ID/TS-4C,4D

REACTOR CONTAINMENT BUILDING
INTEGRATED LEAK RATE TEST

QUAD-CITIES NUCLEAR POWER STATION

UNIT TWO

FEBRUARY 9-10, 1984

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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 February 9-10, 1984 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 10 hours or less. The Commission presently requires adjustments to the IPCLRT result for Type B and C repairs performed during the refuel outage prior to the test. In order to both demonstrate a containment leakage below the allowable limit and satisfy the "as found" criteria that the adjusted Type A test result be less than 75% of L_a, it was necessary to perform a 24 hour test. Failure to satisfy the latter criteria would have made it necessary to perform IPCLRT's on consecutive refuel outages. Without regulatory relief (e.g. a higher "as found" corrected limit than for the IPCLRT), short duration testing has very little advantage to Quad-Cities, except in the circumstance where the test will be interpretted as an "as found" failure regardless of the test technique. Fortunately, this was not the case for this test. The BN-TOP-1 data is not included in this report because it was not used for concluding the IPCLRT.

SECTION A - TEST PREPARATIONS

A.1 Type A Test Procedure

The IPCLRT was performed in accordance with Quad-Cities Procedure QTS 150-1, Rev. 10, including checklists QTS 150-S1, S2, S3, S4, S7, S8, S9, S10, S11, S12 S18, and subsections T1, T2, T3, and T8. Approved Temporary Procedure 2035 was written for the operation of the IPCLRT air compressor and the method for pressurizing the containment volume. Approved Temporary Procedure 2036 was written to update QTS 150-S7 (Unit Two valve line-up) for recent modifications to containment attached piping.

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 due to a pending change to 10 CFR 50, Appendix J.

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	±.015PSI	±.001 PSI
RTD's (30)	Burns Engineering	SP1A1-5½-3A	50-200°F	±.5°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	83	0-8.44 scfm	±.084 scfm	
Level Indicator LI 1-263-100A	Yarway	SCR/M	-60-+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 Drywall and Torus
Used to Calculate Free Volumes

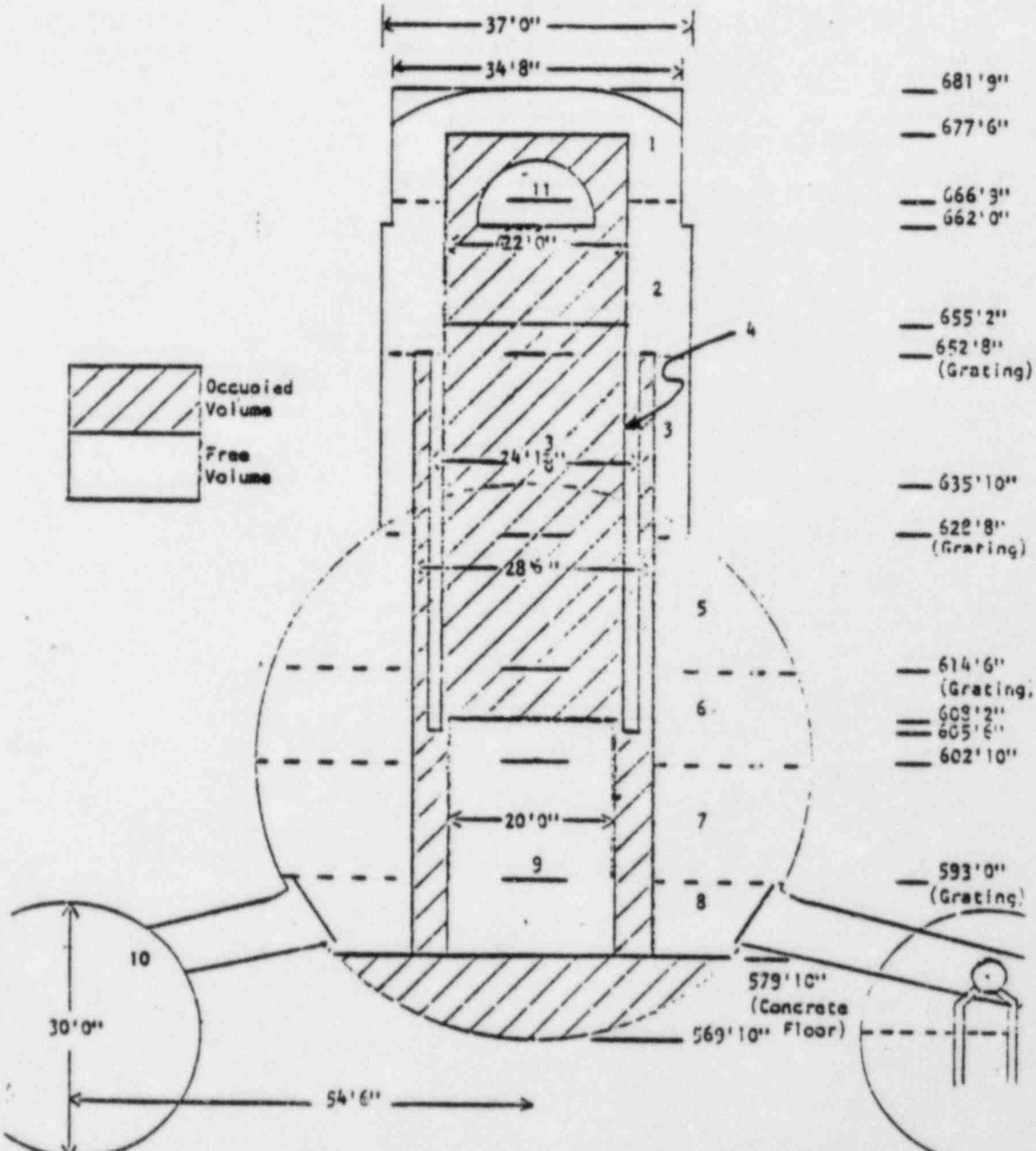


FIGURE 1

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 1A1-5½-3A. 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 07731. The standard was calibrated by Volumetrics on July 27, 1983 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 scanned the output of each RTD-bridge network and converted the output to engineering units using the calibration constants.

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 0-100 PSIA in 5 PSI increments using a third precision pressure gauge (Volumetrics Model 07726) that had been sent to Volumetrics for calibration. The pressure standard was calibrated on July 26, 1983 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 calibrated on August 3, 1983 by Volumetrics.

The calibration constants (the slope and intercept of a regression line) for each dewcell were computed relating the 0-150 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 8311A9265R0001, was used for the flow measurement during the induced leakage phase of the IPCLRT. The flowmeter was calibrated on December 7, 1983 by Fischer-Porter to within ±1% of full scale (.8-8.44 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 6.30 SCFM by adjusting a 3/8" needle valve on the flowmeter inlet.

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, calculate, and print results with minimal manual inputs and without the disadvantages of multiplexers or positioning sensitive electronic hardware inside the containment during the test.

The process computer was used to compute the statistically averaged leak rate and upper confidence limit for the ANS/ANSI mass plot method. Data sets giving instrument outputs were transferred to a Prime 750 computer. The Prime 750 was used to perform the BN-TOP-1 calculations. 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 temperature and partial pressure of water vapor for each subvolume, reactor water temperature and level, absolute pressure, etc. in real time. In all cases data was plotted within approximately 30 minutes of the time it was taken. The plotting of data and the computer printed summaries of data allowed rapid identificatin of any problems as they might develop. Figure 2 shows a schematic of the data acquisition system.

With the exception of a few brief problems with the process computer, all of the equipment performed perfectly. No instruments inside the containment failed during the test.

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.

MEAUSREMENT SYSTEM SCHEMATIC ARRANGEMENT

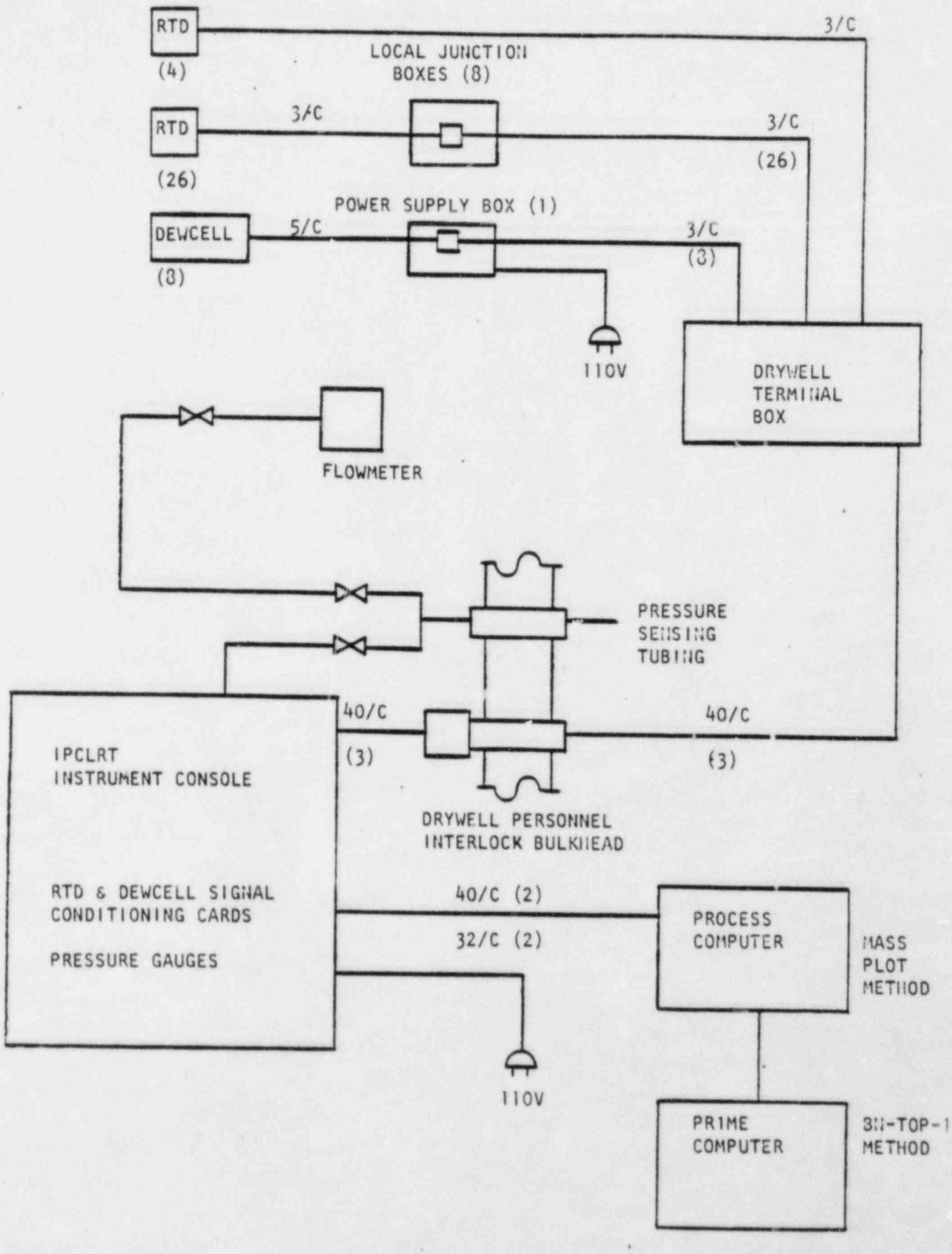


FIGURE 2

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.

There has been some criticism of this technique on a technical basis (Gogol and Reytblatt) in that the use of a volume weighted temperature in a total containment dry air mass calculation is not mathematically equivalent to computing a dry air mass for each subvolume and totalling the results to obtain a containment dry air mass. While the criticism has some merit in terms of mathmetical exactness, both methods are in fact approximations. When using the volume weighted temperature the assumption is that the dry air mass within the containment can be approximated by an ideal gas that is at thermal equilibrium at the volume weighted temperature. When computing and then totalling the dry air masses for each subvolume, the assumption is that each subvolume is in thermal equilibrium or that sensors are perfectly placed within the subvolume to measure temperature fluctuations within the subvolume. There are studies on going by EPRI and others that would seem to indicate that the two techniques do not give very different results. This certainly is what could be expected since the test gives an excellent verification of the test validity, including both the method of calculation and the subvolume modeling and weighting factors. This verification is in the form of the supplemental verification phase of the test where an induced leak must be measured along with the containment leakage to an accuracy of 25% of L_a. Since the verification phase of the test normally shows an accuracy much better than the limit, it can only be assumed that the test method has the required accuracy. Any better method of computing the containment leakage should demonstrate an improvement in the verification phase result or show that it is better able to handle troublesome temperature related test problems, such as diurnal effects at PWR's where ambient temperatures fluctuate greatly.

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 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 ± 25% of L_A.

There are no references to the use of upper confidence limits to evaluate the acceptablility 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 6.30 SCFM or 0.772 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 values are inversely proportional to the test duration. Since no instruments failed during the test and the test duration was 24 hours, these values reflect the actual test instrument uncertainties.

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. The instrumentation uncertainty is always present in the data and is incorporated in the 95% upper confidence limit.

SECTION C - SEQUENCE OF EVENTS

C.1 Test Preparation Chronology

The pretest preparation phase and containment inspection was completed on February 8, 1984 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.

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) Completion of all repairs and installations in the containment.

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

C.2 Test Pressurization and Stabilization Chronology

DATE	TIME	EVENT
12-08-84	2000	Began pressurizing the Unit Two containment.
	2025	2 PSIG in drywell.
	2045	Containment piping and valves are being inspected for apparent leaks.
	2250	Compressor tripped dut to N_2 leak on auxiliary oil pump. Containment isolated.
	2300	Leak of 5 SCFH found on LT 2-1641-5B.
	2327	Compressor re-started and pressurization continuing.
02-09-84	0145	Compressor unloaded to 50%. Containment pressure 63 PSIA.
	0210	Pressurization complete at 65 PSIA.
	0355	Process computer down. Restarted 5 minutes later.
	0650	Spool piece removed and blank flange installed at the MO-2-1001-26A valve where the containment was pressurized. The volume weighted containment temperature is decreasing at a rate of .30-.40 degrees per hour.

C.3 Measured Leak Rate Phase Chronology

DATE	TIME	EVENT
02-09-84	0649	The 0649 scan by the process computer will represent the start of the test.
		Containment temperature declining .33 degrees F/hr.
		Instrumentation responding normally.
	0900	Reactor water temperature is increasing steadily and at a rate of less than .2 degrees F/hr. This will be no problem for the test.
		Reactor water level is decreasing steadily and at a rate less than .5 inch/hour. This will be no problem for the test.
	1900	Decided to continue test for a full 24 hours since the lower leak rates that can be demonstrated by continuing the test will allow passing the "as found" leakage criteria.
02-09-84	1900	Computer down.
	1920	Computer up.
	2020	Still having trouble with computer.
02-10-84	0653	The 24 hour test was terminated. Total containment pressure is 62.95 PSIA.

C.4 Induced Leakage Phase Chronology

02-10-84	0718	Induced leak .75% scale reading on flowmeter, which corresponds to 6.30 SCFM. Radiation Protection taking sample for release to Reactor Building.
	0819	Stabilization complete. Computer program set for first scan for this part of the test.
	1219	Induced leakage phase terminated successfully. Total containment pressure is 63.04 PSIA.

C.5 Depressurization Phase Chronology

DATE	TIME	EVENT
02-10-84	1300	Began de-pressurization.
02-11-84	0330	Depressurization complete. Drywell entry made to verify undisturbed instrumentation and begin post test checklists.

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 TEST RESULTS

QUAD CITIES UNIT 2 0642 02/10/84

****SUMMARY OF DATA SETS 30 THRU 170 ****

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS T=0	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	MEAS. LEAK RATE % / DAY POINT	CALC. LEAK RATE %/DAY	UPPER 95% CONF LIMIT
0.00	6:49:45	2/ 9/84	85.74	0.907305872E 05		63.568				
0.17	6:59:45	2/ 9/84	85.66	0.907296972E 05		63.558	0.1412	0.1412		
0.33	7: 9:45	2/ 9/84	85.62	0.907256663E 05	0.907311106E 05	63.549	0.3905	0.6398	0.3905	1.0888
0.50	7:19:45	2/ 9/84	85.56	0.907220374E 05	0.907314490E 05	63.540	0.4523	0.5760	0.4711	0.6950
0.67	7:29:45	2/ 9/84	85.51	0.907166745E 05	0.907320295E 05	63.530	0.5520	0.8512	0.5632	0.7270
0.83	7:39:45	2/ 9/84	85.46	0.907097568E 05	0.907328924E 05	63.519	0.6612	1.0981	0.6659	0.8254
1.00	7:49:45	2/ 9/84	85.42	0.907055435E 05	0.907332808E 05	63.510	0.6625	0.6689	0.7029	0.8180
1.17	7:59:45	2/ 9/84	85.37	0.907005051E 05	0.907335766E 05	63.500	0.6821	0.7999	0.7263	0.8132
1.33	8: 9:44	2/ 9/84	85.32	0.906973446E 05	0.907335186E 05	63.493	0.6596	0.5026	0.7224	0.7881
1.50	8:19:44	2/ 9/84	85.27	0.906941726E 05	0.907332841E 05	63.484	0.6423	0.5036	0.7084	0.7621
1.67	8:29:44	2/ 9/84	85.22	0.906900216E 05	0.907330976E 05	63.476	0.6439	0.6591	0.6986	0.7430
1.83	8:39:44	2/ 9/84	85.18	0.906874739E 05	0.907327402E 05	63.468	0.6221	0.4045	0.6816	0.7222
2.00	8:49:44	2/ 9/84	85.13	0.906827751E 05	0.907325516E 05	63.459	0.6325	0.7461	0.6734	0.7085
2.17	8:59:44	2/ 9/84	85.09	0.906785273E 05	0.907324227E 05	63.452	0.6357	0.6745	0.6683	0.6985
2.33	9: 9:44	2/ 9/84	85.06	0.906752560E 05	0.907322271E 05	63.445	0.6270	0.5161	0.6611	0.6882
2.50	9:19:44	2/ 9/84	85.02	0.906709015E 05	0.907321056E 05	63.437	0.6313	0.6915	0.6570	0.6809
2.67	9:29:44	2/ 9/84	84.98	0.906674724E 05	0.907319466E 05	63.429	0.6259	0.5446	0.6519	0.6735
2.83	9:39:44	2/ 9/84	84.94	0.906633623E 05	0.907318280E 05	63.421	0.6274	0.6528	0.6484	0.6[illegible]
3.00	9:49:44	2/ 9/84	84.91	0.906588758E 05	0.907317735E 05	63.415	0.6321	0.7126	0.6459	0.6643
3.17	9:59:44	2/ 9/84	84.87	0.906557517E 05	0.907316500E 05	63.408	0.6250	0.4962	0.6436	0.6576
3.33	10: 9:46	2/ 9/84	84.84	0.906540795E 05	0.907313588E 05	63.402	0.6071	0.2665	0.6363	0.65[illegible]
3.50	10:19:46	2/ 9/84	84.81	0.906491702E 05	0.907311996E 05	63.395	0.6153	0.7798	0.6325	0.6476
3.67	10:29:46	2/ 9/84	84.78	0.906459181E 05	0.907310166E 05	63.389	0.6108	0.5166	0.6284	0.6427
3.83	10:39:46	2/ 9/84	84.74	0.906434498E 05	0.907307597E 05	63.382	0.6012	0.3921	0.6228	0.6371
4.00	10:49:46	2/ 9/84	84.70	0.906346231E 05	0.907308974E 05	63.370	0.6346	1.4022	0.6257	0.6390
4.17	10:59:46	2/ 9/84	84.65	0.906295325E 05	0.907310689E 05	63.361	0.6415	0.8088	0.6295	0.6424
4.33	11: 9:45	2/ 9/84	84.62	0.906241937E 05	0.907313384E 05	63.351	0.6495	0.8497	0.6342	0.6470
4.50	11:19:45	2/ 9/84	84.58	0.906208687E 05	0.907315031E 05	63.346	0.6450	0.5283	0.6372	0.6495
4.67	11:29:45	2/ 9/84	84.54	0.906184827E 05	0.907315401E 05	63.339	0.6354	0.3792	0.6379	0.6493
4.83	11:39:45	2/ 9/84	84.51	0.906148718E 05	0.907315467E 05	63.333	0.6333	0.5738	0.6380	0.6486
5.00	11:49:45	2/ 9/84	84.47	0.906128947E 05	0.907314329E 05	63.327	0.6226	0.3142	0.6361	0.6462
5.17	11:59:45	2/ 9/84	84.45	0.906072037E 05	0.907314315E 05	63.320	0.6317	0.9044	0.6361	0.6456
5.33	12: 9:45	2/ 9/84	84.41	0.906074513E 05	0.907311950E 05	63.315	0.6107	-0.0393	0.6325	0.6420
5.50	12:19:45	2/ 9/84	84.38	0.906044049E 05	0.907309409E 05	63.309	0.6068	0.4642	0.6287	0.6384
5.67	12:29:45	2/ 9/84	84.36	0.906035020E 05	0.907305612E 05	63.306	0.5932	0.1435	0.6232	0.6338
5.83	12:39:45	2/ 9/84	84.33	0.906001494E 05	0.907302023E 05	63.299	0.5915	0.5328	0.6182	0.6293
6.00	12:49:45	2/ 9/84	84.30	0.905983917E 05	0.907297831E 05	63.294	0.5828	0.2794	0.6125	0.6244
6.17	12:59:45	2/ 9/84	84.28	0.905948690E 05	0.907294003E 05	63.289	0.5822	0.5599	0.6075	0.6198
6.34	13:10: 6	2/ 9/84	84.24	0.905949857E 05	0.907288696E 05	63.284	0.5658	-0.0179	0.6006	0.6141
6.50	13:19:46	2/ 9/84	84.23	0.905955401E 05	0.907282085E 05	63.283	0.5495	-0.0912	0.5924	0.6074
6.67	13:29:46	2/ 9/84	84.21	0.905943921E 05	0.907275075E 05	63.280	0.5404	0.1825	0.5839	0.6004
6.83	13:39:46	2/ 9/84	84.20	0.905908044E 05	0.907268824E 05	63.275	0.5411	0.5703	0.5764	0.5937
7.00	13:49:46	2/ 9/84	84.18	0.905886149E 05	0.907262646E 05	63.272	0.5365	0.3480	0.5692	0.5871
7.17	13:59:46	2/ 9/84	84.17	0.905853541E 05	0.907257004E 05	63.268	0.5360	0.5183	0.5628	0.5810
7.33	14: 9:44	2/ 9/84	84.15	0.905835538E 05	0.907251231E 05	63.264	0.5303	0.2824	0.5564	0.5749
7.50	14:19:44	2/ 9/84	84.14	0.905807686E 05	0.907245782E 05	63.260	0.5284	0.4475	0.5505	0.5691
7.67	14:29:44	2/ 9/84	84.12	0.905768662E 05	0.907241063E 05	63.255	0.5304	0.6204	0.5455	0.5639
7.83	14:39:44	2/ 9/84	84.11	0.905749636E 05	0.907236217E 05	63.252	0.5255	0.3025	0.5405	0.5588
8.00	14:49:44	2/ 9/84	84.10	0.905724196E 05	0.907231517E 05	63.249	0.5230	0.4045	0.5359	0.5539
8.17	14:59:44	2/ 9/84	84.08	0.905702832E 05	0.907226804E 05	63.244	0.5192	0.3397	0.5311	0.5491
8.34	15: 9:54	2/ 9/84	84.07	0.905661921E 05	0.907222792E 05	63.240	0.5217	0.6413	0.5272	0.5449
8.50	15:19:54	2/ 9/84	84.05	0.9056[illegible] 05	0.907218102E 05	63.237	0.5127	0.0678	0.5227	0.5403
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 3

9.00	15:49:54	2/ 9/84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.17	15:59:54	2/ 9/84	84.00	0.9055481465E 05	0.9072026146E 05	63.222	0.5079	0.0964	0.5087	0.5250
9.34	16: 9:54	2/ 9/84	83.98	0.9055152156E 05	0.9071983616E 05	63.219	0.5017	0.1592	0.5050	0.5212
9.50	16:19:54	2/ 9/84	83.97	0.9054882705E 05	0.9071949771E 05	63.214	0.5060	0.7456	0.5021	0.5180
9.67	16:29:54	2/ 9/84	83.95	0.9054742776E 05	0.9071912848E 05	63.210	0.5011	0.2219	0.4990	0.5146
9.84	16:39:54	2/ 9/84	83.94	0.9054477259E 05	0.9071877416E 05	63.207	0.4997	0.4226	0.4961	0.5115
10.00	16:49:54	2/ 9/84	83.93	0.9054251331E 05	0.9071842096E 05	63.203	0.4974	0.3593	0.4933	0.5084
10.17	16:59:54	2/ 9/84	83.91	0.9054023586E 05	0.9071807008E 05	63.200	0.4951	0.3622	0.4905	0.5053
10.33	17: 9:49	2/ 9/84	83.90	0.9053726892E 05	0.9071774427E 05	63.196	0.4949	0.4795	0.4879	0.5025
10.50	17:19:49	2/ 9/84	83.88	0.9053581246E 05	0.9071740376E 05	63.192	0.4914	0.2793	0.4853	0.4997
10.67	17:29:49	2/ 9/84	83.87	0.9053364971E 05	0.9071711248E 05	63.188	0.4933	0.6144	0.4831	0.4972
10.83	17:39:49	2/ 9/84	83.87	0.9052797831E 05	0.9071686667E 05	63.185	0.4947	0.5840	0.4813	0.4950
11.00	17:49:49	2/ 9/84	83.84	0.9052774486E 05	0.9071658753E 05	63.182	0.4878	0.0371	0.4790	0.4925
11.17	17:59:49	2/ 9/84	83.83	0.9052464631E 05	0.9071625898E 05	63.178	0.4878	0.4929	0.4767	0.4902
11.34	18: 9:58	2/ 9/84	83.82	0.9052100966E 05	0.9071600631E 05	63.174	0.4890	0.5662	0.4751	0.4881
11.50	18:19:58	2/ 9/84	83.81	0.9051860258E 05	0.9071575551E 05	63.170	0.4874	0.3926	0.4733	0.4861
11.67	18:29:58	2/ 9/84	83.79	0.9051711078E 05	0.9071540086E 05	63.166	0.4838	0.2362	0.4714	0.4840
11.84	18:39:58	2/ 9/84	83.78	0.9051332277E 05	0.9071524226E 05	63.162	0.4854	0.5924	0.4698	0.4821
12.00	18:49:58	2/ 9/84	83.77	0.9051059766E 05	0.9071502116E 05	63.158	0.4848	0.4455	0.4683	0.4804
12.17	18:59:58	2/ 9/84	83.75	0.9051045996E 05	0.9071473876E 05	63.156	0.4784	0.0211	0.4665	0.4783
12.51	19:20:23	2/ 9/84	83.84	0.9048049541E 05	0.9071510256E 05	63.145	0.5288	2.3350	0.4688	0.4805
12.68	19:30:23	2/ 9/84	83.78	0.9048683356E 05	0.9071519795E 05	63.142	0.5086	-1.0087	0.4694	0.4808
12.84	19:40:23	2/ 9/84	83.74	0.9049181800E 05	0.9071508636E 05	63.140	0.4922	-0.7614	0.4687	0.4798
13.01	19:50:23	2/ 9/84	83.73	0.9048808120E 05	0.9071499755E 05	63.136	0.4930	0.5628	0.4682	0.4790
13.18	20: 0:23	2/ 9/84	83.68	0.9049167610E 05	0.9071475106E 05	63.133	0.4796	-0.5721	0.4667	0.4773
13.34	20:10:16	2/ 9/84	83.67	0.9048875711E 05	0.9071452096E 05	63.129	0.4795	0.4700	0.4653	0.4757
13.51	20:20:16	2/ 9/84	83.65	0.9048830236E 05	0.9071424556E 05	63.126	0.4744	0.0724	0.4636	0.4739
13.68	20:30:16	2/ 9/84	83.64	0.9048553236E 05	0.9071396476E 05	63.123	0.4725	0.3135	0.4620	0.4721
13.84	20:40:16	2/ 9/84	83.63	0.9048339336E 05	0.9071370216E 05	63.120	0.4724	0.4677	0.4604	0.4704
14.01	20:50:16	2/ 9/84	83.62	0.9048137036E 05	0.9071343516E 05	63.117	0.4706	0.3219	0.4589	0.4688
14.18	21: 0:16	2/ 9/84	83.60	0.9047930856E 05	0.9071317015E 05	63.112	0.4693	0.3632	0.4574	0.4671
14.33	21: 9:48	2/ 9/84	83.58	0.9047426896E 05	0.9071287786E 05	63.110	0.4656	0.1369	0.4557	0.4654
14.50	21:19:48	2/ 9/84	83.58	0.9047613076E 05	0.9071258616E 05	63.107	0.4642	0.3403	0.4541	0.4637
14.67	21:29:48	2/ 9/84	83.56	0.9047277006E 05	0.9071232286E 05	63.103	0.4650	0.5349	0.4527	0.4621
14.83	21:39:48	2/ 9/84	83.56	0.9047011456E 05	0.9071205936E 05	63.100	0.4645	0.4227	0.4513	0.4606
15.00	21:49:48	2/ 9/84	83.54	0.9047019456E 05	0.9071176748E 05	63.098	0.4592	-0.0127	0.4497	0.4589
15.17	21:59:48	2/ 9/84	83.53	0.9046733386E 05	0.9071148295E 05	63.094	0.4591	0.4553	0.4482	0.4573
15.34	22:10:11	2/ 9/84	83.52	0.9046509366E 05	0.9071119996E 05	63.091	0.4579	0.3495	0.4467	0.4557
15.51	22:20:11	2/ 9/84	83.51	0.9046125686E 05	0.9071095286E 05	63.087	0.4594	0.6044	0.4454	0.4543
15.67	22:30:11	2/ 9/84	83.50	0.9046032186E 05	0.9071067896E 05	63.084	0.4560	0.1377	0.4440	0.4528
15.84	22:40:11	2/ 9/84	83.50	0.9045617106E 05	0.9071044856E 05	63.082	0.4582	0.6719	0.4428	0.4515
16.01	22:50:11	2/ 9/84	83.47	0.9045891946E 05	0.9071011866E 05	63.080	0.4489	-0.4378	0.4411	0.4498
16.17	23: 0:11	2/ 9/84	83.47	0.9045581166E 05	0.9070981226E 05	63.077	0.4494	0.4967	0.4396	0.4482
16.34	23: 9:52	2/ 9/84	83.45	0.9045375546E 05	0.9070990946E 05	63.073	0.4483	0.3378	0.4381	0.4467
16.50	23:19:52	2/ 9/84	83.44	0.9045129706E 05	0.9070921626E 05	63.070	0.4477	0.3840	0.4367	0.4452
16.67	23:29:52	2/ 9/84	83.44	0.9044794216E 05	0.9070894916E 05	63.067	0.4485	0.5325	0.4354	0.4438
16.84	23:39:52	2/ 9/84	83.41	0.9044905376E 05	0.9070862156E 05	63.064	0.4424	-0.1778	0.4339	0.4422
17.00	23:49:52	2/ 9/84	83.41	0.9044548196E 05	0.9070832586E 05	63.061	0.4436	0.5686	0.4324	0.4408
17.17	23:59:52	2/ 9/84	83.40	0.9044492386E 05	0.9070800376E 05	63.059	0.4401	0.0881	0.4309	0.4392
17.34	0:10: 9	2/10/84	83.40	0.9043980396E 05	0.9070773996E 05	63.057	0.4436	0.7916	0.4297	0.4379
17.51	0:20: 9	2/10/84	83.39	0.9043674676E 05	0.9070749316E 05	63.052	0.4448	0.4868	0.4286	0.4367
17.67	0:30: 9	2/10/84	83.38	0.9043435996E 05	0.9070722536E 05	63.049	0.4433	0.3737	0.4275	0.4355
17.84	0:40: 9	2/10/84	83.36	0.9043448376E 05	0.9070697662E 05	63.046	0.4390	-0.0133	0.4262	0.4342
18.01	0:50: 9	2/10/84	83.36	0.9043114596E 05	0.9070672246E 05	63.043	0.4399	0.5315	0.4251	0.4330
18.17	1: 0: 9	2/10/84	83.34	0.9042957006E 05	0.9070645496E 05	63.040	0.4377	0.2032	0.4239	0.4317
18.35	1:10:40	2/10/84	83.33	0.9042897526E 05	0.9070614656E 05	63.038	0.4340	0.1356	0.4226	0.4304
18.52	1:20:40	2/10/84	83.32	0.9042733986E 05	0.9070587020E 05	63.036	0.4331	0.2509	0.4213	0.4291
18.68	1:30:40	2/10/84	83.32	0.9042316566E 05	0.9070561526E 05	63.031	0.4353	0.6743	0.4202	0.4279
18.85	1:40:40	2/10/84	83.31	0.9042152926E 05	0.9070535426E 05	63.029	0.4337	0.2606	0.4191	0.4267
19.02	1:50:40	2/10/84	83.29	0.9042208436E 05	0.9070505036E 05	63.027	0.4292	-0.0884	0.4178	0.4254
19.18	2: 0:43	2/10/84	83.28	0.9041809626E 05	0.9070478256E 05	63.023	0.4309	0.6367	0.4167	0.4242
19.88	2:42:43	2/10/84	83.30	0.9040726226E 05	0.9070450206E 05	63.016	0.4301	0.4100	0.4156	0.4230
20.05	2:52:43	2/10/84	83.28	0.9040571846E 05	0.9070421646E 05	63.013	0.4286	0.2459	0.4144	0.4218

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20.33	3:12:44	2/11/84	83.24	0.904097290E	05	0.907031796E	05	63.010	0.4164	0.4146	0.4111	0.4185
20.50	3:19:34	2/10/84	83.24	0.904083061E	05	0.907029645E	05	63.009	0.4151	0.1920	0.4095	0.4169
20.66	3:29:34	2/10/84	83.24	0.904084671E	05	0.907025411E	05	63.008	0.4123	0.0699	0.4078	0.4153
20.83	3:39:34	2/10/84	83.23	0.904072506E	05	0.907021147E	05	63.006	0.4106	0.1938	0.4062	0.4137
21.00	3:49:34	2/10/84	83.22	0.904065974E	05	0.907016761E	05	63.004	0.4082	0.1040	0.4045	0.4120
21.16	3:59:34	2/10/84	83.23	0.904032903E	05	0.907012693E	05	63.003	0.4091	0.5268	0.4629	0.4105
21.33	4: 9:45	2/10/84	83.21	0.904023050E	05	0.907008544E	05	63.000	0.4070	0.1540	0.4013	0.4089
21.50	4:19:45	2/10/84	83.21	0.904003024E	05	0.907004396E	05	62.998	0.4056	0.2234	0.3998	0.4074
21.67	4:29:45	2/10/84	83.21	0.903943273E	09	0.907001962E	05	62.994	0.4105	1.0473	0.3995	0.4061
21.83	4:39:45	2/10/84	83.20	0.903927029E	05	0.906997731E	05	62.991	0.4094	0.2588	0.3973	0.4048
22.00	4:49:45	2/10/84	83.19	0.903874082E	05	0.906994969E	05	62.986	0.4126	0.8434	0.3963	0.4037
22.17	4:59:45	2/10/84	83.18	0.903851202E	05	0.906992136E	05	62.983	0.4111	0.2053	0.3952	0.4027
22.33	5: 9:44	2/10/84	83.17	0.903828800E	05	0.906989534E	05	62.979	0.4118	0.5175	0.3943	0.4016
22.50	5:19:44	2/10/84	83.16	0.903792631E	05	0.906987206E	05	62.975	0.4130	0.5762	0.3935	0.4007
22.67	5:29:44	2/10/84	83.14	0.903785536E	05	0.906984709E	05	62.972	0.4108	0.1131	0.3926	0.3998
22.83	5:37:44	2/10/84	83.13	0.903764470E	05	0.906982256E	05	62.969	0.4103	0.3356	0.3917	0.3988
23.00	5:49:44	2/10/84	83.12	0.903749239E	05	0.906979763E	05	62.966	0.4090	0.2427	0.3908	0.3979
23.17	5:59:44	2/10/84	83.11	0.903722871E	05	0.906977391E	05	62.963	0.4091	0.4202	0.3900	0.3970
23.33	6: 9:44	2/10/84	83.09	0.903704302E	05	0.906974995E	05	62.960	0.4081	0.2638	0.3892	0.3961
23.50	6:19:44	2/10/84	83.09	0.903670856E	05	0.906972845E	05	62.957	0.4092	0.5648	0.3884	0.3953
23.67	6:29:44	2/10/84	83.07	0.903671526E	05	0.906970423E	05	62.955	0.4062	-0.0107	0.3874	0.3944
23.83	6:39:44	2/10/84	83.07	0.903618201E	05	0.906968493E	05	62.951	0.4093	0.8497	0.3869	0.3937
24.00	6:49:44	2/10/84	83.06	0.903620731E	05	0.906966263E	05	62.949	0.4062	-0.0403	0.3862	0.3929

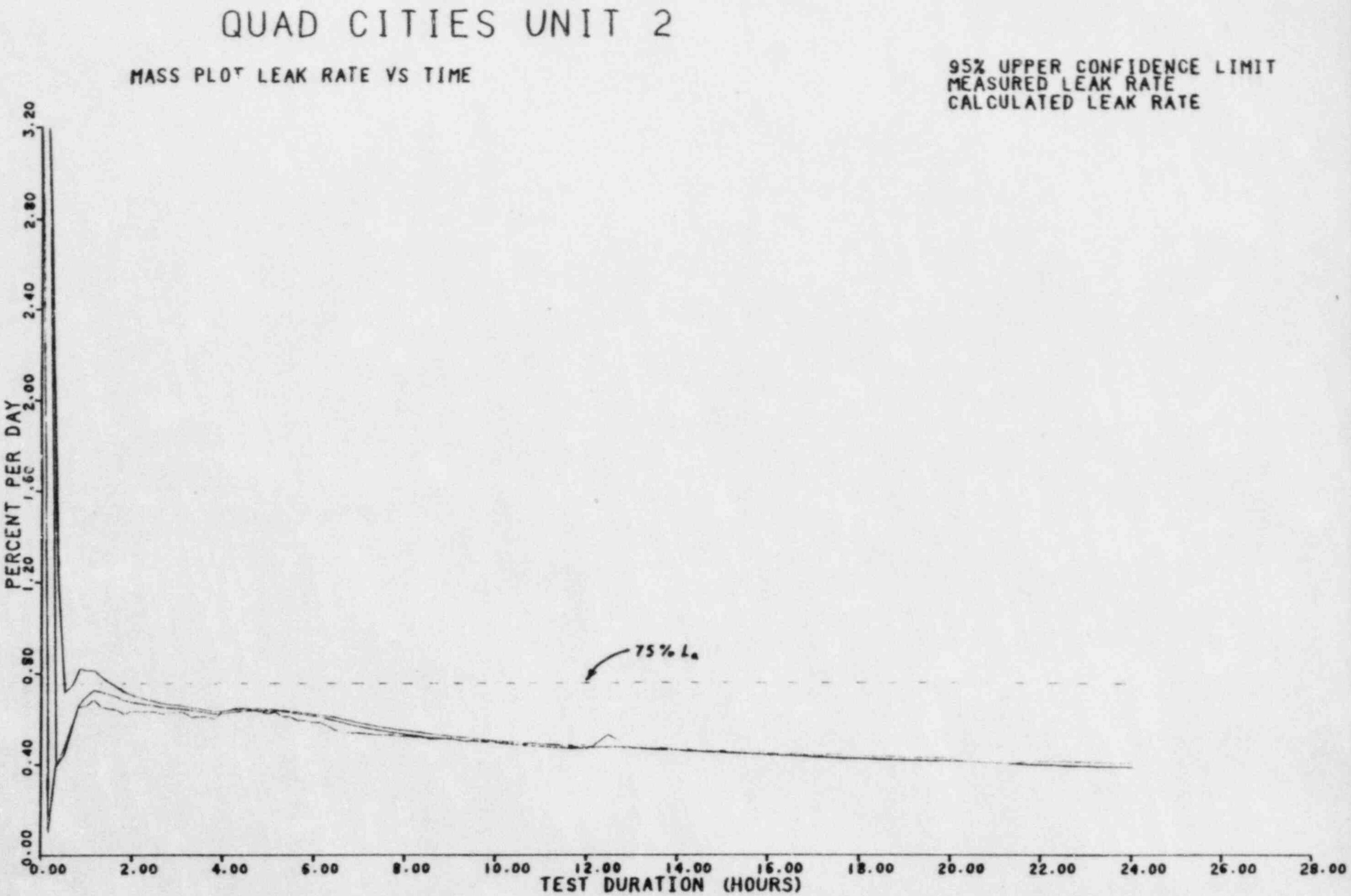
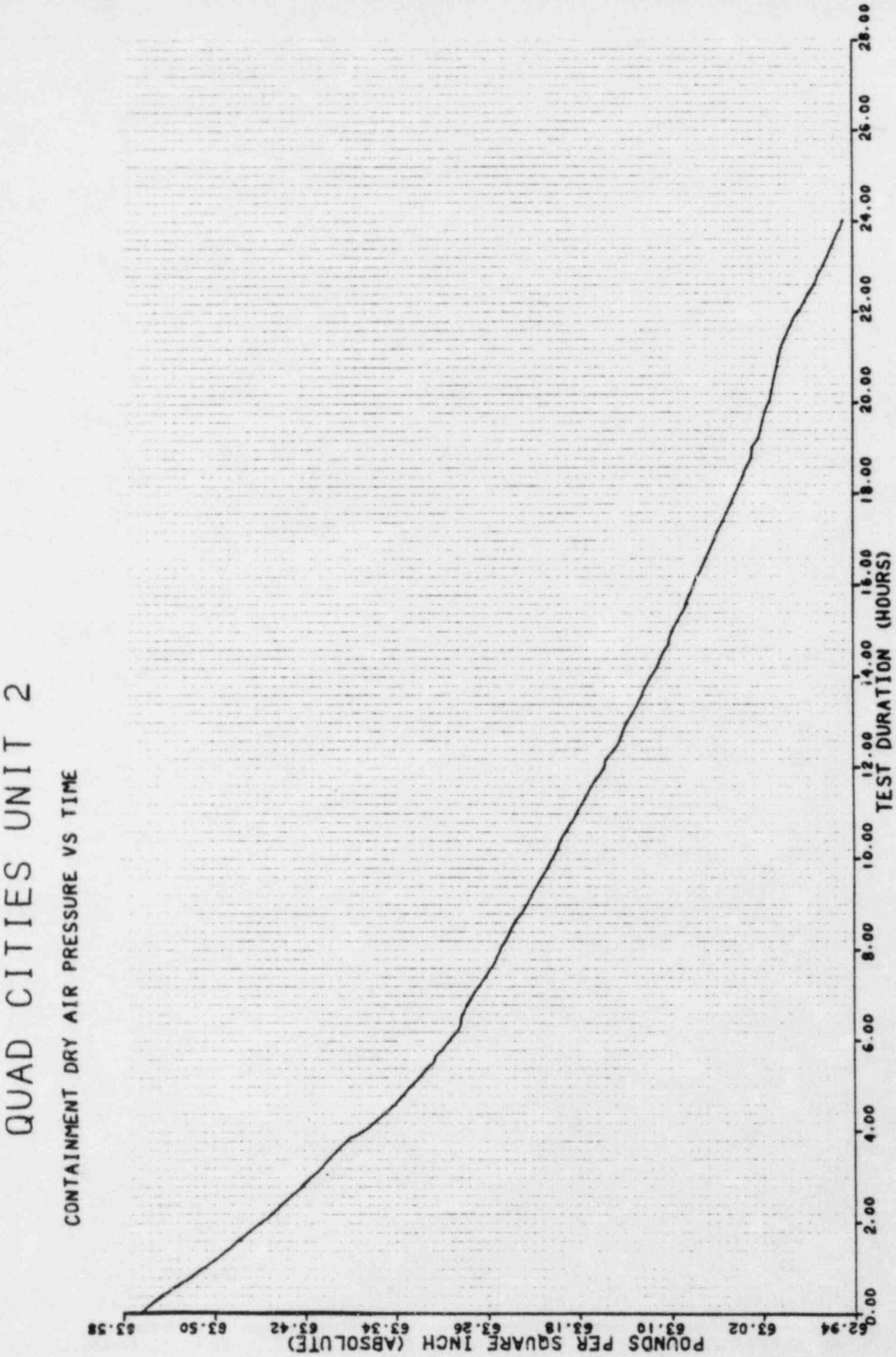

QUAD CITIES UNIT 2
MASS PLOT LEAK RATE VS TIME
95% UPPER CONFIDENCE LIMIT
MEASURED LEAK RATE
CALCULATED LEAK RATE
PERCENT PER DAY
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
75% L_a
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
TEST DURATION (HOURS)

FIGURE 3



QUAD CITIES UNIT 2
CONTAINMENT DRY AIR PRESSURE VS TIME
TEST DURATION (HOURS)
POUNDS PER SQUARE INCH (ABSOLUTE)

FIGURE 4

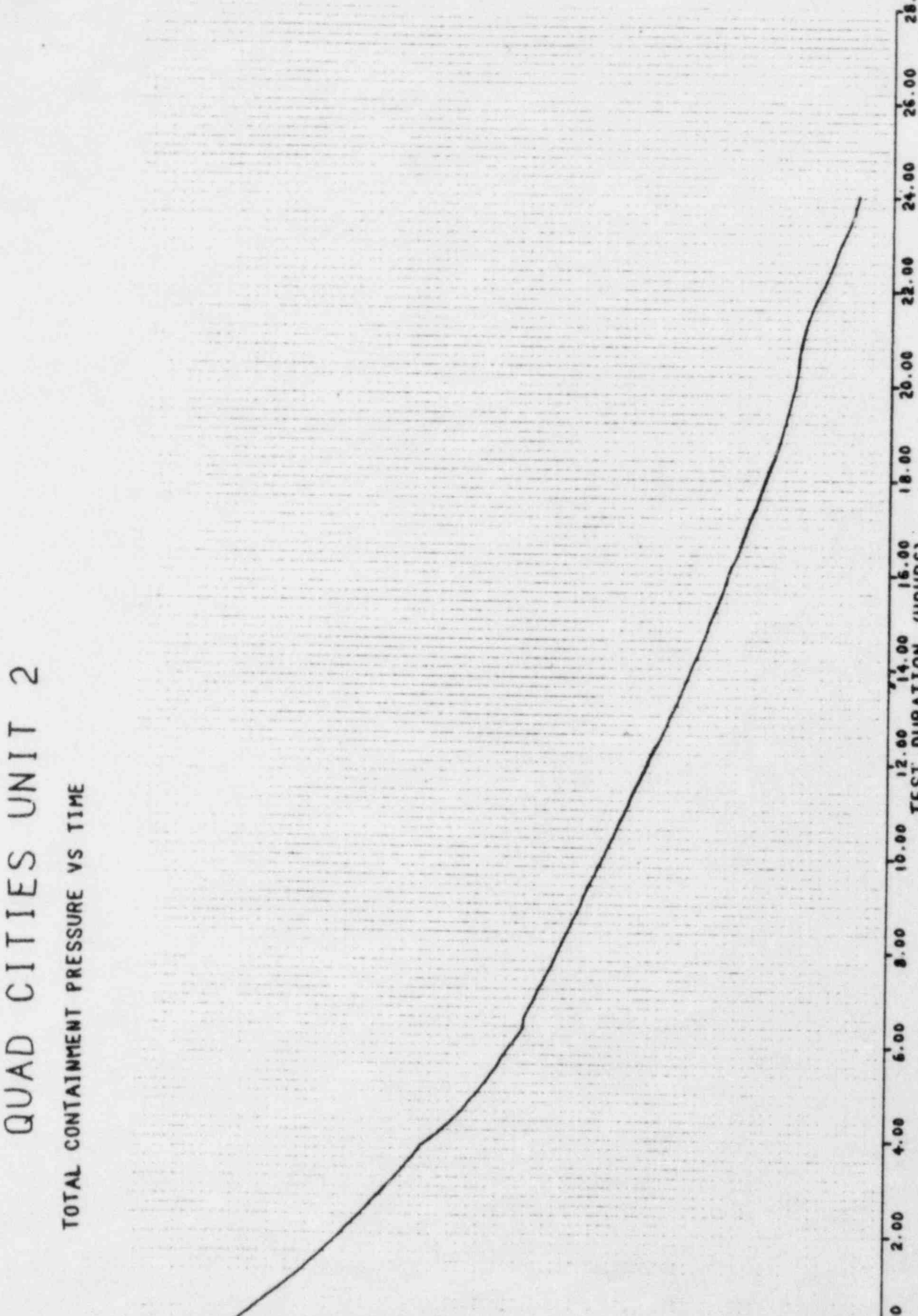

QUAD CITIES UNIT 2
TOTAL CONTAINMENT PRESSURE VS TIME
TEST DURATION (HOURS)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
POUNDS PER SQUARE INCH (ABSOLUTE)
63.20
63.30
63.40
63.50
63.60
63.70
63.80
63.90
64.00

FIGURE 5

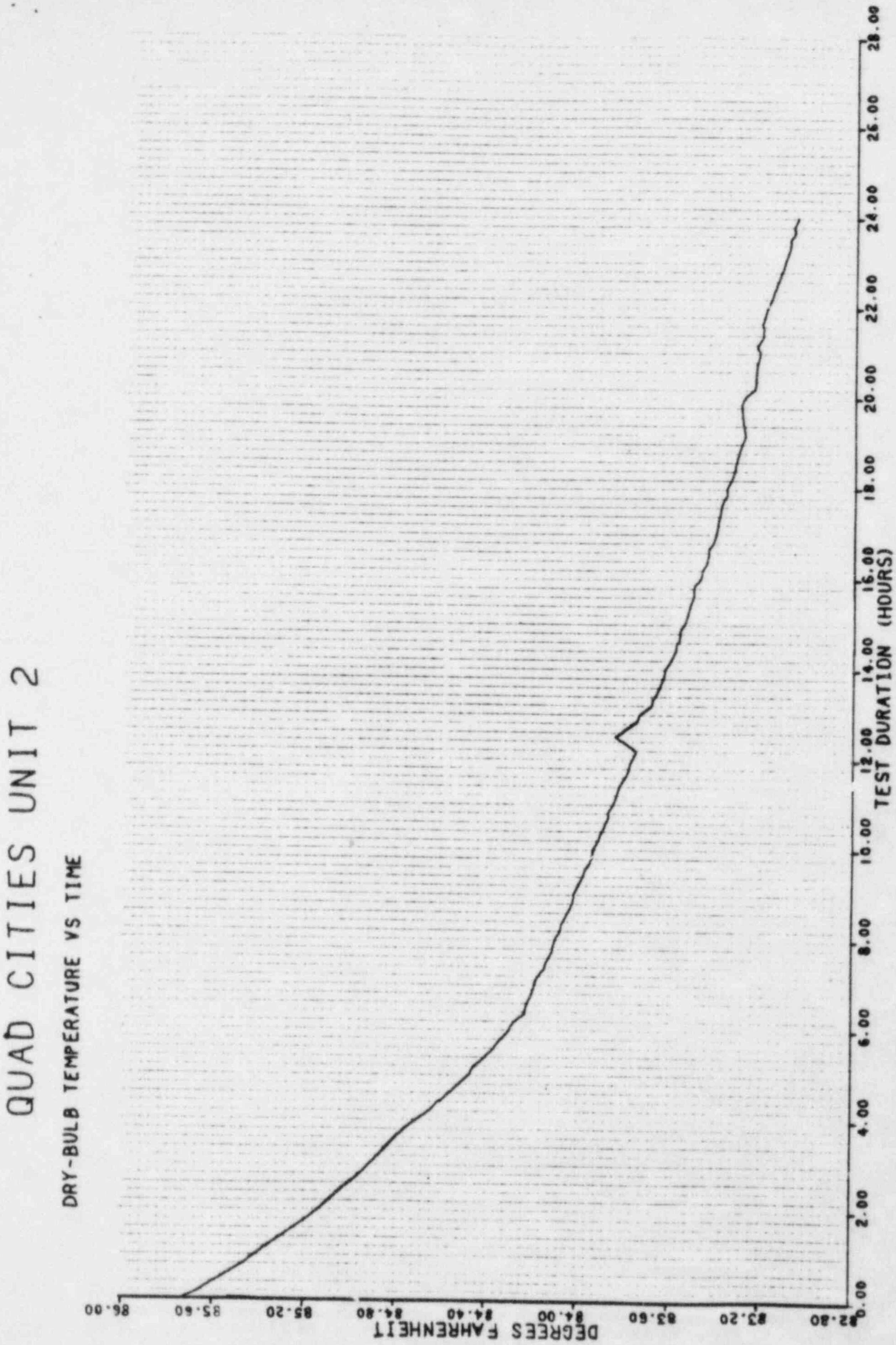

QUAD CITIES UNIT 2
DRY-BULB TEMPERATURE VS TIME
DEGREES FAHRENHEIT
86.00
85.60
85.20
84.80
84.40
84.00
83.60
83.20
82.80
TEST DURATION (HOURS)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00

FIGURE 6

INDUCED LEAKAGE PHASE DATA

QUAD CITIES UNIT 2 1211 02/10/84

****SUMMARY OF DATA SETS 179 THRU 203 ****

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS TRD	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	POINT	CALC. LEAK RATE %/DAY	UPPER 95% CONF LIMIT
0.00	8:19:37	2/10/84	82.96	0.903123603E 05		62.900				
0.17	8:29:37	2/10/84	82.96	0.9030335698E 05		62.894	1.4356	1.4356		
0.33	8:39:37	2/10/84	82.94	0.9029932558E 05	0.9031153315E 05	62.888	1.0392	0.6428	1.0392	2.1499
0.50	8:49:37	2/10/84	82.94	0.9029314462E 05	0.9031129816E 05	62.893	1.0212	0.9854	0.9834	1.2861
0.67	8:59:37	2/10/84	82.93	0.9028359716E 05	0.9031190449E 05	62.875	1.1465	1.5229	1.0800	1.2746
0.83	9: 9:41	2/10/84	82.93	0.9027757175E 05	0.9031198555E 05	62.871	1.1081	0.9555	1.0827	1.2063
1.00	9:19:41	2/10/84	82.91	0.9027190068E 05	0.9031181398E 05	62.864	1.0742	0.9046	1.0733	1.1536
1.17	9:29:41	2/10/84	82.90	0.9026427508E 05	0.9031187716E 05	62.858	1.0944	1.2164	1.0784	1.1364
1.33	9:39:41	2/10/84	82.90	0.9025875675E 05	0.9031171806E 05	62.853	1.0676	0.8804	1.0675	1.1129
1.50	9:49:41	2/10/84	82.89	0.9025189956E 05	0.9031164966E 05	62.847	1.0705	1.0946	1.0634	1.0992
1.67	9:59:41	2/10/84	82.89	0.9024292646E 05	0.9031172106E 05	62.840	1.1065	1.4311	1.0778	1.1105
1.88	10:12:14	2/10/84	82.88	0.9023514366E 05	0.9031200896E 05	62.833	1.0933	0.9896	1.0819	1.1088
2.00	10:19:30	2/10/84	82.87	0.9023147835E 05	0.9031190135E 05	62.829	1.0745	0.7887	1.0772	1.1004
2.17	10:29:30	2/10/84	82.86	0.9022631765E 05	0.9031164795E 05	62.825	1.0551	0.9236	1.0671	1.0894
2.33	10:39:30	2/10/84	82.86	0.9021547478E 05	0.9031180416E 05	62.817	1.0919	1.5710	1.0728	1.0930
2.50	10:49:30	2/10/84	82.85	0.9021034675E 05	0.9031185644E 05	62.812	1.0842	0.9781	1.0746	1.0923
2.67	10:59:30	2/10/84	82.83	0.9020593288E 05	0.9031166855E 05	62.806	1.0604	0.7046	1.0686	1.0853
2.84	11:10: 3	2/10/84	82.84	0.9019597235E 05	0.9031180616E 05	62.799	1.0889	1.5277	1.0728	1.0881
3.01	11:20: 3	2/10/84	82.82	0.9019087815E 05	0.9031176448E 05	62.794	1.0735	0.8133	1.0716	1.0853
3.17	11:30: 3	2/10/84	82.81	0.9018575186E 05	0.9031159576E 05	62.789	1.0601	0.8185	1.0671	1.0802
3.34	11:40: 3	2/10/84	82.81	0.9017663995E 05	0.9031166278E 05	62.783	1.0797	1.4549	1.0698	1.0807
3.51	11:50: 3	2/10/84	82.81	0.9016875165E 05	0.9031180946E 05	62.776	1.0881	1.2597	1.0723	1.0836
3.67	12: 0: 3	2/10/84	82.80	0.9016109166E 05	0.9031199786E 05	62.770	1.0942	1.2233	1.0766	1.0878
3.83	12: 9:30	2/10/84	82.80	0.9015338995E 05	0.9031223816E 05	62.764	1.1019	1.2813	1.0813	1.0933
4.00	12:19:30	2/10/84	82.78	0.9014917796E 05	0.9031225266E 05	62.758	1.0840	0.6728	1.0821	1.0926

TABLE 4

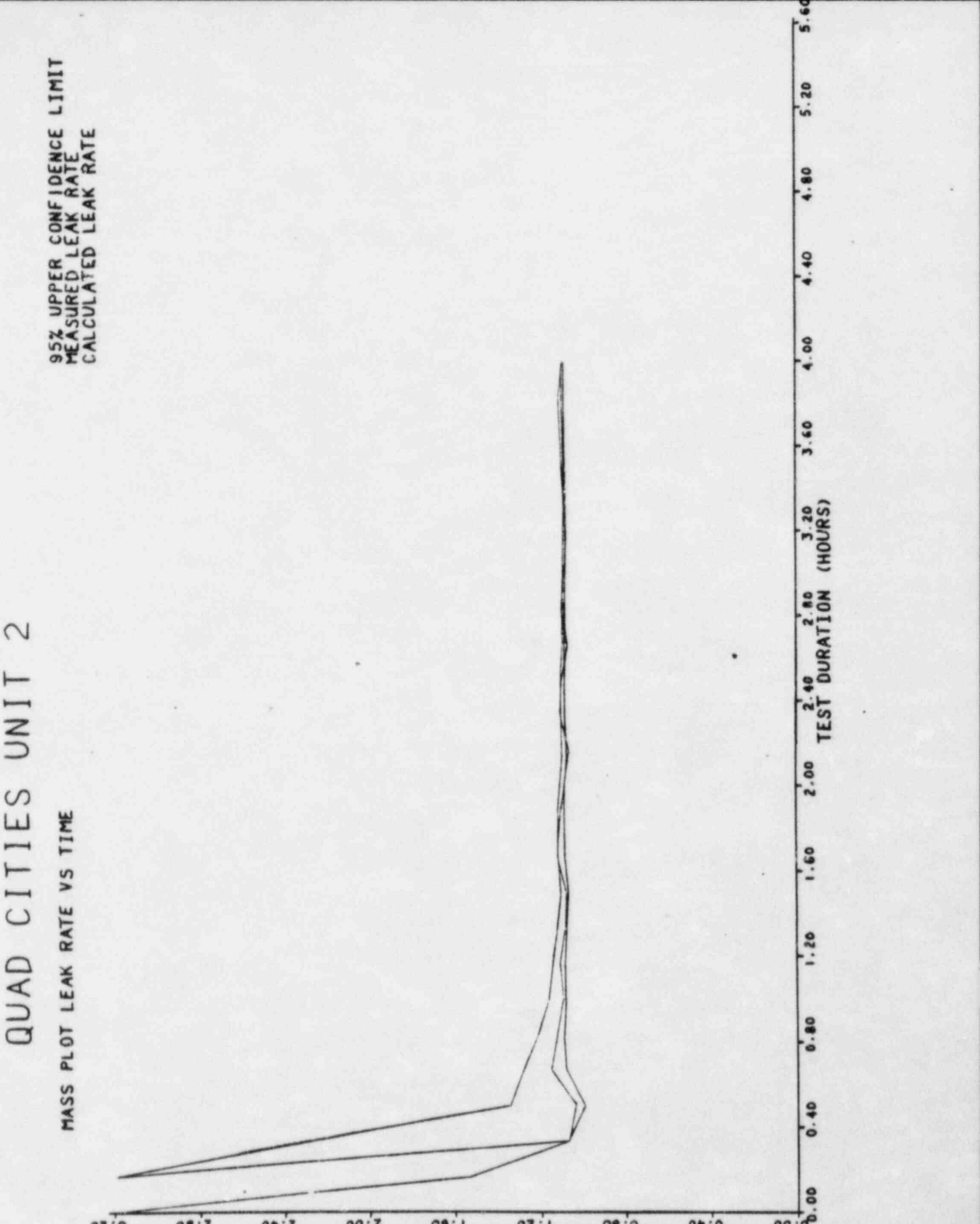
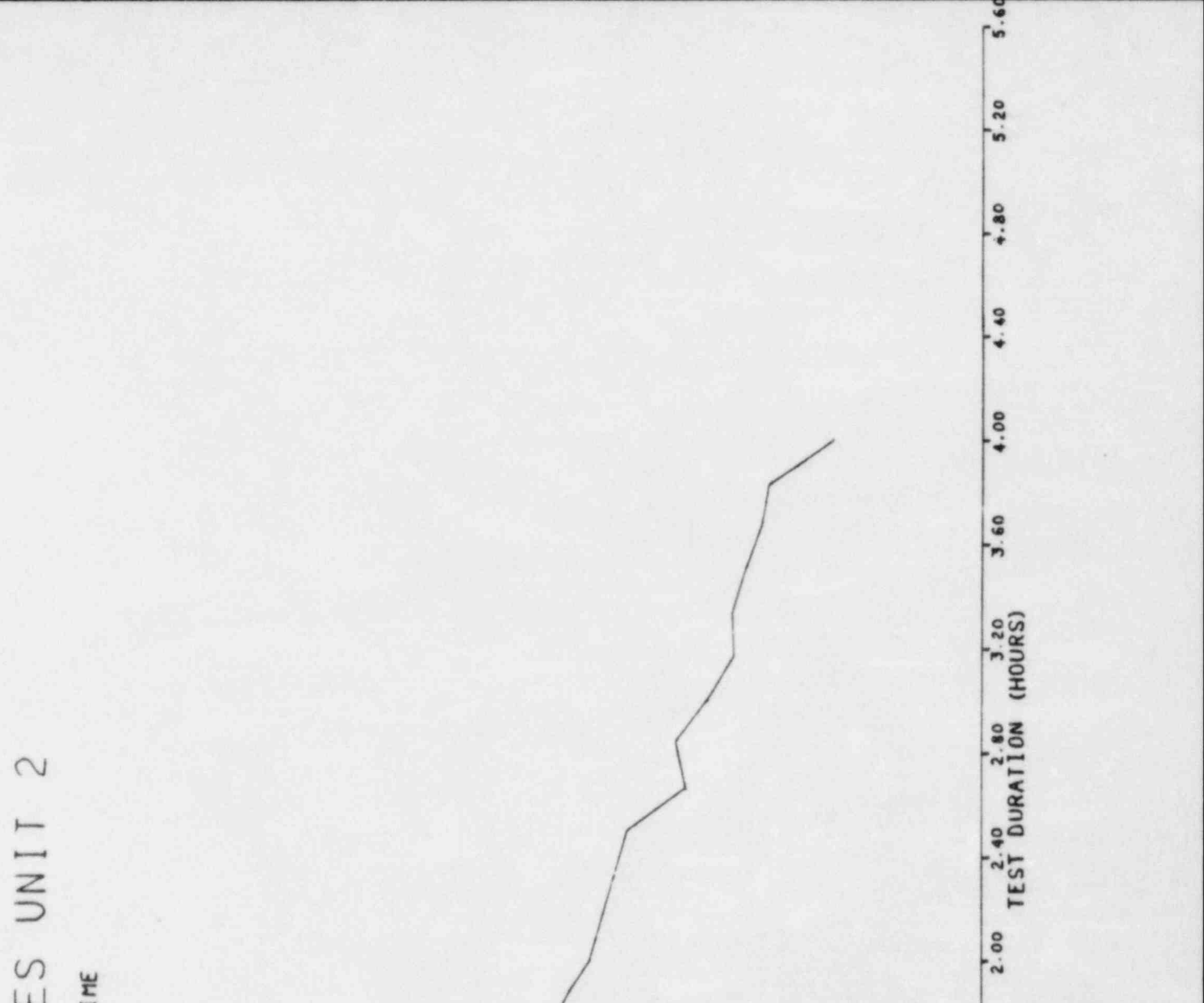

QUAD CITIES UNIT 2
MASS PLOT LEAK RATE VS TIME
95% UPPER CONFIDENCE LIMIT
MEASURED LEAK RATE
CALCULATED LEAK RATE
PERCENT PER DAY
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
5.20
5.60
TEST DURATION (HOURS)

FIGURE 7



QUAD CITIES UNIT 2
DRY-BULB TEMPERATURE VS TIME
DEGREES FAHRENHEIT
83.04
83.00
82.96
82.92
82.88
82.84
82.80
82.76
82.72
TEST DURATION (HOURS)
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
5.20
5.60

FIGURE 8

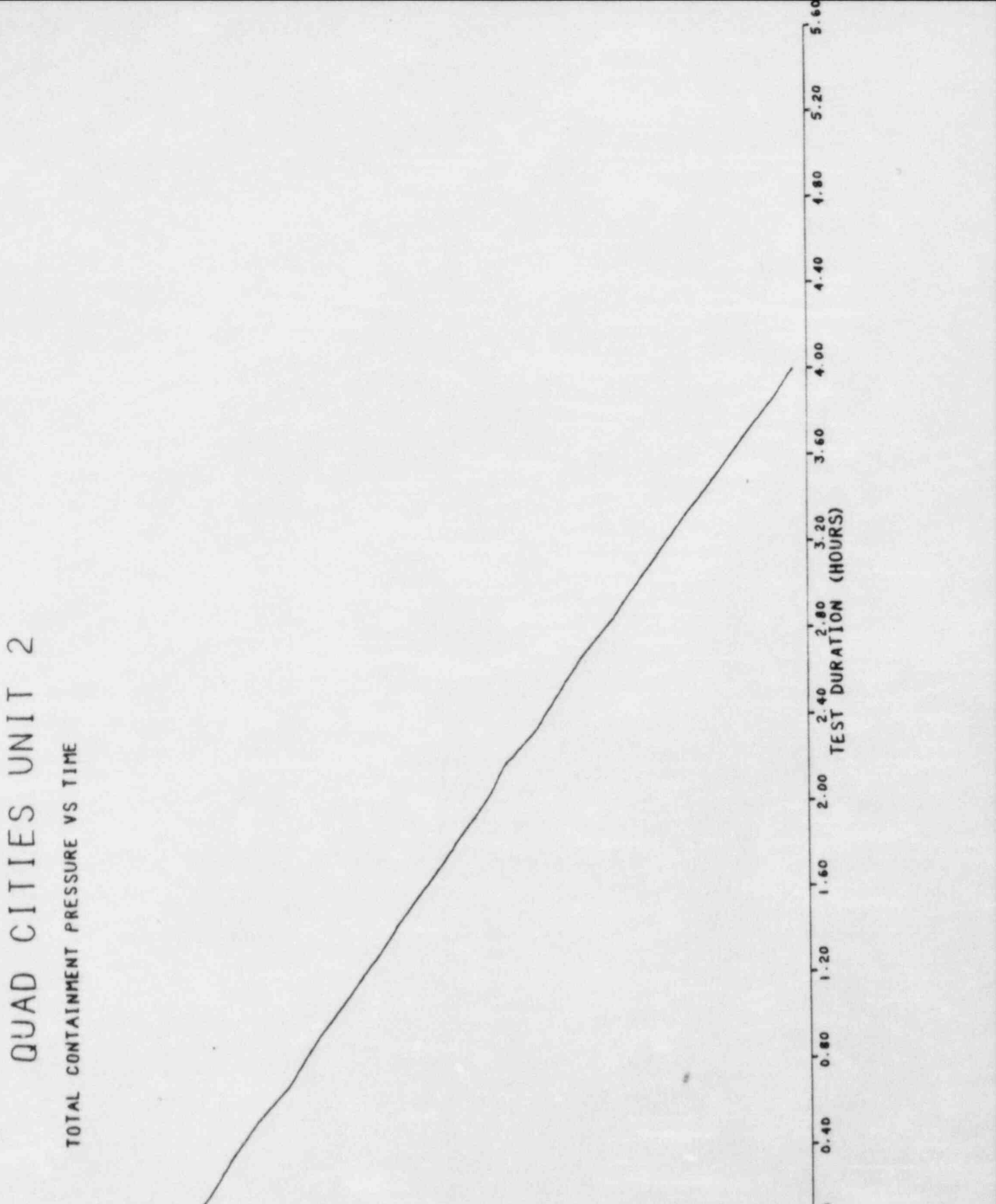

QUAD CITIES UNIT 2
TOTAL CONTAINMENT PRESSURE VS TIME
POUNDS PER SQUARE INCH (ABSOLUTE)
63.04
63.06
63.08
63.10
63.12
63.14
63.16
63.18
63.20
TEST DURATION (HOURS)
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
3.60
4.00
4.40
4.80
5.20
5.60

FIGURE 9

QUAD CITIES UNIT 2

CONTAINMENT DRY AIR PRESSURE VS TIME

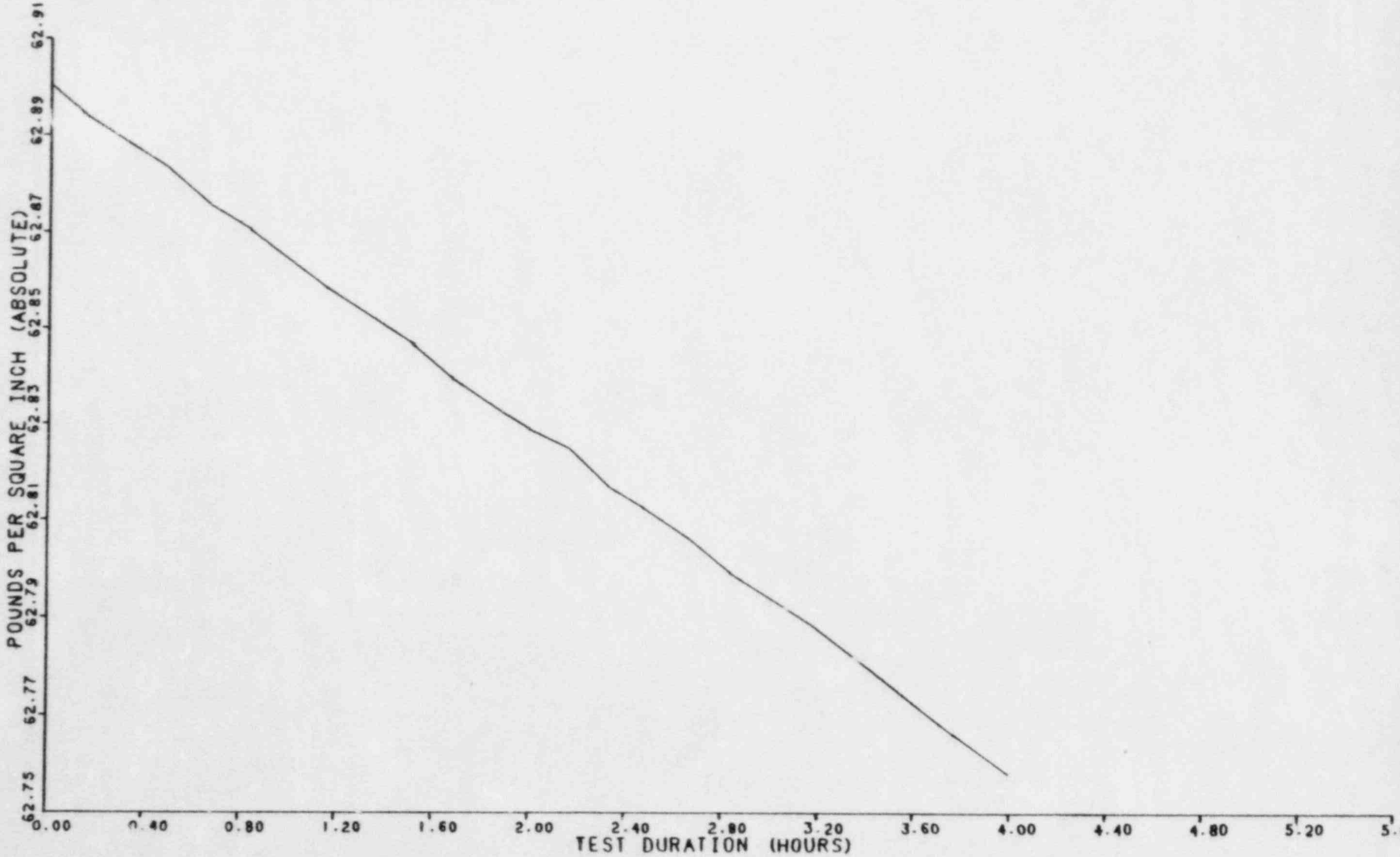


FIGURE 10

SECTION E - TEST CALCULATIONS

Calculations for the IPCLRT using the ANSI method are found in Quad-Cities procedures QTS 150-T3. A reproduction of these procedures can be found in Appendix C. The origins of these calculations are the N274 draft for ANSI/ANS 56.8. These calculations are consistent with the standard as it was published in 1981.

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 0.385 wt %/day with an upper confidence limit of 0.392 wt %/day.

F.2 Induced Leakage Test Results

A leak rate of 6.3 SCFM (0.772 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)	0.385	0.385
Induced Leak (6.3 SCFM)	0.772	0.772
Allowed Error Band (25% L_a)	+ 0.250	- 0.250
	1.407	0.907
Statistically Averaged Leak Rate (Induced Leakage Phase)	1.082 wt %/day	

Therefore, the required test accuracy was satisfied.

F.3 Leak Rate Compensation For Non-Vented Penetrations

The IPCLRT was performed with the following penetrations not drained and vented as required by 10 CFR 50, Appendix J. The "as left" leak rates for each of these penetrations, as determined by Type C testing, is also listed:

SYSTEM	STATUS	THROUGH LEAKAGE FROM TYPE B AND C TESTING	
		SCFH	WT %/DAY
'A' Rx Feedwater	Isolated, Filled, Unvented	0.52	0.00106
'B' Rx Feedwater	Isolated, Filled, Unvented	25.80	0.05270
RHR System	Isolated, Filled, Unvented	8.34	0.01704
Rx Water CU	Used for Core Cooling	0.83	0.00180
ACAD/CAM	Isolated	1.50	0.00306
Primary Sample	Isolated	0.18	0.00036
All Electrical Penetrations	Test bellows filled and pressurized with dry N_2.	1.65	0.00337
		38.87	0.07939

This correction yields the following adjusted leak rates:

Statistically Averaged Leak Rate (ANSI) 0.464 wt %/day

Upper Confidence Limit (ANSI) 0.471 wt %/day

F.4 Pre-Operational Results vs. Test Results

Past IPCLRT reports have compared the results of those tests with the pre-operational IPCLRT, performed from August 29 to September 2, 1971. For comparison purposes the statistically averaged leak rate corrected for non-vented volumes and corrected upper confidence limit are given for the last three Type A tests on Unit Two.

	1976	1980	1983
Statistically Averaged Leak Rate (wt %/day)	0.327	0.449	0.464
Upper Confidence Limit (wt %/day)	0.344	0.459	0.471

The above data shows that there has been no significant deterioration of the containment integrity and that the leakages have been consistently below the allowable limit of 0.750 wt %/day.

F.5 As Found IPCLRT Result

The following table summarizes the results of all Type B and C as well as the IPCLRT results to arrive at an "as found" Type A test result. Since the total is less than 0.750 wt %/day (75 L_a), the present schedule of three Type A tests in 10 years can be maintained. Documentation for the values listed below can be found in RO 83-15/03L-1, Docket No. 50-265, DPR-30.

SUMMARY OF ALL CONTAINMENT
LEAK RATE TESTING DURING
UNIT TWO REFUEL OUTAGE
FALL, 1983

	AS FOUND (SCFH)		AS LEFT (SCFH)	
	LLRT (TOTAL MEASURED)	WORST CASE THROUGH LEAKAGE	LLRT (TOTAL MEASURED)	WORST CASE THROUGH LEAKAGE
(1) MSIV's @ 25 PSIG	59.92	17.30	27.66	10.36
(2) MSIV's converted to 48 PSIG*	94.67	27.33	43.70	16.37
(3) All Type C Tests (Except MSIV's)	1095.79	144.92	215.66	109.40
(4) All Type B Tests	108.31	54.23	22.49	11.32
TOTAL (2 + 3 + 4)	1298.77	226.48	281.85	137.09

(1) Type A Test (Integrated Leak Rate Test) = 0.385 wt %/day

(2) Upper Confidence Limit of Type A Test Result = 0.392 wt %/day

(3) Correction for Unvented Volumes During Type A Test = 0.079 wt %/day

(4) Correction for Repairs Prior to Type A Test (As Found - As Left) = 0.183 wt %/day $\left(\frac{226.48 - 137.09}{489.59}\right)$

(5) Correction for Leak Repaired During Type A Test = 0.020 wt %/day

TOTAL (2 + 3 + 4 + 5) 0.674 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.

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, 1979. All valves with leakage in excess of the individual valve leakage limit were restored to an acceptable leak tightness prior to the resumption of power operation. 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.

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*	9.24	09-06-83	9.24	09-06-83
		4.60	09-07-81	4.60	09-07-81
AO 203-2A		34.56	09-06-83	2.30	12-27-83
		2.30	09-08-81	0.00	09-11-81
AO 203-1B		4.60	09-05-83	4.60	09-05-83
		0.00	09-07-81	0.00	09-07-81
AO 203-2B		4.60	09-05-83	4.60	09-05-83
		0.00	09-07-81	0.00	09-07-81
AO 203-1C		2.30	09-05-83	2.30	09-05-83
		0.00	09-07-81	0.00	09-07-81
AO 203-2C		2.30	09-05-83	2.30	09-05-83
		0.00	09-07-81	0.00	09-07-81
AO 203-1D		9.20	09-04-83	9.20	09-04-83
		2.30	09-07-81	2.30	09-07-81
AO 203-2D		9.20	09-04-83	9.20	09-04-83
		2.30	09-07-81	2.30	09-07-81
MO 220-1	Main Steam Line Drains	39.27	09-05-83	7.46	01-12-84
MO 220-2		66.30/5.50	09-07-81	8.63	12-23-81
AO 220-44	Primary Sample	0.35	09-27-83	0.35	09-27-83
AO 220-45		0.00	10-16-81	0.0	10-16-81
CV 220-58A	Feedwater Inlet Loop "A" Inboard	267.3	10-05-83	0.52	01-09-84
		1.03	09-21-81	1.03	09-21-81
CV 220-62A	Feedwater Inlet Loop "A" Outboard	2.70	10-06-83	5.26	01-06-84
		1140.0	09-22-81	6.20	10-07-81
CV 220-58B	Feedwater Inlet Loop "B" Inboard	1.00	09-13-83	25.80	12-22-84
		42.40	09-10-81	0.00	11-12-81
CV 220-62B	Feedwater Inlet Loop "B" Outboard	362.0	09-14-83	28.50	12-30-83
		1018.0	09-17-81	13.60	11-13-81

* 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	RHRS to Radwaste	0.00	09-05-83	0.00	09-05-83
MO 1001-21		0.00	12-23-81	0.00	12-23-81
MO 1001-23A	RHRS Containment Spray -	3.08	01-04-84	3.08	01-04-84
MO 1001-26A	System I	1.10	09-15-81	1.10	09-15-81
MO 1001-29A	RHRS Return Loop "A"	0.00	01-04-84	0.00	01-04-84
		3.00	09-14-81	3.00	09-14-81
MO 1001-34A	RHRS Suppression Chamber	0.00	01-04-84	0.00	01-04-84
MO 1001-36A	Spray - System I	34.60	09-14-81	1.21	11-18-81
MO 1001-37A					
MO 1001-23B	RHRS Containment Spray -	7.88	09-22-83	7.88	09-22-83
MO 1001-26B	System II	4.10	09-24-81	4.10	09-24-81
MO 1001-29B	RHRS Return Loop "B"	2.07	09-22-83	2.07	09-22-83
		0.00	09-23-81	0.00	09-23-81
MO 1001-34B	RHRS Suppression	2.40/163.83	12-01-83	1.20	12-13-83
MO 1001-36B	Chamber Spray	1638.0	09-23-81	6.07	12-19-81
MO 1001-37B	System II				
MO 1001-47	RHRS Shutdown	0.00	10-20-83	0.00	10-20-83
MO 1001-50	Cooling Suction	7.04	11-20-81	7.04	11-20-81
MO 1001-60	RHRS Head Spray	0.38	01-06-84	0.38	01-06-84
MO 1001-63		1.33	12-22-81	1.33	12-22-81
MO 1201-2	Clean-Up System	2.61/1.76	09-28-83	2.39	02-02-84
MO 1201-5	Suction	4.58	10-16-81	4.58	10-16-81
MO 1301-16	RCIC Steam Supply	20.40	09-06-83	3.35	01-18-84
MO 1301-17		29.00	09-07-81	0.46	12-01-81
CV 1301-40	RCIC Condensate Drain	5.03	09-05-83	5.03	09-05-83
		3.90	09-09-81	3.90	09-09-81
CV 1301-41	RCIC Turbine Exhaust	24.90	09-05-83	5.78	01-14-84
		24.90	09-07-81	1.00	09-30-81
AO 1601-21	Drywell and Suppression	68.10	09-27-83	24.80	01-10-84
AO 1601-22	Chamber Purge	53.60	09-29-81	10.32	12-20-81
AO 1601-55					
AO 1601-56					
AO 1601-20A	Suppression Chamber	6.70	09-23-83	6.70	09-23-83
CV 1601-31A	Vent Lines #1	7.60	09-24-81	7.60	09-24-81

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	Suppression Chamber	7.10	09-12-83	7.10	09-12-83
CV 1601-31B	Vent Lines #2	19.90	09-23-81	10.70	09-30-81
AO 1601-57	Drywell and Suppression	0.00	09-15-83	0.00	09-15-83
AO 1601-58	Chamber Supply Air	0.05	09-11-81	0.05	09-11-81
AO 1601-59	Purge				
AO 1601-23	Drywell and Suppression	9.00	09-30-83	9.00	09-30-83
AO 1601-24	Chamber Exhaust	17.99	10-18-81	17.99	10-18-81
AO 1601-60					
AO 1601-61					
AO 1601-62					
AO 1601-63					
AO 2001-3	Drywell Floor Drain	8.10	09-08-83	2.81	01-06-84
AO 2001-4	Sump Discharge	0.00	10-27-81	0.00	10-27-81
AO 2001-15	Drywell Equipment	0.014	09-08-83	7.35	01-23-84
AO 2001-16	Drain Sump Discharge	7.50	02-23-83	7.50	02-23-83
		0.30	10-27-81	0.30	10-27-81
MO 2301-4	HPCI Steam Supply	2.30	09-05-83	2.30	09-05-83
MO 2301-5		3.40	09-07-81	3.40	09-07-81
CV 2301-34	HPCI Condensate Drain	6.76	09-05-83	6.10	01-11-84
		7.00	09-08-81	7.00	09-08-81
CV 2301-45	HPCI Steam Exhaust	0.00	09-05-83	0.00	09-05-83
		165.0	09-08-81	12.04	10-06-81
AO 4720	Drywell Pneumatic	0.00	09-15-83	0.00	09-15-83
	Suction	0.00	09-11-81	0.00	09-11-81
AO 4721	Drywell Pneumatic	0.00	09-15-83	0.00	09-15-83
	Suction	0.00	09-11-81	0.00	09-11-81
AO 8801A	Oxygen Analyzer Suction	0.00	10-03-83	0.00	10-03-83
		0.10	09-29-81	0.10	09-29-81
AO 8802A	Oxygen Analyzer Suction	0.00	10-03-83	0.00	10-03-83
		0.10	09-29-81	0.10	09-29-81
AO 8801B	Oxygen Analyzer Suction	0.00	10-03-83	0.00	10-03-83
		0.00	09-29-81	0.00	09-29-81
AO 8802B	Oxygen Analyzer Suction	0.00	10-03-83	0.00	10-03-83
		0.00	09-29-81	0.00	09-29-81

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	6.00	10-03-83	6.00	10-03-83
		4.40	09-29-81	4.40	09-29-81
AO 8802C	Oxygen Analyzer Suction	16.00	10-03-83	1.40	11-29-83
		0.40	09-29-81	0.40	09-29-81
AO 8801D	Oxygen Analyzer Suction	0.00	10-03-83	0.00	10-03-83
		0.00	09-29-81	0.00	09-29-81
AO 8802D	Oxygen Analyzer Suction	0.00	10-03-83	0.00	10-03-83
		0.00	09-29-81	0.00	09-29-81
AO 8803	Oxygen Analyzer Return	0.60	10-14-83	0.60	10-14-83
		1.70	10-01-81	1.70	10-01-81
AO 8804	Oxygen Analyzer Return	10.00	10-14-83	10.00	10-14-83
		9.50	10-01-81	9.50	10-01-81
733-1	Automatic TIP Ball Valve	0.25	11-07-83	0.25	11-07-83
		0.70	02-02-83	0.70	02-02-83
		0.15	09-25-81	0.15	09-25-81
733-2	Automatic TIP Ball Valve	0.40	11-07-83	0.40	11-07-83
		0.00	02-17-83	0.00	02-17-83
		0.40	02-02-83	0.40	02-02-83
		0.20	09-25-81	0.20	09-25-81
733-3	Automatic TIP Ball Valve	0.70	11-07-83	0.70	11-07-83
		0.00	02-02-83	0.00	02-02-83
		0.10	09-25-81	0.10	09-25-81
733-4	Automatic TIP Ball Valve	0.00	11-07-83	0.00	11-07-83
		0.00	02-02-83	0.00	02-02-83
		2.10	09-25-81	2.10	09-25-81
733-5	Automatic TIP Ball Valve	4.50	11-07-83	4.50	11-07-83
		0.00	02-02-83	0.00	02-02-83
		0.00	09-25-81	0.00	09-25-81
700-743	TIP Purge Check Valve	7.50	11-07-83	7.50	11-07-83
		4.70	09-25-81	4.70	09-25-81
SO 2499-1A	CAM - Drywell	0.00	10-12-83	0.00	10-12-83
SO 2499-2A		0.10	09-28-81	0.10	09-28-81
SO 2499-3A	CAM - Suppression Chamber	0.00	10-14-83	0.00	10-14-83
SO 2499-4A		0.00	09-28-81	0.00	09-28-81

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
SO 2499-1B	CAM - Drywell	0.00	10-07-83	0.00	10-07-83
SO 2499-2B		0.00	09-28-81	0.00	09-28-81
SO 2499-3B	CAM - Suppression	0.00	10-12-83	0.00	10-12-83
SO 2499-4B	Chamber	0.00	09-28-81	0.00	09-28-81
AO 2599-2A	ACAD to Drywell	5.00/0.00	10-07-83	5.00/0.00	10-07-83
CV 2599-23A		0.20	09-28-81	0.20	09-28-81
AO 2599-3A	ACAD to Suppression	0.90/15.10	10-12-83	0.30	11-08-83
CV 2599-24A	Chamber	2.00	09-28-81	2.00	09-28-81
AO 2599-2B	ACAD to Drywell	1.50/4.00	10-07-83	1.50/4.00	10-07-83
CV 2599-23B		1.70	09-28-81	1.70	09-28-81
AO 2599-3B	ACAD to Suppression	0.00	10-12-83	0.00	10-12-83
CV 2599-24B	Chamber	0.00	09-28-81	0.00	09-28-81
AO 2599-4A	ACAD Drywell Bleed to	1.80	09-23-83	1.80	09-23-83
FCV 2599-5A	SBGTS	1.40	09-28-81	1.40	09-28-81
AO 2599-4B	ACAD Drywell	6.50	09-23-83	6.50	09-23-83
FCV 2599-5B	Bleed to SBGTS	U.D.	09-28-81	9.50	12-18-81
X-1	Drywell Equipment Hatch	0.00	09-04-83	0.00	02-07-84
		0.00	03-28-83	0.00	03-28-83
		0.00	12-23-81	0.00	12-23-81
X-2	Drywell Personnel	24.73	01-14-84	1.37	01-20-84
	Airlock	10.30	12-18-81	10.30	12-18-81
X-4	Drywell Head Access	0.00	10-17-83	0.00	11-08-83
	Hatch	0.00	10-01-81	0.00	10-01-81
X-6	CRD Removal Hatch	0.00	09-04-83	0.00	01-19-84
		0.00	03-26-83	0.00	03-26-83
		0.00	12-23-81	0.00	12-23-81
X-35A	TIP Flux Mon. Flange	0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81
X-35B		0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81

* 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
X-35C		0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81
X-35D		0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81
X-35E		0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81
X-35F		0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81
X-35G		0.00	11-07-83	0.00	11-07-83
		0.00	09-25-81	0.00	09-25-81
X-200A	Suppression Chamber	0.00	09-04-83	0.00	02-14-84
	Access Hatch	0.00	03-28-83	0.00	03-28-83
		0.00	12-24-81	0.00	12-24-81
X-200B		0.00	09-04-83	0.00	02-06-84
		0.00	12-24-81	0.00	12-24-81
Drywell Head	Drywell Head Flange	7.50	09-05-83	0.00	02-07-84
		0.00	12-23-81	0.00	12-23-81
SL-1	Shear Lug Inspection	0.00	10-31-83	0.00	10-31-83
	Hatches	0.05	09-18-81	0.05	09-18-81
SL-2		0.00	10-31-83	0.00	10-31-83
		0.00	09-18-81	0.00	09-18-81
SL-3		0.00	10-31-83	0.00	10-31-83
		0.00	09-18-81	0.00	09-18-81
SL-4		0.00	10-31-83	0.00	10-31-83
		0.00	09-18-81	0.00	09-18-81
SL-5		0.00	10-31-83	0.00	10-31-83
		0.00	09-18-81	0.00	09-18-81
SL-6		0.00	10-31-83	0.00	10-31-83
		0.00	09-18-81	0.00	09-18-81
SL-7		0.00	10-31-83	0.00	10-31-83
		0.00	09-18-81	0.00	09-18-81

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		0.00	10-31-83	0.00	10-31-83
		0.05	09-18-81	0.05	09-18-81
X-7A	Primary Steam	0.00	10-27-83	0.00	10-27-83
		0.00	09-10-81	0.00	09-10-81
X-7B		0.00	10-27-83	0.00	10-27-83
		0.00	09-10-81	0.00	09-10-81
X-7C		0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81
X-7D		0.00	10-07-83	0.00	10-07-83
		1.20	09-10-81	1.20	09-10-81
X-8	Primary Steam	0.00	10-27-83	0.00	10-27-83
	Drain Line	0.10	09-10-81	0.10	09-10-81
X-9A	Reactor Feedwater	0.00	10-27-83	0.00	10-27-83
		0.00	09-10-81	0.00	09-10-81
X-9B		0.55	10-07-83	0.55	10-07-83
		0.50	09-10-81	0.50	09-10-81
X-10	Steam to RCIC	0.00	10-07-83	0.00	10-07-83
		0.30	09-10-81	0.30	09-10-81
X-11	HPCI to Steam Supply	0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81
X-12	RHRS Supply	3.20	10-07-83	3.20	10-07-83
		1.70	09-10-81	1.70	09-10-81
X-13A	RHRS Return	0.00	10-27-83	0.00	10-27-83
		0.00	09-10-81	0.00	09-10-81
X-13B		0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81
X-14	Cleanup Supply	0.95	10-27-83	0.95	10-27-83
		0.70	09-10-81	0.70	09-10-81
X-23	Cooling Water	0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81
X-24	Cooling Water Return	0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81

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	1.95	10-27-83	1.95	10-27-83
		2.20	09-10-81	2.20	09-10-81
		2.10	05-08-81	2.10	05-08-81
X-26	Vent to Drywell	1.40	10-27-83	1.40	10-27-83
		0.40	09-10-81	0.40	09-10-81
X-36	CRD Hydraulic System Return	0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81
X-47	Standby Liquid Control	0.00	10-07-83	0.00	10-07-83
		0.00	09-10-81	0.00	09-10-81
X-17	Reactor Vessel Head Spray	1.40	10-27-83	1.40	10-27-83
		1.20	09-10-81	1.20	09-10-81
X-16A	Core Spray Inlet	6.00	10-27-83	6.00	10-27-83
		4.00	09-10-81	4.00	09-10-81
X-16B	Core Spray Inlet	19.00	10-27-83		
		11.00	09-10-81	11.00	09-10-81
X-100B	CRD Position Indication	0.05	10-27-83	0.05	10-27-83
		0.00	09-15-81	0.00	09-15-81
X-100C	Neutron Monitor	0.20	10-28-83	0.20	10-28-83
		0.50	09-21-81	0.50	09-21-81
X-100E	CRD Position Indication	0.20	10-28-83	0.20	10-28-83
		0.00	09-21-81	0.00	09-21-81
X-100F	Power	0.00	11-04-83	0.00	11-04-83
		0.00	09-23-81	0.00	09-23-81
X-100G	CRD Position Indication	0.35	11-04-83	0.35	11-04-83
		0.00	03-26-83	0.00	03-26-83
		0.00	09-25-81	0.00	09-25-81
X-101A	Recirc Pump	0.20	10-28-83	0.20	10-28-83
		0.00	09-16-81	0.00	09-16-81
X-101B	Recirc Pump	0.20	10-28-83	0.20	10-28-83
		0.35	09-17-81	0.35	09-17-81

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	0.20	11-04-83	0.20	11-04-83
		0.00	09-25-81	0.00	09-25-81
X-102B	Neutron Monitors	0.15	10-28-83	0.15	10-28-83
		0.00	09-17-81	0.00	09-17-81
X-103	Neutron Monitor	0.25	10-28-83	0.25	10-28-83
		0.15	09-17-81	0.15	09-17-81
X-104A	CRD Position Indication	0.00	10-27-83	0.00	10-27-83
		0.00	09-16-81	0.00	09-16-81
X-104B	Drywell Coolers	0.00	10-27-83	0.00	10-27-83
		0.00	09-16-81	0.00	09-16-81
X-104C	CRD Position Indication	0.25	10-28-83	0.25	10-28-83
		0.00	09-17-81	0.00	09-17-81
X-104D	CRD Position Indication	0.25	10-28-83	0.25	10-28-83
		0.15	09-21-81	0.15	09-21-81
X-104F	Recirc Pump Power	0.15	11-04-83	0.15	11-04-83
		0.00	09-25-81	0.00	09-25-81
X-105C	Neutron Monitors	0.25	10-28-83	0.25	10-28-83
		0.10	09-17-81	0.10	09-17-81
X-106A	CRD Position Indication	0.05	10-27-83	0.05	10-27-83
		0.00	09-16-81	0.00	09-16-81
X-106B	Thermocouples	0.25	10-28-83	0.25	10-28-83
		0.00	09-25-81	0.00	09-25-81
X-107A	Neutron Monitor	0.25	10-28-83	0.25	10-28-83
		0.30	09-21-81	0.30	09-21-81
X-107B	Recirc Pump Power	0.30	11-04-83	0.30	11-04-83
		0.00	09-25-81	0.00	09-25-81
X-227A	ACAD/CAM	0.00	11-08-83	0.00	11-08-83
		0.00	09-28-81	0.00	09-28-81
X-227B	ACAD/CAM	0.00	11-08-83	0.00	11-08-83
		0.00	09-28-81	0.00	09-28-81

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 after 12 hours of testing. Table B-3 has the data set at the conclusion of the 24 hour test. Table B-4 has the data set at the start of the induced phase of the test. Table B-5 has the data set at the conclusion of the induced phase of the test.

QUAD CITIES UNIT 2 0641 02/09/84

**** DATA SET INPUT ****

SUB VOL #	AVG TEMP	AVG DEW CELL	AVG VAP
1	113.60	62.86	0.28360
-2	113.95	61.81	0.27327
-3	112.00	41.91	0.27327
-4	110.64	51.81	0.27327
-5	102.80	58.97	0.26573
-5	96.93	59.48	0.25158
-7	86.90	53.48	0.25158
-8	72.67	52.80	0.19753
9	76.01	52.80	0.19753
10	74.14	71.57	0.38293
11	131.83	131.83	2.33328

SET # 30 AT 064945 2/ 9/84 BASE DATA SET = 13

P1= 63.89690 P2= 63.88532 HLFRL=[illegible] 49.74 TEMP= 85.74 DWCL= 66.41 VAPR=0.32095 DRYP=63.56836

MASS= 0.90773058725E 05

RTDS

1 113.49 113.75
2 111.94 119.97
3 111.23 112.77
4 112.99 108.32
5 101.33 103.31 103.77
6 97.74 97.73 96.01 96.25
7 87.26 84.27 89.13 86.95
8 72.08 72.59 73.97 72.45
9 76.01
10 74.18 73.87 74.58 74.16 74.01 74.92
11 131.03 131.73

DEWCELLS

1 62.86
2 64.00 59.62
5 [illegible] 60.97
7 59.98 59.98
9 52.05 53.55
10 71.47 71.67

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS T+0	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	MEAS. LEAK RATE % / DAY POINT	CALC. LEAK RATE %/DAY	UPPER 95% CONF LIMIT
[illegible]	6:49:45	2/ 9/84	85.74	0.9073058726E 05	0.9080537688E 05	63.568	0.6493	1.0880	0.6982	0.7294

SUMMATION DATA

TIME	MASS	DELTA MASS	DELTA MASS**2	TIME**2	MASS*TIME
0.25499990E 02	0.16338728E 07	0.58020778E [illegible]	0.28192928E 00	0.49582926E 02	0.73142188E 07

TABLE B-1

QUAD CITIES UNIT 2   1842   02/09/84

**** DATA SET INPUT ****

SUB VOL #	AVG TEMP	AVG DEW CELL	AVG VAP
1	111.45	57.02	0.23036
2	113.14	56.43	0.22548
3	112.46	56.43	0.22548
4	110.93	56.43	0.22548
5	102.42	56.00	0.22197
6	98.41	56.18	0.22341
7	82.92	56.18	0.22341
8	69.14	51.65	0.18937
9	71.84	51.65	0.18937
10	71.89	69.72	0.35965
11	133.58	133.58	2.44403

SET #102   AT 184958   2/ 9/84   BASE DATA SET = 30

P1= 63.45459 P2= 63.44727 WLEVL=+4.94 TEMP= 83.77 DWCL= 63.77 VAPR=0.29274 DRYP=63.15820

MASS= 0.9051059956E 05

RTDS

1	111.91	111.39				
2	111.19	115.10				
3	112.05	112.89				
4	113.54	108.32				
5	100.89	102.87	103.74			
6	97.24	97.18	99.40	95.78		
7	83.17	79.78	86.03	82.74		
8	68.60	69.11	69.62	69.09		
9	71.84					
10	71.89	71.54	72.41	71.93	71.83	71.77
11	133.53	133.63				

DEWCELLS

1	57.09	
4	58.59	54.27
5	56.00	
7	56.17	56.18
9	51.00	52.31
10	70.06	69.38

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS T=0	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	POINT	CALC. LEAK RATE %/DAY	UPPER 99% CONF LIMIT
12.00	18:49:58	2/ 9/84	83.77	0.905105992E 05	0.9071502116E 05	63.158	0.4848	0.4495	0.4683	0.4804

SUMMATION DATA

TIME	MASS	DELTA MASS	DELTA MASS**2	TIME**2	MASS*TIME
0.4380611E 03	0.A614442E 07	0.8690975E 04	0.1369875E 07	0.3529453E 04	0.3967624E 08

TABLE B-2

QUAD CITIES UNIT 2 2642 02/10/84

**** DATA SET INPUT ****

SUB VOL #	AVG TEMP	AVG DEW CELL	AVG VAP
1	108.49	55.79	0.22034
2	112.06	55.61	0.21888
3	112.05	55.61	0.21888
4	110.76	55.51	0.21898
5	102.48	55.19	0.21556
6	95.79	55.51	0.21809
7	81.00	55.51	0.21809
8	68.16	51.33	0.18714
9	70.57	51.33	0.18714
10	71.41	57.09	0.35197
11	134.98	134.94	2.53580

SET #170 AT 064944 2/10/84 BASE DATA SET = 30

P1= 63.24463 P2= 63.22656 WLEVL=40.60 TEMP= 83.06 DWCL= 63.16 VAPR=0.28659 DRYP=62.94922

MASS= 0.9034207313E 05

RTDS

1	108.54	108.43				
2	110.08	114.03				
3	111.90	112.20				
4	112.98	108.56				
5	100.89	102.95	103.62			
6	96.64	95.65	94.83	95.07		
7	81.04	77.90	84.28	80.87		
8	67.68	68.04	68.83	68.11		
9	70.57					
10	71.38	71.07	71.94	71.45	71.36	71.30
11	134.83	135.13				

DEWCELLS

1	55.79	
4	57.60	53.62
5	55.19	
7	56.68	55.37
9	50.71	51.95
10	69.34	68.84

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS T=0	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	POINT	CALC. LEAK RATE %/DAY	UPPER 95% CONF LIMIT
24.00	6:49:44	2/10/84	83.06	0.903420731E 05	0.9069662636E 05	62.949	0.4062	-0.0403	0.3862	0.3929

SUMMATION DATA

TIME	MASS	DELTA MASS	DELTA MASS**2	TIME**2	MASS*TIME
0.1669714E 04	0.1274386E 08	0.2915550E 05	0.7518362E 07	0.2666197E 05	0.1510484E 09

TABLE B-3

QUAD CITIES UNIT 2   0819   02/10/84

**** DATA SET INPUT ****

SUB VOL #	AVG TEMP	AVG DEW CELL	AVG VAP
1	108.11	55.56	0.21851
2	111.90	55.61	0.21888
3	111.93	55.61	0.21888
4	110.68	55.61	0.21898
5	102.48	55.15	0.21523
6	95.71	55.42	0.21735
7	80.79	55.42	0.21735
8	68.01	51.24	0.18652
9	70.41	51.24	0.18652
10	71.35	68.92	0.34986
11	134.98	134.98	2.53590

SET #179   AT 081937   2/10/84   BASE DATA SET *

P1= 63.19580 P2= 63.17578 WLEVL=40.09 TEMP= 82.96 DWCL= 63.04 VAPR=0.28536 DRYP=62.90039

MASS= 0.9031236630E 05

RTDS

1	108.19	109.03				
2	109.93	113.87				
3	111.93	112.04				
4	112.79	109.56				
5	100.89	102.91	103.66			
6	95.56	96.55	94.75	94.99		
7	80.81	77.60	84.12	80.63		
8	67.57	67.80	68.67	67.99		
9	70.41					
10	71.34	70.99	71.90	71.37	71.32	71.22
11	135.04	134.94				

DEWCELLS

1	55.56	
4	57.67	53.55
5	55.15	
7	55.50	55.33
9	50.66	51.82
10	69.07	68.76

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS T=0	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	POINT	CALC. LEAK RATE %/DAY	UPPER 95% CONF LIMIT
	8:19:37	2/10/84	82.96	0.903123603E 05	0.9036035856E 05	62.900	0.9625	0.9115	0.9755	1.0320

SUMMATION DATA

TIME	MASS	DELTA MASS	DELTA MASS**2	TIME**2	MASS*TIME
0.5876919E 01	0.7224670E 06	0.2182199E 03	0.7985096E 04	0.5742324E 01	0.5308296E 06

TABLE B-4

QUAD CITIES UNIT 2   1211   02/10/84

**** DATA SET INPUT ****

SUB VOL #	AVG TEMP	AVG DEW CELL	AVG VAP
1	107.36	55.56	0.21851
2	111.50	55.48	0.21783
3	111.62	55.48	0.21783
4	110.52	55.48	0.21783
5	102.51	55.06	0.21457
6	95.53	55.32	0.21660
7	80.27	55.32	0.21660
8	67.73	51.10	0.18556
9	70.09	51.10	0.18556
10	71.25	68.97	0.35053
11	135.34	135.34	2.55923

SET #203 AT 121939 2/10/84 BASE DATA SET = 179

P1= 63.05469 P2= 63.03125 WLEVL=38.76 TEMP= 82.78 DWCL= 53.02 VAPR=0.26518 DRYP=62.75781

MASS= 0.9014917793E 05

RTDS

1	107.48	107.24				
2	109.53	113.47				
3	111.51	111.73				
4	112.48	108.56				
5	100.80	102.95	103.70			
6	96.40	96.35	94.59	94.70		
7	80.33	77.08	83.69	80.00		
8	67.33	67.44	68.40	67.75		
9	70.09					
10	71.18	70.91	71.82	71.29	71.20	71.14
11	135.44	135.24				

DEWCELLS

1	55.56	
4	57.52	53.43
5	55.06	
7	55.42	55.22
9	50.47	51.73
10	69.22	68.72

TEST DUR. HOURS	CLOCK TIME	DATE	TEMP (F)	MEASURED MASS	CALC. MASS T=0	DRY AIR PRESS. (PSIA)	MEAS. LEAK RATE % / DAY TOTAL	MEAS. LEAK RATE % / DAY POINT	CALC. LEAK RATE %/DAY	UPPER 95% CONF LIMIT
4.00	12:19:39	2/10/84	82.78	0.901491779E 05	0.903122526E 05	62.758	1.0840	0.6728	1.0871	1.0926

SUMMATION DATA

TIME	MASS	DELTA MASS	DELTA MASS**2	TIME**2	MASS*TIME
0.5009553E 02	0.2255766E 07	0.2042549E 04	0.2249523E 06	0.1365857E 03	0.4518678E 07

TABLE B-5

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 copy of that procedure is presented here.

CALCULATIONS PERFORMED FOR IPCLRT DATA

ID/8B

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.

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

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

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.

$$T = \sum_{j=1}^{NVOL} (VF_j) * (T_j) \ {}^oF \qquad (3)$$

$$D.P. = \sum_{j=1}^{NVOL} (VF_j) * (D.P._j) \ {}^oF \qquad (4)$$

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

FOR REFERENCE ONLY

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.

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

$$X = 647.27 - D.P.(^{o}K)$$

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

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

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

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

289506 = primary containment volume

FOR REFERENCE ONLY

NOTE

This volume is the summation of the subvolumes calculated in QTS 150-T2. These subvolumes were calculated using QTS 150-T8. Since the measured leak rate is a difference in air masses, this number is just as conservative as using the FSAR number.

E. Measured Leak Rate.

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

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

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:

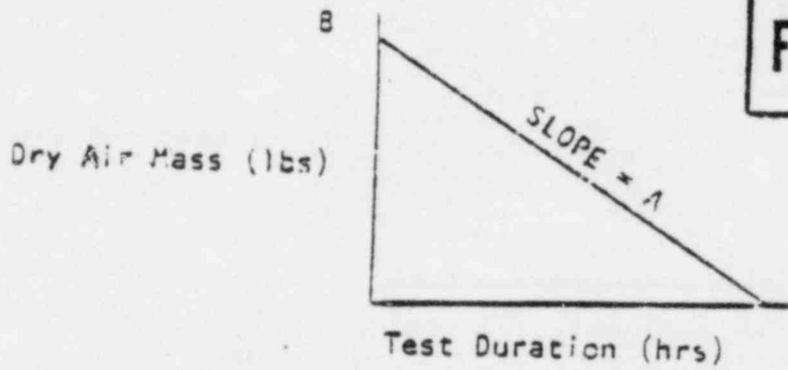
$W = At + B$

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 in the process computer program 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 TDistribution function are used as follows.

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

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

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