT test done by General Electric between August 29 and September 2, 1971 was found to be 0.1112 weight %/day. Previous IPCLRT test reports for Unit Two show that the uncertainty of the pre-operational test was large compared to more recent tests. The instrumentation and statistical analysis of the pre-operational test was relatively inexact by present standards. The leak rate of .4071 wt %/day found in this test compares favorably with recent tests and shows that there is no significant deterioration of the containment.

F.5 As Found IPCLRT Result

The following table summarizes the results of all Type B and C testing, as well as the IPCLRT results to arrive at an "as found" Type A test result. The station does not agree with the present regulatory interpretation of adding Type B and C test results to the Type A test as a penalty for repairs and adjustments made prior to conducting the Type A test.

The reasons why this practice, as it is presently being enforced by the NRC, is considered unfair and inappropriate follows: 1) The present penalties to the Type A test are being regulated without any change to the regulations and constitute a change from past enforcement actions. 2) The Type B and C test results being used as penalties for a variety of reasons (including differences in test configuration and the fact that many of the penalties are for valves that would be OPEN or with systems operating (water filled) during a design basis accident) are not realistic estimates of probable containment leakage during an accident. 3) The change in enforcement policy adds multiple penalties to the Type A test result without any accompanying relief in the allowable leakage limit, even though substantial evidence exists that such limits could be increased without significant impact on public safety. 4) The NRC is imposing on the station a Type A test schedule that requires a Type A test every refuel outage, and the increased cost associated with this testing and increased outage time, without any corresponding increase in public safety being demonstrated or cost/benefit analysis being performed.

The above interpretation is not, however, in agreement with present NRC enforcement policy. For that reason, the following valves give the penalties to the Type A test that have been proposed in draft copies of the NRC proposed changes to Appendix J and the ANSI/ANS 56.8 standard.

SUMMARY OF ALL CONTAINMENT LEAK RATE TESTING DURING UNIT TWO REFUEL OUTAGE SPRING, 1985

	AS FOUND (SCFH) MINIMUM PATHWAY LEAKAGE	AS LEFT (SCFH) MINIMUM PATHWAY LEAKAGE
(1) MSIV's @ 25 PSIG	5.10	5.10
(2) MSIV's converted to 48 PSIG*	8.06	8.06
(3) All Type C Tests (Except MSIV's)	351.65	137.25
(4) All Type B Tests	17.74	17.74
TOTAL (2 + 3 + 4)	377.45	163.05

(1) Type A Test Integrated Leak Rate Test)	= 0.407 wt %/day	
(2) Upper Confidence Limit of Type A Test Result	= 0.409 wt %/day	
(3) Correction for Unvented Volumes During Type A Test	= 0.185 wt %/day	
(4) Correction for Repairs Prior to Type A Test (As Found - As Left)	= 0.438 wt %/day	$\frac{(377.45 - 163.05)}{489.59}$
(5) Correction for Change in Sump Levels **	= 0.000 wt %/day	
TOTAL (2 + 3 + 4 + 5)	1.032 wt %/day (As Found ILRT Result)	

* Leak Rate at 25 PSIG converts to Leak Rate at 48 PSIG using conversion ratio of 1.58. REFERENCE ORNL - NISC - 5, Oak Ridge National Laboratory, Aug. 1965, page 10.55.

** No sump corrections were required because the Drywell Equipment and Floor Drain Sumps did not change in level over the course of the test.

APPENDIX A
TYPE B AND C TESTS

Presented herein are the results of local leak rate tests conducted on all penetrations, double-gasketed seals, and isolation valves since the previous IPCLRT in February, 1984. Total leakage for double gasketed seals and total leakage for all other penetrations and isolation valves following repairs satisfied the Technical Specification limits. These results are listed in Table A-1. Valves that had "as found" leakage valves requiring repair are discussed in detail in LER/RO 85-007, Supplement 1.

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
AO 203-1A	Main Steam Line Isolation Valves**	* 2.30	03-17-85	2.30	03-17-85
AO 203-2A	MSIV	* 2.30	03-17-85	2.30	03-17-85
AO 203-1B	MSIV	0.00	03-17-85	0.00	03-17-85
AO 203-2B	MSIV	13.80	03-17-85	4.61	05-20-85
AO 203-1C	MSIV	* 6.90	03-17-85	6.90	03-17-85
AO 203-2C	MSIV	* 6.90	03-17-85	6.90	03-17-85
AO 203-1D	MSIV	0.00	03-17-85	0.00	03-17-85
AO 203-2D	MSIV	157.70	03-17-85	9.20	05-03-85
MO 220-1 MO 220-2	Main Steam Line Drains	115.70	03-17-85	6.42	05-21-85
AO 220-44 AO 220-45	Primary Sample	0.09	04-08-85	0.09	04-08-85
CV 220-58A	Feedwater Inlet Loop "A" Inboard	1921.70	04-10-85	16.00	05-04-85
CV 220-62A	Feedwater Inlet Loop "A" Outboard	10.85	04-10-85	10.85	04-10-85
CV 220-58B	Feedwater Inlet Loop "B" Inboard	23.20	03-22-85	23.20	03-22-85
CV 220-62B	Feedwater Inlet Loop "B" Outboard	789.50	03-22-85	5.42	05-31-85

* Values are the total inboard and outboard leakage.

** Test Pressure for MSIV's is 25 PSIG. Where the A and B valves in a steam line have identical leakages, the valves were tested as a single volume. The value is a maximum leak rate through the valve assuming that the other valve leaked 0.0 SCFH.

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
MO 1001-20 MO 1001-21	RHRS to Radwaste	12.00/12.00*	03-20-85	12.00/12.00	03-20-85
MO 1001-23A MO 1001-26A	RHRS Containment Spray - System I	0.63	03-20-85	0.84	04-13-85
MO 1001-29A	RHRS Return Loop "A"	4.50	03-20-85	9.00	04-21-85
MO 1001-34A MO 1001-36A MO 1001-37A	RHRS Suppression Chamber Spray - System I	1.22	03-20-85	1.22	03-20-85
MO 1001-23B MO 1001-26B	RHRS Containment Spray - System II	15.12	04-23-85	17.56	05-29-85
MO 1001-29B	RHRS Return Loop "B"	4.14	04-23-85	4.14	05-29-85
MO 1001-34B MO 1001-36B MO 1001-37B	RHRS Suppression Chamber Spray System II	3.04	04-23-85	3.04	04-23-85
MO 1001-47 MO 1001-50	RHRS Shutdown Cooling Suction	0.00	04-17-85	0.00	04-17-85
MO 1001-60 MO 1001-63	RHRS Head Spray	1.00	03-21-85	1.00	04-22-85
MO 1201-2 MO 1201-5	Clean-Up System Suction	5.02	04-08-85	5.02	04-08-85
MO 1301-16 MO 1301-17	RCIC Steam Supply	4.10	03-17-85	2.00	04-27-85
CV 1301-40	RCIC Condensate Drain	6.85	03-18-85	6.85	03-18-85
CV 1301-41	RCIC Turbine Exhaust	7.98	03-18-85	7.98	03-18-85
AO 1601-21 AO 1601-22 AO 1601-55 AO 1601-56	Drywell and Suppression Chamber Purge	33.00	03-23-85	33.00	03-23-85
AO 1601-20A CV 1601-31A	Suppression Chamber Vent Lines #1	11.45	03-23-85	11.45	03-23-85

* Valves tested separately. Individual valve leak rates shown.

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
AO 1601-20B CV 1601-31B	Suppression Chamber Vent Lines #2	13.99	03-23-85	13.99	05-30-85
AO 1601-57 AO 1601-58 AO 1601-59	Drywell and Suppression Chamber Supply Air Purge	6.00	04-26-85	6.00	04-26-85
AO 1601-23 AO 1601-24 AO 1601-60 AO 1601-61 AO 1601-62 AO 1601-63	Drywell and Suppression Chamber Exhaust	342.00	04-29-85	0.00	05-24-85
AO 2001-3 AO 2001-4	Drywell Floor Drain Sump Discharge	0.03	03-23-85	0.03	03-23-85
AO 2001-15 AO 2001-16	Drywell Equipment Drain Sump Discharge	0.26	03-23-85	0.26	03-23-85
MO 2301-4 MO 2301-5	HPCI Steam Supply	0.00	03-17-85	0.00	04-13-85
CV 2301-34	HPCI Condensate Drain	14.20	03-18-85	12.50	06-02-85
CV 2301-45	HPCI Steam Exhaust	33.80	03-18-85	0.00	05-23-85
AO 4720	Drywell Pneumatic Suction	0.00	04-25-85	0.00	04-25-85
AO 4721	Drywell Pneumatic Suction	0.00	04-25-85	0.00	04-25-85
AO 8801A	Oxygen Analyzer Suction	0.00	03-29-85	0.00	03-29-85
AO 8802A	Oxygen Analyzer Suction	0.00	03-29-85	0.00	03-29-85
AO 8801B	Oxygen Analyzer Suction	0.00	03-29-85	0.00	03-29-85
AO 8802B	Oxygen Analyzer Suction	0.00	03-29-85	0.00	03-29-85

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
AO 8801C	Oxygen Analyzer Suction	36.50	03-29-85	13.00	05-22-85
AO 8802C	Oxygen Analyzer Suction	9.70	03-29-85	6.50	05-03-85
AO 8801D	Oxygen Analyzer Suction	0.00	03-29-85	0.00	03-29-85
AO 8802D	Oxygen Analyzer Suction	0.00	03-29-85	0.00	03-29-85
AO 8803	Oxygen Analyzer Return	0.00	03-29-85	0.00	03-29-85
AO 8804	Oxygen Analyzer Return	6.50	03-29-85	3.50	05-22-85
733-1	Automatic TIP Ball Valve	0.25	03-21-85	0.80	04-15-85
733-2	Automatic TIP Ball Valve	0.40	03-21-85	0.80	04-15-85
733-3	Automatic TIP Ball Valve	0.10	03-21-85	1.30	04-15-85
733-4	Automatic TIP Ball Valve	0.00	03-21-85	0.30	04-15-85
733-5	Automatic TIP Ball Valve	1.70	03-21-85	0.50	06-02-85
700-743	TIP Purge Check Valve	4.60	03-21-85	4.60	03-21-85
SO 2499-1A SO 2499-2A	CAM - Drywell	0.00	04-01-85	0.00	05-21-85
SO 2499-3A SO 2499-4A	CAM - Suppression Chamber	0.00	04-01-85	0.00	04-01-85
SO 2499-1B SO 2499-2B	CAM - Drywell	0.00	04-01-85	0.00	05-21-85
SO 2499-3B SO 2499-4B	CAM - Suppression Chamber	0.00	04-01-85	0.00	04-01-85

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
AO 2599-2A CV 2599-23A	ACAD to Drywell	*7.80/0.00	04-01-85	2.30	05-03-85
AO 2599-3A CV 2599-24A	ACAD to Suppression Chamber	0.00	04-01-85	0.00	04-01-85
AO 2599-2B CV 2599-23B	ACAD to Drywell	*1.70/1.85	04-01-85	1.70/1.85	04-01-85
AO 2599-3B CV 2599-24B	ACAD to Suppression Chamber	0.00	04-01-85	0.00	04-01-85
AO 2599-4A FCV 2599-5A	ACAD Drywell Bleed to SBGTS	*1.70/0.00	04-02-85	1.70/0.00	04-02-85
AO 2599-4B FCV 2599-5B	ACAD Drywell Bleed to SBGTS	*6.50/0.00	04-02-85	0.90/0.00	05-03-85
X-1	Drywell Equipment Hatch	0.00	03-17-85	0.00	06-01-85
X-2	Drywell Personnel Airlock	**10.30	05-12-85	10.30	05-12-85
X-4	Drywell Head Access Hatch	0.00	03-17-85	0.00	03-17-85
X-6	CRD Removal Hatch	0.00	03-17-85	0.00	05-25-85
X-35A	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85
X-35B	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85

* Valves tested separately. Individual valve leak rates shown.

** Tested at 48 PSIG.

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
X-35C	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85
X-35D	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85
X-35E	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85
X-35F	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85
X-35G	TIP Flux Mon. Flange	0.00	03-21-85	0.00	03-21-85
X-200A	Suppression Chamber Access Hatch	0.00	03-17-85	0.00	06-05-85
		0.00	01-21-85	0.00	01-21-85
		0.00	12-28-84	0.00	12-28-84
		0.00	10-26-84	0.00	10-26-84
X-200B	Suppression Chamber Access Hatch	0.00	03-17-85	0.00	05-25-85
Drywell Head	Drywell Head Flange	0.00	03-17-85	0.00	05-24-85
SL-1	Shear Lug Inspection Hatches	0.00	03-21-85	0.00	03-21-85
SL-2	Shear Lug Inspection Hatch	0.00	03-21-85	0.00	03-21-85
SL-3	Shear Lug Inspection Hatch	0.00	03-21-85	0.00	03-21-85
SL-4	Shear Lug Inspection Hatch	0.00	03-21-85	0.00	03-21-85
SL-5	Shear Lug Inspection Hatch	0.00	03-21-85	0.00	03-21-85
SL-6	Shear Lug Inspection Hatch	0.25	03-21-85	0.25	03-21-85
SL-7	Shear Lug Inspection Hatch	0.00	03-21-85	0.00	03-21-85

* LLRT performed after closure following entry into suppression chamber.

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
SL-8	Shear Lug Inspection Hatch	0.00	03-21-85	0.00	03-21-85
X-7A	Primary Steam	0.00	03-19-85	0.00	03-19-85
X-7B	Primary Steam	0.00	03-19-85	0.00	03-19-85
X-7C	Primary Steam	0.00	03-18-85	0.00	03-18-85
X-7D	Primary Steam	0.00	03-18-85	0.00	03-18-85
X-8	Primary Steam Drain Line	0.00	03-19-85	0.00	03-19-85
X-9A	Reactor Feedwater	0.00	03-19-85	0.00	03-19-85
X-9B	Reactor Feedwater	0.75	03-18-85	0.75	03-18-85
X-10	Steam to RCIC	0.45	03-18-85	0.45	03-18-85
X-11	HPCI to Steam Supply	0.00	03-18-85	0.00	03-18-85
X-12	RHRS Supply	3.75	03-18-85	3.75	03-18-85
X-13A	RHRS Return	0.00	03-19-85	0.00	03-19-85
X-13B	RHRS Return	0.25	03-18-85	0.25	03-18-85
X-14	Cleanup Supply	1.30	03-19-85	1.30	03-19-85
X-23	Cooling Water	0.40	03-18-85	0.40	03-18-85
X-24	Cooling Water Return	0.00	03-18-85	0.00	03-18-85

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
X-25	Vent From Drywell	1.80	03-19-85	1.80	03-19-85
X-26	Vent to Drywell	0.00	03-19-85	0.00	03-19-85
X-36	CRD Hydraulic System Return	0.00	03-18-85	0.00	03-18-85
X-47	Standby Liquid Control	0.20	03-18-85	0.20	03-18-85
X-17	Reactor Vessel Head Spray	1.50	03-19-85	1.50	03-19-85
X-16A	Core Spray Inlet	6.50	03-18-85	6.50	03-18-85
X-16B	Core Spray Inlet	0.00	06-01-85	0.00	06-01-85
X-100B	CRD Position Indication	0.00	03-21-85	0.00	03-21-85
X-100C	Neutron Monitor	0.00	03-25-85	0.00	03-25-85
X-100E	CRD Position Indication	0.00	03-25-85	0.00	03-25-85
X-100F	Power	0.00	04-15-85	0.00	05-18-84
X-100G	CRD Position Indication	0.20	04-15-85	0.20	04-15-85
X-101A	Recirc Pump Power	0.00	03-21-85	0.00	03-21-85
X-101B	Recirc. Pump Power	0.00	03-21-85	0.00	03-21-85

TABLE A-1
TYPE B AND C TEST RESULTS

VALVE(S) OR PENETRATION	TEST VOLUME	MEASURED LEAK RATE (SCFH) AS FOUND	DATE	AS LEFT	DATE
X-101D	Power	0.00	04-15-85	0.00	04-15-85
X-102B	Neutron Monitors	0.00	03-25-85	0.00	03-25-85
X-103	Neutron Monitors	0.00	03-25-85	0.00	03-25-85
X-104A	Drywell Coolers	0.00	03-19-85	0.00	03-19-85
X-104B	Drywell Coolers	0.00	03-19-85	0.00	03-19-85
X-104C	CRD Position Indication	0.00	03-25-85	0.00	03-25-85
X-104D	CRD Position Indication	0.10	03-25-85	0.10	03-25-85
X-104F	Recirc Pump Power	0.30	04-15-85	0.30	04-15-85
X-105C	Neutron Monitors	0.05	03-25-85	0.05	03-25-85
X-106A	CRD Position Indication	0.00	03-19-85	0.00	03-19-85
X-106B	Thermocouples	0.00	03-25-85	0.00	03-25-85
X-107A	Neutron Monitors	0.10	03-25-85	0.10	03-25-85
X-107B	Recirc Pump Power	0.00	04-15-85	0.00	04-15-85
X-227A	ACAD/CAM	0.00	03-23-85	0.00	03-25-85
X-227B	ACAD/CAM	0.00	03-25-85	0.00	03-25-85
1-2252-81A/81B	H_2/O_2 Analyzer Panel	0.45/3.35	06-04-85	0.45/3.35	06-04-85
LT 2-1641-5A/5B	Torus Wide Range Level Inst. Lines	0.00/0.00	03-26-85	0.00/0.00	03-26-85

APPENDIX B

SELECTED DATA SETS FOR TYPE A TEST

Presented herein are data sets at arbitrarily selected points during the Type A test. Table B-1 has the data set at the start of the 24 hour test. Table B-2 has the data set at the conclusion of the 24 hour test. Table B-3 has the data set at the start of the induced phase of the test. Table B-4 has the data set at the conclusion of the induced phase of the test.

DATA SET AT START OF 24 HOUR TEST

SET # 51 AT 001 19:26:58

FAILED SENSORS:

RTD(4) IN S.V.# 7 = 25.986 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
RTD(1) IN S.V.# 8 =105.504 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
DEWCELL(1) IN S.V.# 4 = 58.150 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0

PRESSURE 1	= 64.396 PSIA	PRESSURE 2	= 64.417 PSIA
DRY AIR PRESSURE	= 63.897 PSIA	VAPOR PRESSURE	= 0.509 PSIA
VOL WEIGHTED AVE DC	= 80.117 DEG F	VOL WEIGHTED AVERAGE RTD	= 96.884 DEG F
RX WATER LEVEL	= 48.397 INCHES	DRY AIR MASS	=8.9670140625E+04

RTDS:

S.V.# 1	117.103	115.529				
S.V.# 2	121.558	122.600				
S.V.# 3	116.060	111.731				
S.V.# 4	116.228	109.329				
S.V.# 5	113.060	112.570	111.895			
S.V.# 6	108.571	107.511	107.624	109.218		
S.V.# 7	96.716	98.043	98.452	0.000		
S.V.# 8	0.000	90.560	87.146	91.551		
S.V.# 9	87.734					
S.V.# 10	96.574	86.429	96.501	86.348	86.466	86.782
S.V.# 11	138.236	138.236				

DEWCELLS:

S.V.# 1	81.094	
S.V.# 4	0.000	81.207
S.V.# 5	79.677	
S.V.# 7	78.104	77.191
S.V.# 8	74.159	76.376
S.V.# 11	79.553	78.475

TABLE B-1

DATA SET AT END OF 24 HOUR TEST

SET #174 AT 002 1:29:46

FAILED SENSORS:

RTD(4) IN S.V.# 7 = 94.802 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
RTD(1) IN S.V.# 8 =107.165 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
DEWCELL(1) IN S.V.# 4 = 57.496 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0

PRESSURE 1	= 63.940 PSIA	PRESSURE 2	= 63.855 PSIA
DRY AIR PRESSURE	= 63.378 PSIA	VAPOR PRESSURE	= 0.469 PSIA
VOL WEIGHTED AVE DC	= 77.660 DEG F	VOL WEIGHTED AVERAGE RTD	= 95.199 DEG F
RX WATER LEVEL	= 35.720 INCHES	DRY AIR MASS	=8.9309078125E+04

RTDS:

S.V.# 1	111.429	111.124				
S.V.# 2	119.929	120.849				
S.V.# 3	117.051	111.977				
S.V.# 4	116.653	111.714				
S.V.# 5	114.288	113.855	113.120			
S.V.# 6	110.508	109.242	109.593	110.883		
S.V.# 7	95.156	96.924	97.626	0.000		
S.V.# 8	0.000	84.704	85.131	89.857		
S.V.# 9	95.730					
S.V.# 10	93.537	83.450	83.616	83.208	83.353	83.689
S.V.# 11	134.324	134.324				

DEWCELLS:

S.V.# 1	76.999		
S.V.# 4	0.000	76.967	
S.V.# 5	76.239		
S.V.# 7	75.376	73.178	
S.V.# 8	72.881	74.347	
S.V.# 10	77.454	76.503	

TABLE B-2

DATA SET AT THE START OF THE INDUCED TEST

SET #188 AT 002 17:49:58

FAILED SENSORS:

RTD(4) IN S.V.# 7 = 94.732 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
RTD(1) IN S.V.# 8 =107.215 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
DEWCELL(1) IN S.V.# 4 = 57.427 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0

PRESSURE 1	= 63.759 PSIA	PRESSURE 2	= 63.770 PSIA	
DRY AIR PRESSURE	= 63.297 PSIA	VAPOR PRESSURE	= 0.468 PSIA	
VOL WEIGHTED AVE DC	= 77.548 DEG F	VOL WEIGHTED AVERAGE RTD	= 95.044 DEG F	
RX WATER LEVEL	= 34.444 INCHES	DRY AIR MASS	=8.9229953125E+04	

RTDS:

S.V.# 1	110.911	110.480				
S.V.# 2	119.753	120.701				
S.V.# 3	117.021	111.977				
S.V.# 4	116.623	112.013				
S.V.# 5	114.308	113.805	113.099			
S.V.# 6	110.528	109.272	109.623	110.932		
S.V.# 7	94.997	96.805	97.526	0.000		
S.V.# 8	0.000	88.649	94.914	89.590		
S.V.# 9	85.531					
S.V.# 10	83.349	83.242	93.458	83.039	83.164	83.491
S.V.# 11	136.041	136.041				

DEWCELLS:

S.V.# 1	76.885					
S.V.# 4	0.000	76.843				
S.V.# 5	75.982					
S.V.# 7	75.299	74.850				
S.V.# 8	72.568	74.115				
S.V.# 10	77.365	76.639				

TABLE B-3

DATA SET AT THE END OF THE INDUCED TEST

SET #212 AT 002 21:58:27

FAILED SENSORS:

RTD(6) IN S.V.# 7 = 94.464 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
RTD(1) IN S.V.# 8 =107.215 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0
DEWCELL(1) IN S.V.# 4 = 57.510 DEG F HAS BEEN DELETED FROM SCAN & SET TO 0.0

PRESSURE 1	= 63.591 PSIA	PRESSURE 2	= 63.605 PSIA
DRY AIR PRESSURE	= 63.134 PSIA	VAPOR PRESSURE	= 0.465 PSIA
VOL WEIGHTED AVE DC	= 77.340 DEG F	VOL WEIGHTED AVERAGE RTD	= 94.858 DEG F
RX WATER LEVEL	= 32.288 INCHES	DRY AIR MASS	=8.9045921875E+04

RTDS:

S.V.# 1	110.275	109.936					
S.V.# 2	119.490	120.552					
S.V.# 3	117.051	112.007					
S.V.# 4	116.623	112.171					
S.V.# 5	114.288	113.706	113.039				
S.V.# 6	110.558	109.292	109.672	110.932			
S.V.# 7	94.749	96.607	97.377	0.000			
S.V.# 8	0.000	88.263	84.637	89.124			
S.V.# 9	85.222						
S.V.# 10	83.131	83.004	83.240	82.849	82.966	83.293	
S.V.# 11	135.910	135.910					

DEWCELLS:

S.V.# 1	76.585	
S.V.# 4	0.000	76.480
S.V.# 5	75.747	
S.V.# 7	75.066	74.943
S.V.# 8	72.285	73.753
S.V.# 10	77.185	76.557

TABLE B-4

APPENDIX C

COMPUTATIONAL PROCEDURE

The procedure for computing the containment parameters, leak rates, and statistical confidence limits is given by Quad-Cities procedure QTS 150-T3, Revision 7. A summary of that procedure is presented here.

Data collected from pressure sensors, dew cells and RTD's located in the containment are processed using the following calculations. If the test is concluded with a test period of <24 hours, additional calculations given in QTS 150-T9 will be required.

A. Average Subvolume Temperature and Dewpoint.

$$T_j = \frac{\Sigma(\text{all RTD's in the jth subvolume})}{\text{Number of RTD's in jth subvolume}} \quad °F \quad (1)$$

$$D.P._j = \frac{\Sigma(\text{all dew cells in jth subvolume})}{\text{Number of dew cells in jth subvolume}} \quad °F \quad (2)$$

where T_j = average temperature of the jth subvolume

$D.P._j$ = average dewpoint of the jth subvolume

B. Average Primary Containment Temperature and Dewpoint.

$$T = \sum_{j=1}^{NVOL} (VF_j) * (T_j) \quad °F \quad (3)$$

$$D.P. = \sum_{j=1}^{NVOL} (VF_j) * (D.P._j) \quad °F \quad (4)$$

where T = average containment temperature

D.P. = average containment dewpoint

VF_j = volume fraction of the jth subvolume

NVOL = number of subvolumes

If T_j is undefined then

$T_j = T_{j+1}$ for $1 \leq j \leq (NVOL - 2)$

$T_j = T_{j-1}$ for $j = NVOL - 1$

T_j = estimate for $j = NVOL$

If $D.P._j$ is undefined

$D.P._j = D.P._{j+1}$ for $1 \leq j \leq (NVOL - 2)$

$D.P._j = D.P._{j-1}$ for $j = NVOL - 1$

$D.P._j$ = estimate for $j = NVOL$

C. Calculation of Dry Air Pressure.

$$D.P.(°K) = 273.16 + \frac{D.P.(°F) - 32}{1.8}$$

$$X = 647.27 - D.P.(°K)$$

$$EXPON = \frac{X * (Y + Z * X + C * X^3)}{(D.P.(°K)) * (1 + D * X)}$$

$$P_V = \frac{(218.167) * (14.696)}{e^{(EXPON * \ln(10))}} \quad (PSI)$$

$$P = \frac{\Sigma(\text{all absolute pressure gauges})}{\text{Number of absolute pressure gauges}} - P_V \text{ (psia)} \qquad (5)$$

where $Y = 3.2437814$

$Z = 5.86826 \times 10^{-3}$

$C = 1.1702379 \times 10^{-8}$

$D = 2.1878462 \times 10^{-3}$

P_V = volume weighted containment vapor pressure

P = containment dry air absolute pressure

C, D, X, Y, Z, and EXPON are dewpoint to vapor pressure conversion constants and coefficients.

D. Containment Dry Air Mass.

$$W = \frac{(28.97) * (144) * (P) * (288737 - 25 * (LEVEL - 35))}{1545.33 * (T + 459.69)} \qquad (6)$$

where W = containment dry air mass

LEVEL = reactor water level

288737 = containment free air space with water level = 35 inches

E. Measured Leak Rate.

$$L_m(TOTAL) = \frac{(W_{BASE} - W_i) * 2400}{t_i * W_{BASE}} \quad \%/DAY \qquad (7)$$

$$L_m(POINT) = \frac{(W_{i-1} - W_i) * 2400}{(t_i - t_{i-1}) * W_{i-1}} \quad \%/DAY \qquad (8)$$

where W_{BASE} = containment dry air mass at t = 0

t_i = time from start of test at ith data set

t_{i-1} = time from start of test at (i-1)th data set

W_i = dry air mass at ith data set

W_{i-1} = dry air mass at (i-1)th data set

$L_m(TOTAL)$= measured leakage from the start of test to ith data set

$L_m(POINT)$= measured leakage between the last two data sets

F. Statistical Leak Rate and Confidence Limit.

LINEAR LEAST SQUARES FITTING THE IPCLRT DATA

The method of "Least Squares" is a statistical procedure for finding the best fitting regression line for a set of measured data. The criterion for the best fitting line to a set of data points is that the sum of the squares of the deviations of the observed points from the line must be a minimum. When this criterion is met, a unique best fitting line is obtained based on all of the data points in the ILRT. The value of the leak rate based on the regression is called the statistically average leak rate.

Since it is assumed that the leak rate is constant during the testing period, a plot of the measured containment dry air mass versus time would ideally yield a straight line with a negative slope (assuming a non-zero leak rate). Obviously, sampling techniques and test conditions are not perfect and consequently the measured values will deviate from the ideal straight line situation.

Based on this statistical process, the calculated leak rate is obtained from the equation:

$W = At + B$

where W = contained dry air mass at time t

B = calculated dry air mass at time t = 0

A = calculated leak rate

t = test duration

The values for the Least Squares fit constants A and B are given by:

$$A = \frac{\{N * \Sigma(t_i) * (W_i) - \Sigma t_i * \Sigma W_i\}}{\{N * \Sigma(t_i)^2 - (\Sigma t_i)^2\}} = \frac{\Sigma(t_i - \bar{t}) * (W_i - \bar{W})}{\Sigma(t_i - \bar{t})^2}$$

$$B = \frac{\Sigma W_i - A * \Sigma t_i}{N} = \frac{\{\Sigma(t_i)^2 * \Sigma(W_i)\} - \{\Sigma(t_i) * (W_i)\}}{N * \Sigma(t_i)^2 - (\Sigma t_i)^2}$$

where $\bar{t}$ = the average time for all data sets

$\bar{W}$ = the average air mass for all data sets

The second formulas are used to reduce round-off-error.

By definition, leakage out of the containment is considered positive leakage; therefore, the statistically average leak rate is given by:

$$L_S = \frac{(-A) * (2400)}{B} \quad \text{(weight \%/DAY)} \qquad (9)$$

STATISTICAL UNCERTAINTIES

In order to calculate the 95% confidence limits of the statistically average leak rate, the standard deviation of the least squares slope and the student's T-Distribution function are used as follows.

$$\sigma = \left\{\frac{1}{(N-2)} * \left(\frac{N * \Sigma(W_i)^2 - (\Sigma W_i)^2}{N * \Sigma(t_i)^2 - (\Sigma t_i)^2}\right) - A^2\right\}^{1/2}$$

When performing these calculations on the process computer, $\Sigma(W_i)^2$ and $(\Sigma W_i)^2$ become so large that they overflow. To avoid this problem ΔW_i is substituted for W_i. ΔW_i is the difference between W_i and W_{BASE}.

The single sided T-Distribution with 2 degrees of freedom is approximated by the following formula from NBS Handbook 91:

$$T.E. = 1.646698 + \frac{1.455393}{(N-2)} + \frac{1.975971}{(N-2)^2}$$

The upper confidence limit (UCL) is given by

$$UCL = L_S + \frac{\sigma * (TE) * 2400}{B} \quad \text{(weight \%/DAY)} \qquad (10)$$

APPENDIX D

ERROR ANALYSIS PROCEDURE

The procedure for computing the system accuracy uncertainty and the system repeatability uncertainty is given by Quad-Cities procedure QTS 150-T1, Revision 5. A summary of that procedure is presented here.

A. INSTRUMENT ACCURACY ERROR ANALYSIS

Per ANSI N45.4-1972, the computation of the leak rate is given by the equation:

$$L(\%) = \left(\frac{24}{H}\right)(100)\left(\frac{W1 - W2}{W1}\right) = \frac{2400}{H}\left(1 - \frac{T1P2}{T2P1}\right)$$

where
- L = primary containment leak rate (%/day)
- H = time interval between data sets #1 & #2 (hours)
- W1 = weight of the contained dry air mass at test data set #1 (lbs)
- W2 = weight of the contained dry air mass at test data set #2 (lbs)
- T1 = volume weighted primary containment temperature at test data set #1 (°R)
- T2 = volume weighted primary containment temperature at test data set #2 (°R)
- P1 = dry air absolute pressure at test data set #1 (PSIA)
- P2 = dry air absolute pressure at test data set #2 (PSIA)

The standard variation on L due to the uncertainties in the measured variables is given by:

$$\delta(L) = \frac{2400}{H}\left[\left(\frac{\partial L}{\partial P1}\,\delta(P1)\right)^2 + \left(\frac{\partial L}{\partial P2}\,\delta(P2)\right)^2 + \left(\frac{\partial L}{\partial T1}\,\delta(T1)\right)^2 + \left(\frac{\partial L}{\partial T2}\,\delta(T2)\right)^2\right]^{1/2}$$

substituting

$$H = 24 \text{ hours}$$

$$\frac{\partial L}{\partial P1} = \frac{T1\ P2}{T2\ P1^2} \approx \frac{1}{P1}$$

$$\frac{\partial L}{\partial P2} = -\frac{T1}{T2\ P1} \approx -\frac{1}{P1}$$

$$\frac{\partial L}{\partial T1} = -\frac{P2}{T2\ P1} \approx -\frac{1}{T2}$$

$$\frac{\partial L}{\partial T2} = \frac{T1\ P2}{T2^2 P1} \approx \frac{1}{T2}$$

assuming $P1 \approx P2 \approx \bar{P}$ and $T1 \approx T2 \approx \bar{T}$

where $\bar{P}$ = average absolute dry air pressure

$\bar{T}$ = average volume weighted primary containment absolute temperature

Therefore,

$$\delta(L) = 100 \left[2\left(\frac{\delta(\bar{P})}{\bar{P}} \right)^2 + 2\left(\frac{\delta(\bar{T})}{\bar{T}} \right)^2 \right]^{1/2}$$

1. Calculation of $\delta(\bar{T})$

$$\bar{T} = \sum_{j=1}^{11} (VFj)\,(Tave,j)$$

where VFj = the volume weighting factors

Tave,j = the average absolute temperature in the jth subvolume

$$Tave,j = \sum_{i=1}^{Nj} \frac{Ti,j}{Nj}$$

where Ti,j = the absolute temperature of the ith RTD in the jth subvolume

Nj = the number of RTD's in the jth subvolume

Now, $\delta(\bar{T})$ is calculated from

$$\delta(\bar{T}) = \sum_{J=1}^{11} \frac{\delta\bar{T}}{\delta Tave,j}\ \delta(Tave,j)$$

where $\frac{\delta\bar{T}}{\delta Tave,j} = VFj$

$$\delta(Tave,j) = \frac{\text{RTD accuracy}}{(Nj)^{1/2}}$$

Therefore,

$$\delta(\bar{T}) = \sum_{j=1}^{11} (VFj)\ \frac{(\text{RTD accuracy})}{(Nj)^{1/2}}$$

2. Calculation of $\delta(\bar{P})$

$$\delta(P) = [\delta(P_T)^2 + \delta(P_V)^2]^{1/2}$$

where P_T = total absolute primary containment pressure

P_V = partial pressure of water vapor in the primary containment

substituting $\delta(P_T) = \frac{\text{PPG accuracy}}{(\#\text{ of PPG's})^{1/2}}$

$$\delta(P_V) = \sum_{j=1}^{11} (VFj) \frac{(\text{dewcell accuracy})}{(N_j)^{1/2}}$$

where PPG = precision pressure gauge

Nj = number of dewcells in the jth subvolume

Therefore,

$$\delta(\bar{P}) = \left[\left(\frac{\text{PPG accuracy}}{(\#\text{ of PPG's})^{1/2}} \right)^2 + \left(\sum_{J=1}^{11} (VFj) \left(\frac{\text{dewcell accuracy}}{(N_j)^{1/2}} \right)^2 \right] \right]^{1/2}$$

3. Instrument Specifications

(SEE TABLE ONE)

4. Calculation of $\delta(L)$, Accuracy Analysis

Following are the designated volume fractions and sensor allocations:

Subvolume	Volume Fraction	No. of RTD's
1	0.03486	2
2	0.03174	2
3	0.03634	2
4	0.01251	2
5	0.07979	3
6	0.10670	4
7	0.09134	3
8	0.08624	3
9	0.03083	1
10	0.46689	6
11	0.02276	1 T.C.

Subvolumes	Volume Fraction	No. of Dewcells
1	0.03486	1
2,3,4	0.08059	1
5	0.07979	1
6,7	0.19804	2
8,9	0.11707	2
10	0.46689	2
11	0.02276	Sat.

Assume the following values:

$\bar{P}$ = 63.0 PSIA

$\bar{T}$ = 85°F = 544.7°R

Dewpoint = 65°F

Therefore,

$$\delta(\bar{T}) = \left(0.03486 \times \frac{0.50}{(2)^{1/2}}\right) + \left(0.03174 \times \frac{0.50}{(2)^{1/2}}\right) + \left(0.03634 \times \frac{0.50}{(2)^{1/2}}\right)$$

$$+ \left(0.01251 \times \frac{0.50}{(2)^{1/2}}\right) + \left(0.07979 \times \frac{0.50}{(3)^{1/2}}\right) + \left(0.10670 \times \frac{0.50}{(4)^{1/2}}\right)$$

$$+ \left(0.09134 \times \frac{0.50}{(3)^{1/2}}\right) + \left(0.08624 \times \frac{0.50}{(3)^{1/2}}\right) + \left(0.03083 \times \frac{0.50}{(1)^{1/2}}\right)$$

$$+ \left(0.46689 \times \frac{0.50}{(6)^{1/2}}\right) + \left(0.02276 \times \frac{2.0}{(1)^{1/2}}\right)$$

$\delta(\bar{T})$ = 0.2980°R

$$\delta(P_T) = \frac{0.015}{(2)^{1/2}} = 0.01061 \text{ PSIA}$$

For the subvolumes, other than the air space in the reactor, an accuracy of the dewcells of ± 1°F at an average dewpoint of 65°F corresponds to ± .011 PSI in vapor pressure. For subvolume #11 at an average temperature of 140°F, an accuracy of ± 2°F corresponds to ±.150 PSI.

$$\delta(P_V) = \left(0.03486 \times \frac{0.011}{(1)^{1/2}}\right) + \left(0.08059 \times \frac{0.011}{(1)^{1/2}}\right) + \left(0.07979 \times \frac{0.011}{(1)^{1/2}}\right)$$

$$+ \left(0.19804 \times \frac{0.011}{(2)^{1/2}}\right) + \left(0.11707 \times \frac{0.011}{(2)^{1/2}}\right) + \left(0.46689 \times \frac{0.011}{(2)^{1/2}}\right)$$

$$+ \left(0.02276 \times \frac{0.150}{(1)^{1/2}}\right)$$

$$= .00038 + .00089 + .00088 + .00154 + .00091 + .00363 + .00341$$

$\delta(P_V)$ = 0.01164 PSI

Therefore,

$$\delta(\bar{P}) = [(0.01061)^2 + (0.01164)^2]^{1/2}$$

$$= 0.01575 \text{ PSI}$$

The accuracy uncertainty for a 24 hour test is then found to be

$$\delta(L)_a = 100\left[2\left(\frac{.01575}{63.0}\right)^2 + 2\left(\frac{.2980}{544.7}\right)^2\right]^{1/2}$$

$$= 0.0851 \text{ weight \%/day}$$

5. Calculation of $\delta(L)$, Repeatability Analysis

Using the formulas developed previously, the repeatability error analysis is performed by substituting the instrument repeatability errors for the instrument accuracy errors.

$$\delta(\bar{T}) = \left(0.03486 \times \frac{0.10}{(2)^{1/2}}\right) + \left(0.03174 \times \frac{0.10}{(2)^{1/2}}\right) + \left(0.03634 \times \frac{0.10}{(2)^{1/2}}\right)$$

$$+ \left(0.01251 \times \frac{0.10}{(2)^{1/2}}\right) + \left(0.07979 \times \frac{0.10}{(3)^{1/2}}\right) + \left(0.10670 \times \frac{0.10}{(4)^{1/2}}\right)$$

$$+ \left(0.09134 \times \frac{0.10}{(3)^{1/2}}\right) + \left(0.08624 \times \frac{0.10}{(3)^{1/2}}\right) + \left(0.03083 \times \frac{0.10}{(1)^{1/2}}\right)$$

$$+ \left(0.46689 \times \frac{0.10}{(6)^{1/2}}\right) + \left(0.02276 \times \frac{0.10}{(1)^{1/2}}\right)$$

$$\delta(\bar{T}) = 0.0528°R$$

$$\delta(P_T) = \frac{0.001}{(2)^{1/2}} = 0.00071 \text{ PSIA}$$

For the subvolumes, other than the air space in the reactor, a repeatability uncertainty of the dewcells of 0.5°F at an average dewpoint of 65°F corresponds to ± .006 PSI in vapor pressure. For subvolume #11 at an average temperature of 140°F, a repeatability uncertainty of ± 0.1°F corresponds to ±.008 PSI in vapor pressure.

$$\delta(P_V) = \left(0.03486 \times \frac{0.006}{(1)^{1/2}}\right) + \left(0.08059 \times \frac{0.006}{(1)^{1/2}}\right) + \left(0.07979 \times \frac{0.006}{(1)^{1/2}}\right)$$

$$+ \left(0.19804 \times \frac{0.006}{(2)^{1/2}}\right) + \left(0.11707 \times \frac{0.006}{(2)^{1/2}}\right) + \left(0.46689 \times \frac{0.006}{(2)^{1/2}}\right)$$

$$+ \left(0.02276 \times \frac{.008}{(1)^{1/2}}\right)$$

$$= .00021 + .00048 + .00048 + .00084 + .00050 + .00198 + .00018$$

$$\delta(P_V) = 0.00467 \text{ PSI}$$

Therefore,

$$\delta(\bar{P}) = [(0.00071)^2 + (0.00467)^2]^{1/2}$$

$$= 0.00473 \text{ PSI}$$

The repeatability uncertainty for a 24 hour test is then found to be

$$\delta(L)_r = 100 \left[2\left(\frac{0.00473}{63.0}\right)^2 + 2\left(\frac{0.0528}{544.7}\right)^2\right]^{1/2}$$

$$= 0.0173 \text{ weight \%/day}$$

6. Total Instrument Uncertainty

$$\alpha(L) \text{ Total} = [(\delta(L)_a)^2 + (\delta(L)_r)^2]^{1/2}$$

$$= [(0.0851)^2 + (0.0173)^2]^{1/2}$$

$$= 0.0868 \text{ weight \%/day}$$

$$2\alpha(L) \text{ Total} = 0.1737 \text{ weight \%/day}$$

APPENDIX E

BN-TOP-1, REV. 1 RESULTS

BN-TOP-1, REV. 1 SUMMARY

(24 HOUR TEST)

#	TIME	TEMP	PRESSURE	LEAK RATE	CALC LEAK RATE	95% CONFIDENCE	
30	15.45	96.48	63.[illegible]	0.00000+00	0.00000+00	0.0000+00	0.0000+00
31	15.62	96.43	63.[illegible]	0.42500+00	0.00000+00	0.0000+00	0.0000+00
32	15.78	96.35	63.837	0.38260+00	0.00000+00	0.0000+00	0.0000+00
33	15.95	96.30	63.882	0.40140+00	0.44450+00	-.1510+02	0.1600+02
34	16.12	96.27	63.877	0.44010+00	0.43790+00	-.3240+01	0.4120+01
35	16.28	96.25	63.873	0.37190+00	0.39450+00	-.1370+01	0.2160+01
36	16.43	96.23	63.868	0.37710+00	0.37540+00	-.6390+00	0.1390+01
37	16.62	96.20	63.864	0.36870+00	0.36140+00	-.3040+00	0.1030+01
38	16.78	96.68	63.860	0.34800+00	0.34470+00	-.1250+00	0.8150+00
39	16.95	96.67	63.855	0.37310+00	0.34400+00	-.2550-01	0.7130+00
40	17.12	96.65	63.850	0.37940+00	0.36620+00	0.4190-01	0.6500+00
41	17.29	96.62	63.846	0.35270+00	0.35970+00	0.9320-01	0.5860+00
42	17.46	96.61	63.843	0.34840+00	0.33400+00	0.1290+00	0.5370+00
43	17.62	96.59	63.838	0.35990+00	0.33320+00	0.1550+00	0.5120+00
44	17.79	96.58	63.835	0.35470+00	0.33160+00	0.1750+00	0.4890+00
45	17.96	96.56	63.830	0.36940+00	0.33400+00	0.1900+00	0.4780+00
46	18.12	96.54	63.827	0.35120+00	0.33200+00	0.2030+00	0.4610+00
47	18.29	96.53	63.823	0.35440+00	0.33130+00	0.2130+00	0.4500+00
48	18.46	96.51	63.818	0.36090+00	0.33220+00	0.2220+00	0.4430+00
49	18.62	96.50	63.814	0.37190+00	0.33520+00	0.2290+00	0.4410+00
50	18.79	96.47	63.806	0.37260+00	0.33480+00	0.2330+00	0.4360+00
51	19.12	96.46	63.804	0.36200+00	0.33600+00	0.2400+00	0.4330+00
52	19.29	96.44	63.800	0.36250+00	0.33800+00	0.2460+00	0.4300+00
53	19.46	96.43	63.797	0.35660+00	0.33820+00	0.2500+00	0.4260+00
54	19.63	96.42	63.793	0.36240+00	0.33950+00	0.2550+00	0.4240+00
55	19.79	96.40	63.789	0.36170+00	0.34010+00	0.2580+00	0.4220+00
56	19.96	96.39	63.784	0.37310+00	0.34250+00	0.2620+00	0.4230+00
57	20.13	96.36	63.780	0.36080+00	0.34280+00	0.2650+00	0.4210+00
58	20.29	96.35	63.776	0.36390+00	0.34360+00	0.2680+00	0.4200+00
59	20.46	96.33	63.771	0.37220+00	0.34530+00	0.2710+00	0.4200+00
60	20.63	96.31	63.767	0.37100+00	0.34680+00	0.2730+00	0.4200+00
61	20.79	96.29	63.763	0.36790+00	0.34770+00	0.2760+00	0.4200+00
62	20.96	96.28	63.759	0.37840+00	0.34970+00	0.2780+00	0.4210+00
63	21.13	96.29	63.756	0.39040+00	0.35300+00	0.2820+00	0.4240+00
64	21.29	96.28	63.753	0.39290+00	0.35620+00	0.2850+00	0.4280+00
65	21.46	96.28	63.750	0.39690+00	0.35950+00	0.2880+00	0.4310+00
66	21.63	96.27	63.748	0.39360+00	0.36220+00	0.2910+00	0.4330+00
67	21.80	96.28	63.745	0.40470+00	0.36580+00	0.2950+00	0.4370+00
68	21.96	96.28	63.741	0.41380+00	0.36990+00	0.2980+00	0.4420+00
69	22.13	96.28	63.739	0.41130+00	0.37350+00	0.3020+00	0.4450+00
70	22.30	96.27	63.737	0.40990+00	0.37660+00	0.3050+00	0.4480+00
71	22.46	96.27	63.735	0.40950+00	0.37950+00	0.3080+00	0.4510+00
72	22.63	96.27	63.730	0.42060+00	0.38310+00	0.3120+00	0.4550+00
73	22.80	96.26	63.728	0.41480+00	0.38570+00	0.3150+00	0.4570+00
74	22.96	96.27	63.725	0.42260+00	0.38920+00	0.3180+00	0.4600+00
75	23.13	96.26	63.723	0.41840+00	0.39190+00	0.3210+00	0.4620+00
76	23.30	96.26	63.721	0.41720+00	0.39430+00	0.3240+00	0.4640+00
77	23.46	96.26	63.717	0.42560+00	0.39720+00	0.3270+00	0.4670+00
78	23.63	96.26	63.715	0.42700+00	0.40000+00	0.3310+00	0.4690+00
79	23.80	96.25	63.711	0.42990+00	0.40280+00	0.3340+00	0.4720+00
80	23.96	96.25	63.709	0.42870+00	0.40510+00	0.3370+00	0.4740+00
81	24.13	96.25	63.706	0.42940+00	0.40770+00	0.3400+00	0.4760+00
82	24.30	96.25	63.704	0.43220+00	0.41030+00	0.3420+00	0.4780+00
83	24.47	96.26	63.701	0.43470+00	0.41260+00	0.3450+00	0.4800+00
84	24.63	96.25	63.698	0.43610+00	0.41510+00	0.3480+00	0.4820+00
85	24.80	96.25	63.695	0.43500+00	0.41720+00	0.3510+00	0.4840+00
86	24.97	96.24	63.693	0.43100+00	0.41900+00	0.3530+00	0.4850+00
87	25.13	96.23	63.690	0.42680+00	0.42030+00	0.3550+00	0.4860+00

BN-TOP-1, REV. 1 SUMMARY

(CONT'D)

#	TIME	TEMP	PRESSURE	LEAK RATE	CALC LEAK RATE	95% CONFIDENCE	
89	25.48	96.21	63.686	0.42300+00	0.42180+00	0.3570+00	0.4860+00
90	25.64	96.17	63.683	0.41700+00	0.42200+00	0.3580+00	0.4860+00
91	25.81	96.15	63.678	0.41410+00	0.42240+00	0.3590+00	0.4860+00
92	25.97	96.14	63.675	0.40410+00	0.42230+00	0.3590+00	0.4850+00
93	26.14	96.12	63.670	0.40920+00	0.42230+00	0.3600+00	0.4850+00
94	26.31	96.11	63.666	0.40870+00	0.42230+00	0.3600+00	0.4840+00
99	26.47	96.08	63.662	0.40380+00	0.42190+00	0.3600+00	0.4840+00
96	26.64	96.06	63.657	0.40280+00	0.42160+00	0.3600+00	0.4830+00
97	26.81	96.04	63.653	0.40040+00	0.42110+00	0.3600+00	0.4820+00
98	26.97	96.02	63.649	0.39770+00	0.42040+00	0.3590+00	0.4810+00
99	27.14	96.00	63.644	0.39820+00	0.41990+00	0.3590+00	0.4810+00
100	27.31	95.96	63.638	0.39560+00	0.41920+00	0.3590+00	0.4800+00
101	27.47	95.95	63.635	0.39320+00	0.41840+00	0.3580+00	0.4790+00
102	27.64	95.94	63.630	0.39800+00	0.41780+00	0.3580+00	0.4780+00
103	27.81	95.91	63.625	0.39610+00	0.41730+00	0.3570+00	0.4770+00
104	27.98	95.90	63.621	0.39760+00	0.41680+00	0.3570+00	0.4760+00
105	28.14	95.87	63.617	0.39280+00	0.41600+00	0.3560+00	0.4760+00
106	28.31	95.85	63.612	0.39330+00	0.41540+00	0.3560+00	0.4750+00
107	28.48	95.84	63.608	0.39620+00	0.41490+00	0.3560+00	0.4740+00
108	28.64	95.82	63.603	0.39780+00	0.41450+00	0.3560+00	0.4730+00
109	28.81	95.81	63.599	0.39710+00	0.41410+00	0.3560+00	0.4730+00
110	28.98	95.79	63.595	0.39470+00	0.41360+00	0.3550+00	0.4720+00
111	29.14	95.78	63.591	0.39550+00	0.41310+00	0.3550+00	0.4710+00
112	29.31	95.76	63.587	0.39320+00	0.41260+00	0.3550+00	0.4700+00
113	29.48	95.74	63.583	0.39310+00	0.41200+00	0.3540+00	0.4700+00
114	29.64	95.73	63.579	0.39580+00	0.41160+00	0.3540+00	0.4690+00
115	29.81	95.71	63.574	0.39710+00	0.41130+00	0.3540+00	0.4680+00
116	29.98	95.70	63.572	0.39550+00	0.41090+00	0.3540+00	0.4680+00
117	30.15	95.69	63.568	0.39410+00	0.41040+00	0.3540+00	0.4670+00
118	30.31	95.68	63.564	0.39630+00	0.41010+00	0.3540+00	0.4670+00
119	30.48	95.67	63.560	0.39860+00	0.40990+00	0.3540+00	0.4660+00
120	30.65	95.66	63.557	0.39920+00	0.40970+00	0.3540+00	0.4660+00
121	30.81	95.65	63.554	0.39880+00	0.40960+00	0.3540+00	0.4650+00
122	30.98	95.65	63.550	0.40180+00	0.40950+00	0.3540+00	0.4650+00
123	31.15	95.64	63.547	0.40120+00	0.40940+00	0.3540+00	0.4640+00
124	31.31	95.64	63.543	0.40090+00	0.40940+00	0.3550+00	0.4640+00
125	31.48	95.64	63.540	0.40510+00	0.40940+00	0.3550+00	0.4640+00
126	31.65	95.64	63.539	0.40420+00	0.40940+00	0.3550+00	0.4640+00
127	31.81	95.62	63.534	0.40320+00	0.40940+00	0.3560+00	0.4630+00
128	31.98	95.61	63.531	0.40200+00	0.40940+00	0.3560+00	0.4630+00
129	32.15	95.61	63.528	0.40290+00	0.40940+00	0.3560+00	0.4630+00
130	32.32	95.61	63.525	0.40600+00	0.40950+00	0.3560+00	0.4630+00
131	32.48	95.60	63.522	0.40770+00	0.40970+00	0.3570+00	0.4620+00
132	32.65	95.59	63.519	0.40600+00	0.40990+00	0.3570+00	0.4620+00
133	32.82	95.59	63.516	0.40620+00	0.40990+00	0.3580+00	0.4620+00
134	32.98	95.58	63.513	0.40690+00	0.41000+00	0.3580+00	0.4620+00
135	33.15	95.57	63.510	0.40610+00	0.41010+00	0.3580+00	0.4620+00
136	33.32	95.56	63.506	0.40770+00	0.41030+00	0.3590+00	0.4620+00
137	33.48	95.56	63.503	0.40750+00	0.41040+00	0.3590+00	0.4620+00
138	33.65	95.55	63.500	0.40870+00	0.41060+00	0.3600+00	0.4620+00
139	33.82	95.54	63.497	0.40820+00	0.41070+00	0.3600+00	0.4610+00
140	33.98	95.53	63.493	0.40960+00	0.41090+00	0.3600+00	0.4610+00
141	34.15	95.52	63.490	0.40580+00	0.41090+00	0.3610+00	0.4610+00
142	34.32	95.51	63.486	0.40830+00	0.41110+00	0.3610+00	0.4610+00
143	34.48	95.50	63.484	0.40600+00	0.41110+00	0.3610+00	0.4610+00
144	34.65	95.49	63.480	0.40780+00	0.41130+00	0.3620+00	0.4610+00
145	34.82	95.48	63.476	0.40870+00	0.41140+00	0.3620+00	0.4610+00
			63.473	0.40630+00	0.41140+00	0.3620+00	0.4610+00

#	TIME	TEMP	PRESSURE	LEAK RATE	CALC LEAK RATE	95% CONFIDENCE	
146	34.99	95.47	63.463	0.40880+00	0.41160+00	0.3630+00	0.4600+00
147	35.16	95.46	63.467	0.40630+00	0.41160+00	0.3630+00	0.4600+00
148	35.32	95.45	63.463	0.40630+00	0.41170+00	0.3630+00	0.4600+00
149	35.49	95.44	63.460	0.40600+00	0.41170+00	0.3630+00	0.4600+00
150	35.66	95.43	63.436	0.40610+00	0.41170+00	0.3640+00	0.4600+00
151	35.82	95.42	63.453	0.40570+00	0.41170+00	0.3640+00	0.4600+00
152	35.99	95.41	63.450	0.40480+00	0.41180+00	0.3640+00	0.4600+00
153	36.16	95.40	63.446	0.40690+00	0.41180+00	0.3640+00	0.4590+00
154	36.32	95.40	63.443	0.40680+00	0.41190+00	0.3650+00	0.4590+00
155	36.49	95.38	63.440	0.40590+00	0.41190+00	0.3650+00	0.4590+00
156	36.66	95.36	63.436	0.40490+00	0.41190+00	0.3650+00	0.4590+00
157	36.82	95.36	63.432	0.40670+00	0.41190+00	0.3650+00	0.4590+00
158	36.99	95.34	63.429	0.40500+00	0.41190+00	0.3650+00	0.4590+00
159	37.16	95.33	63.425	0.40430+00	0.41190+00	0.3650+00	0.4580+00
160	37.32	95.32	63.420	0.40720+00	0.41190+00	0.3660+00	0.4580+00
161	37.49	95.31	63.418	0.40410+00	0.41190+00	0.3660+00	0.4580+00
162	37.66	95.31	63.415	0.40650+00	0.41190+00	0.3660+00	0.4580+00
163	37.83	95.30	63.412	0.40610+00	0.41190+00	0.3660+00	0.4580+00
164	37.99	95.29	63.408	0.40580+00	0.41190+00	0.3660+00	0.4580+00
165	38.16	95.28	63.404	0.40650+00	0.41200+00	0.3670+00	0.4570+00
166	38.33	95.27	63.402	0.40400+00	0.41190+00	0.3670+00	0.4570+00
167	38.49	95.25	63.398	0.40490+00	0.41190+00	0.3670+00	0.4570+00
168	38.66	95.25	63.395	0.40560+00	0.41190+00	0.3670+00	0.4570+00
169	38.83	95.23	63.392	0.40450+00	0.41180+00	0.3670+00	0.4570+00
170	39.00	95.22	63.389	0.40210+00	0.41170+00	0.3670+00	0.4560+00
171	39.16	95.21	63.386	0.40080+00	0.41160+00	0.3670+00	0.4560+00
172	39.33	95.20	63.383	0.40230+00	0.41150+00	0.3670+00	0.4560+00
173	39.50	95.20	63.379	0.40230+00	0.41140+00	0.3670+00	0.4560+00

MEAN LEAK RATE OF LAST 20 POINTS:0.40480+00

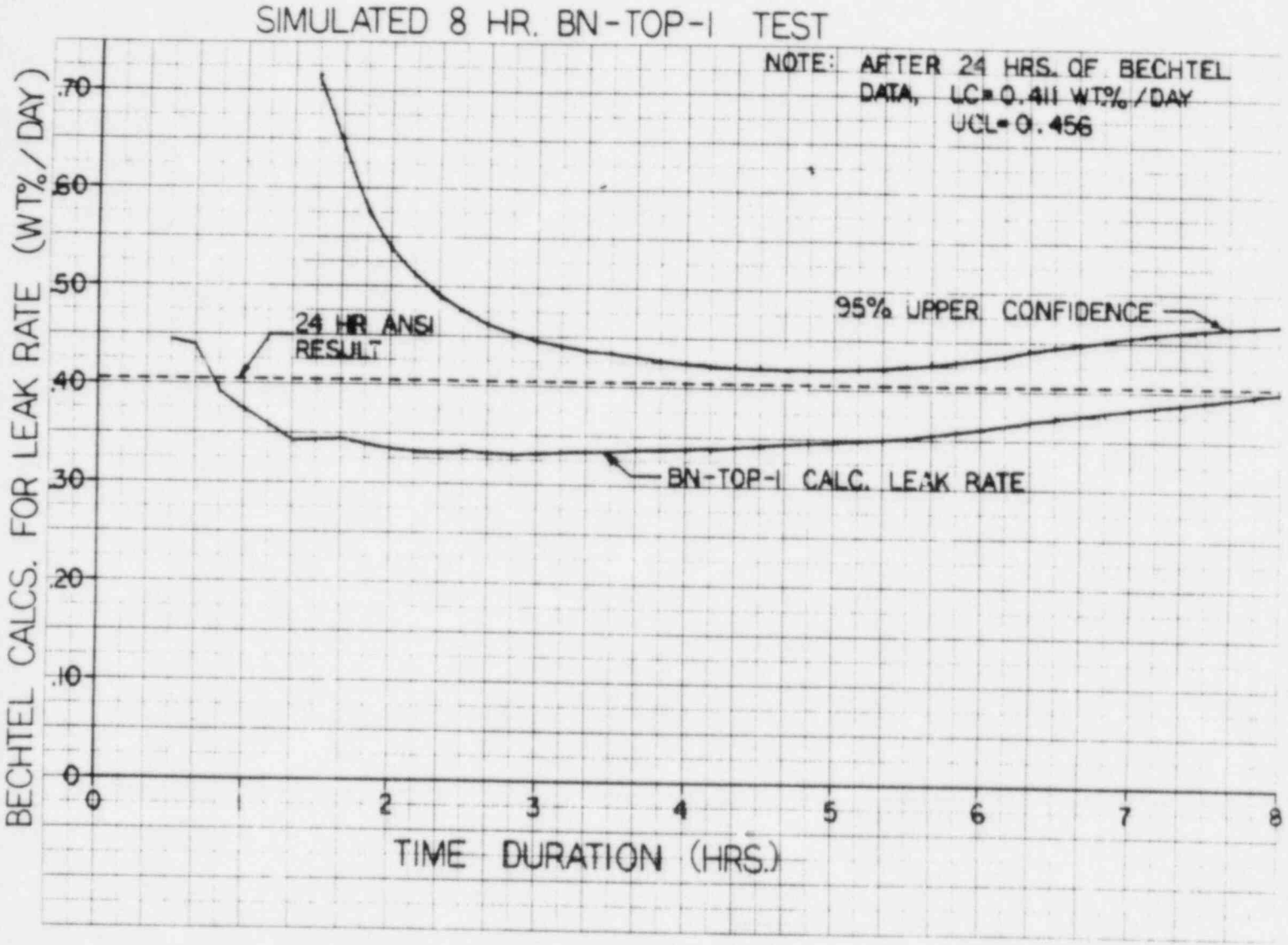
BN-TOP-1, REV. 1 SUMMARY

(INDUCED TEST)

#	TIME	TEMP	PRESSURE	LEAK RATE	CALC LEAK RATE	95% CONFIDENCE	
187	41.83	95.04	63.299	0.0000D+00	0.0000D+00	0.000D+00	0.000D+00
188	42.00	95.03	63.291	0.1363D+01	0.0000D+00	0.000D+00	0.000D+00
189	42.17	95.02	63.284	0.1325D+01	0.0000D+00	0.000D+00	0.000D+00
190	42.33	95.02	63.277	0.1298D+01	0.1296D+01	-.314D+01	0.573D+01
191	42.50	95.01	63.270	0.1298D+01	0.1287D+01	-.318D+01	0.575D+01
192	42.67	95.00	63.263	0.1316D+01	0.1295D+01	-.261D+01	0.521D+01
193	42.84	94.99	63.255	0.1297D+01	0.1290D+01	-.105D+01	0.363D+01
194	43.00	94.98	63.249	0.1279D+01	0.1280D+01	-.261D+00	0.282D+01
195	43.17	94.98	63.241	0.1310D+01	0.1286D+01	-.122D+00	0.269D+01
196	43.34	94.97	63.233	0.1325D+01	0.1296D+01	0.190D-03	0.259D+01
197	43.50	94.95	63.227	0.1278D+01	0.1287D+01	0.261D+00	0.231D+01
198	43.67	94.96	63.221	0.1303D+01	0.1289D+01	0.440D+00	0.214D+01
199	43.84	94.94	63.214	0.1287D+01	0.1286D+01	0.591D+00	0.198D+01
200	44.01	94.94	63.208	0.1256D+01	0.1275D+01	0.661D+00	0.189D+01
201	44.17	94.92	63.202	0.1239D+01	0.1262D+01	0.705D+00	0.182D+01
202	44.34	94.92	63.195	0.1238D+01	0.1252D+01	0.763D+00	0.174D+01
203	44.51	94.91	63.189	0.1231D+01	0.1243D+01	0.812D+00	0.167D+01
204	44.67	94.91	63.182	0.1235D+01	0.1236D+01	0.859D+00	0.161D+01
205	44.84	94.89	63.176	0.1224D+01	0.1228D+01	0.895D+00	0.156D+01
206	45.01	94.89	63.169	0.1228D+01	0.1223D+01	0.926D+00	0.152D+01
207	45.17	94.89	63.162	0.1232D+01	0.1220D+01	0.950D+00	0.149D+01
208	45.34	94.88	63.155	0.1233D+01	0.1217D+01	0.968D+00	0.147D+01
209	45.51	94.86	63.150	0.1215D+01	0.1212D+01	0.986D+00	0.144D+01
210	45.67	94.86	63.143	0.1218D+01	0.1208D+01	0.100D+01	0.142D+01
211	45.84	94.86	63.135	0.1234D+01	0.1207D+01	0.101D+01	0.141D+01

MEAN LEAK RATE OF LAST 20 POINTS:0.1259D+01

GRAPHIC SUMMARY OF A SIMULATED 8 HOUR TEST



GRAPHIC SUMMARY OF INDUCED TEST