REACTOR CONTAINMENT BUILDING

INTEGRATED LEAK RATE TEST

QUAD-CITIES NUCLEAR POWER STATION

UNIT TWO

APRIL 1 - 6, 1992

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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 April 1 - 6, 1992 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.

For the seventh time at Quad Cities a short duration test (less than 24 hours was conducted using the general test method outlined in BN-TOP-1, Revision 1 (Bechtel Corporation Topical Report) dated November 1, 1972. The first short duration test was conducted on Unit One in December, 1982.

Using the above test method, the total primary containment integrated leak rate was calculated to be 0.1764 wt %/day at a test pressure greater than 48 PSIG. The calculated leak rate was within the 0.750 wt %/day acceptance criteria (75% of L_A). The associated upper 95% confidence limit was 0.2458 wt %/day.

The supplemental induced leakage test result was calculated to be 1.0593 wt %/day. This value should compare with the sum of the measured leak rate phase result (0.1764 wt %/day) and the induced leak of 8.5 SCFM (1.0339 wt %/day). The calculated leak rate of 1.0593 wt %/day lies within the allowable tolerance band of 1.2103 wt %/day ± 0.250 wt %/day.

SECTION A - TEST PREPARATIONS

A.1 Type A Test Procedure

The IPCLRT was performed in accordance with Quad-Cities Procedures QCTS 500-1 Rev. 0, QCTS 500-2 through -6, and procedure QCTP 500-3. Approved temporary procedure 7699 was written in conjunction with the test. Procedure 7699 was written to revise the operations pretest checklist. This temporary procedure corrected typographical errors identified in the line-up.

These procedures were written to comply with 10 CFR 50 Appendix J, ANS/ANSI N45.4-1972, and Quad-Cities Unit Two Technical Specifications, and to reflect the Commission's approval of a short duration test using the BN-TOP-1, Rev. 1 Topical Report as a general test method.

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 subvolumes. Instrumentation calibrations were performed using NBS traceable standards. Quad Cities procedure QCTS 500-2 was used to perform the calibration.

TABLE ONE

INSTRUMENT SPECIFICATIONS

INSTRUMENT	MANUFACTURER	MODEL NO.	SERIAL NO.	RANGE	ACCURACY	REPEATABILITY
Precision Pressure Gauges (2)	Volumetrics	PPM-1000	10141-2 10255-2	0.4 - 100 PSIA	±0.015% Rdg ±0.005% F.S.	±0.001% F.S.
Thermistors (30)	Volumetrics	418905000	SEE TABLE TWO	50° - 135°F	0.25°F	0.01°F
Dewcells (10)	Volumetrics	Lithium Chloride	SEE TABLE TWO	93-212°F	0.25°F	0.01°F
Thermocouple	Pall Trinity Micro	14-T-2H		0-600°F	±2.0°F	±.1°F
Flowmeter	Fischer & Porter	10A3555S	8405A0348A1	1.15-11.10 scfm	±.111 scfm	
Level Indicator LT 1-646B	GEMAC	555111BCAA 3AAA		0-60" H_2O		

TABLE TWO
SENSOR PHYSICAL LOCATIONS

THERMISTER NO.	SERIAL NUMBER	SUBVOLUME	ELEVATION	AZIMUTH*
1	11	1	670'0"	180°
2	16	1	670'0"	0°
3	21	2	657'0"	20°
4	8	2	657'0"	197°
5	12	3	639'0"	70°
6	19	3	639'0"	255°
7	22	4(Annular Ring)	643'0"	55°
8	15	4	615'0"	225°
9	23	5	620'0"	5°
10	10533-12	5	620'0"	100°
11	20	5	620'0"	220°
12	7	6	608'0"	40°
13	10533-9	6	608'0"	130°
14	18	6	608'0"	220°
15	9	6	608'0"	310°
16	10602-26	7	598'0"	70°
17	10602-21	7	598'0"	160°
18	10602-4	7	598'0"	250°
19	10602-35	7	598'0"	340°
20	10602-15	8	587'0"	10°
21	10602-34	8	587'0"	100°
22	11340-12	8	587'0"	190°
23	10602-17	8	587'0"	280°
24	10602-19	9(CRD Space)	595'0"	170°
25	10602-24	9(CRD Space))	580'0"	170°
26	10602-31	10(Torus)	578'0"	70°
27	10602-18	10(Torus)	578'0"	140°
28	10602-16	10(Torus)	578'0"	210°
29	17	10(Torus)	578'0"	280°
30	6	10(Torus)	578'0"	350°
Thermocouple	(inlet to clean-up HX)	11(Rx Vessel)		

DEWCELL NO.	SERIAL NUMBER	SUBVOLUME	ELEVATION	AZIMUTH
1	1050292	1	670'0"	180°
2	1000292	2,3,4	653'0"	90°
3	1070292	2,3,4	653'0"	270°
4	0930292	5	620'0"	0°
5	0990292	6	605'0"	45°
6	0980292	7	600'0"	220°
7	0960292	8,9	591'0"	0°
8	0900292	8,9	591'0"	202°
9	0870292	10	578'0"	90°
10	0910292	10	578'0"	270°
Thermocouple (Saturated)		11	---	---

Idealized View of Drywell and Torus
Used to Calculate Free Volumes

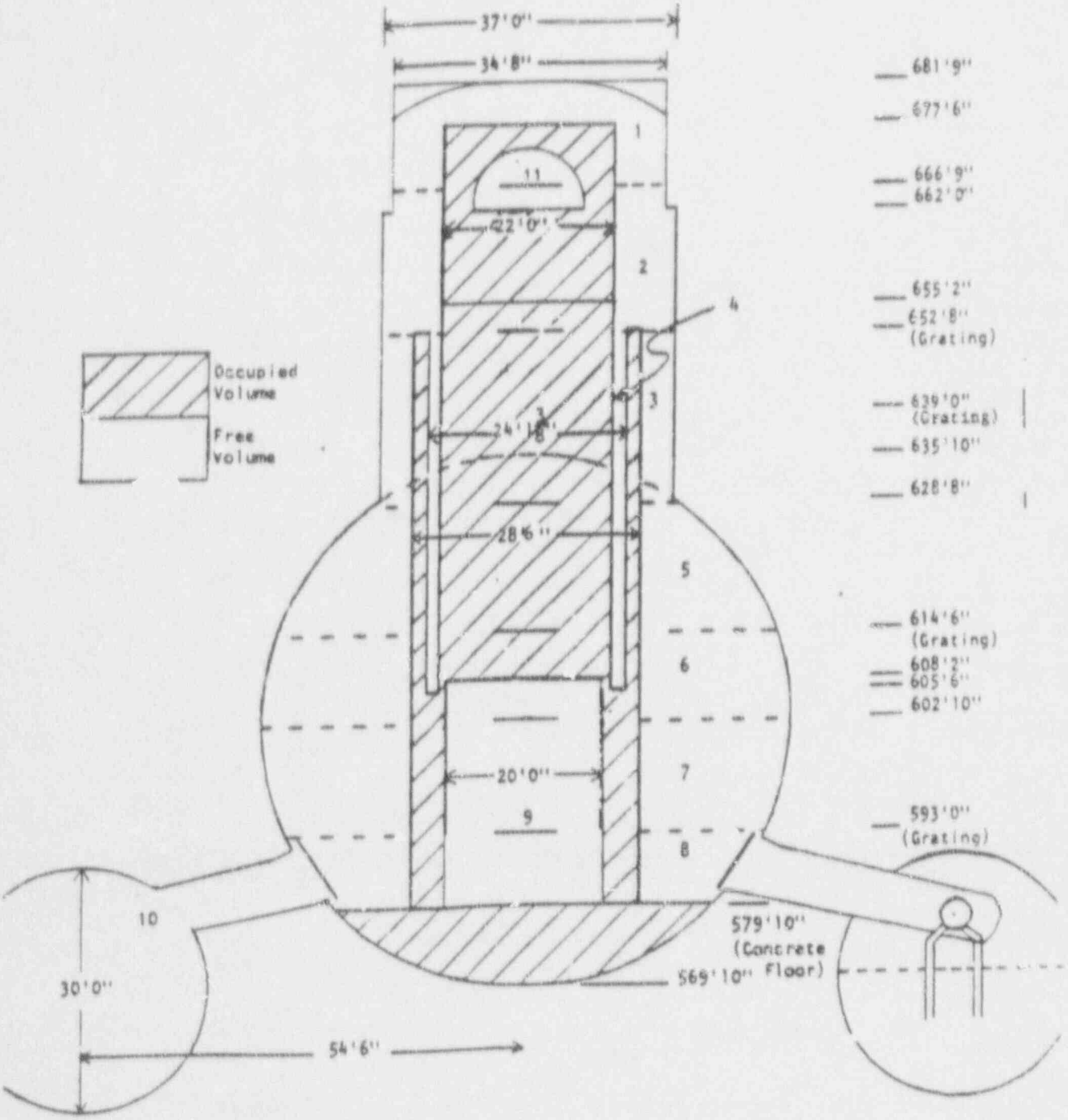

FIGURE 1

A.2.a. Temperature

The location of the 30 thermistor's was chosen to avoid conflict with local temperature variations and thermal influence from metal structures. A temperature survey of the containment was previously performed to verify that the sensor locations were representative of average subvolume conditions.

The Thermistors are hermetically sealed, glass encapsulated units manufactured by YSI Inc. These sensors have a recommended operating range between -110 and 390 degrees F. A stability of better than 0.018 degrees F per ten months can be expected when the units are stored at or below 212 degrees F. Interchangeable Thermistors, model 41890500 were chosen. YSI certifies each sensor to follow the same Resistance verses Temperature curve within 0.1 degrees F over the range of 50 to 135 degrees F.

Each sensor is connected to a signal conditioning card. The Thermistor resistance is converted by this card to a known voltage. The voltage output from the card is a function of the resistance. The Thermistor's change in resistance with temperature is very nonlinear.

Therefore, the variation of output voltage with temperature is nonlinear. In order to allow direct reading of temperature values from the DAS, two sixth order polynominal curve fits are programmed into the DAS's EPROMs. As recommended in ANS 56.8, the DAS output and display has a resolution of 0.01 degrees F.

A.2.b. Pressure

Two Volumetrics PPM-1000 Precision Pressure Monitors were utilized to measure total containment pressure. Each precision pressure gauge was calibrated from 0.4-100.0 PSIA. Primary containment pressure was sensed by the pressure gauges in parallel through a tygon tube connected to pressure taps associated with the Unit Two CAM return to drywell penetration.

Each instrument contains a pressure-sensing element that delivers an electrical frequency (in relation to the applied pressure) to a microprocessor circuit. The microprocessor corrects the signal for nonlinearity, offset, scaling, and temperature effects and displays the corrected pressure value on a 5-1/2 digit LED readout.

The sensor is the vibrating cylinder type. The cylinder is a vibrating mechanical system. A vacuum reference in maintained on the outside of the cylinder. The pressure differential across the wall creates stress on the wall varying the natural resonant frequency of vibration. The resonant frequency depends upon the physical properties of the element such as mass, stress, elasticity, dimensions and temperature. The cylinder is made from a special nickel iron alloy, and closely controlled manaufacturing techniques eliminate mass, dimension, and elasticity effects. Temperature is measured using a calibrated diode and corrected by the microprocessor.

The sensor's electronic circuit conditions the frequency wave and sends it to the pulse rate converter board which counts the period. The period is sent in a 16-bit word to the microprocessor controlled panel meter (MPM).

The sensor's temperature sensing diode voltage is converted to a 15-bit digital signal using the analog-to-digital converter in the MPM. The pressure is calculated by the MPM and displayed in appropriate units on the 5-1/2 digit seven-segment LED display.

Each PPM-1000 was calibrated from 0.40-100.0 PSIA by Volumetrics on January 29, 1992.

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 by Volumetrics on February 25, 1992.

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 by Fischer-Porter on December 3, 1991, to within ±1% of full scale (0.9 - 11.4 SCFM) using NBS traceable standards, to standard atmospheric conditions.

Plant personnel continuously monitored the flow during the induced leakage phase and corrected any minor deviations from the induced flow rate of 8.5 SCFM by adjusting a 3/8" needle valve on the flowmeter inlet. The flow meter outlet was unrestricted and vented to the atmosphere.

A.3 Type A Test Measurement

The IPCLRT was performed utilizing a direct interface with the station prime computer. This system consists of a Data Acquisition System (DAS) and a multiplexer in containment.

Upon initiation of data acquisition cycle, the DAS reads the selected OPERATE mode of single, continuous, or interval, and either block or sequential scan. Once the system has determined which channels to scan (user-defined), it addresses the analog scanner to select the first channel for sampling This address information (three BCD digits from the Printer/Scanner Interface Card) is transmitted at RS-232C voltage levels.

The scanner selects the channel and routes the analog signal to the Analog to Digital Converter (ADC) housed in the DAS. After a relay stabilizing time of approximately ten milliseconds, the Central Processing Card (CPU) initiates the ADC. Although the ADC is capable of 20 conversions per second, the actual scan rate is 10 per second because the CPU has numerous other functions to perform.

Upon conversion request, the ADC resets and selects a 0.1V or 1.0V full scale conversion factor as designated by the CPU. The CPU is then interrupted by the ADC to read the converted data and the ADC status word. The status word indicates the polarity of the input voltage and if it was an overrange. The data is stored in a buffer in RAM. The CPU addresses the scanner for data from the next channel, and the acquisition process continues until all the data from the channels programmed to be scanned is stored in the buffer.

Numerical calculation of the raw data may now begin. The CPU selects the most recent data entry from the buffer and divides it by 65536, the full scale count value of the ADC, to obtain the voltage value. The CPU checks the channel's format byte to determine the channel's assigned engineering unit (0-15). That unit's associated slope and intercept values (m and b) are user-accessible in CMOS RAM>. The slope (m) is multiplied by the voltage value (x), then added to the intercept (b) to obtain the final data value (y).

The final data value is printed out on all enabled outputs. The printout includes the channel number, the final data, the assigned engineering unit, and the channel header. Digital input data, headers, date, and time are also printed out.

The PRIME computer was used to compute and print the leak rate data using either the ANSI/ANS mass plot method (ANSI/ANS 56.8), a total time method based on ANSI/ANS n45.4, or the BN-TOP-1 method. Key parameters, such as total time measure leak rate, volume weighted dry air pressure and temperature, and absolute pressure were monitored using a Tektronix 4208 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

Two PTS 1500 CFM diesel drive, oil-free air compressors were used to pressurize the primary containment. The compressors were physically 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.

TEMPERATURE/HUMIDITY SENSING DEVICE INTERCONNECTION DIAGRAM

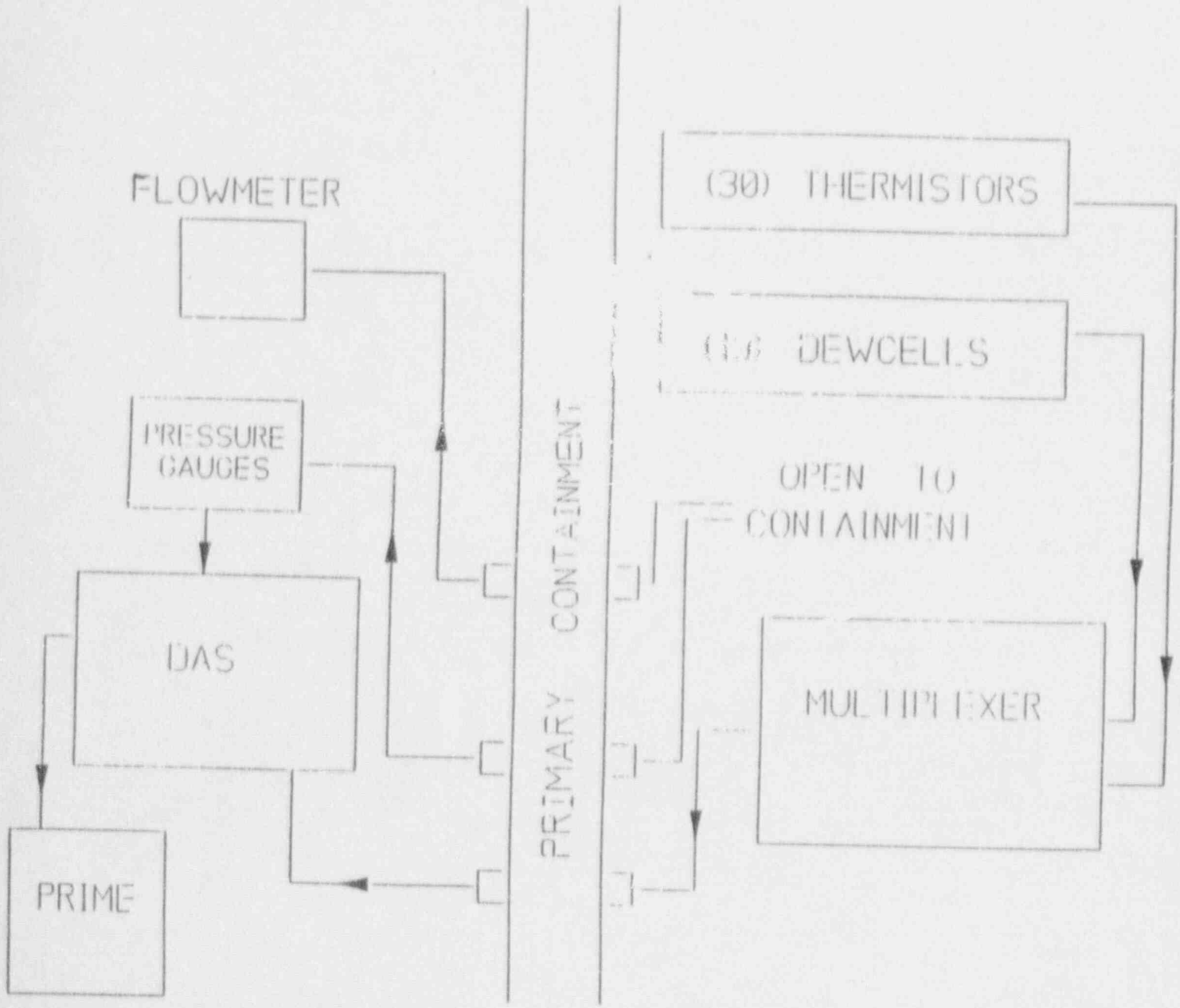

FIGURE 2

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 ANSI N45.4-1972. The inputs to the measured leak rates calculation include subvolume weighted containment temperature, subvolume weighted vapor pressure, and total absolute air pressure.

As required by the Commission in order to perform a short duration test (measured leak rate phase of less than 24 hours), the measured leak rate was statistically analyzed using the principles outlined in BN-TOP-1, Rev. 1. A least squares regression line for the measured total time leak rate versus time since the start of the test is calculated after each new data set is scanned. The calculated leak rate at a point in time, t_i, is th leak rate on the regression line at the time t_i.

The use of a regression line in the BN-TOP-1, Rev. 1 report is different from the way it is used in the ANSI/ANS 56.8 standard. The latter standard uses the slope of the regression line for dry air mass as a function of time to derive a statistically averaged leak rate. In contrast, BN-TOP-1, Rev. 1 calculates a regression line for the measured leak rate, which is a function of the change in dry air mass. For the ANSI/ANS calculations one would expect to always see a negative slope for the regression line, because the dry air mass is decreasing over time due to leakage from the containment. For the regression line computed in the BN-TOP-1, Rev. 1 method the ideal slope is zero, since you presume that the leakage from the containment is constant over time. Since it is impossible to instantaneously and perfectly measure the containment leakage, the slope of the regression line will be positive or negative depending on the scatter in the measured leak rate values obtained early in the test. Since the measured leak rate is a total time calculation, the values computed early in the test will scatter much more than the values computed after a few hours of testing.

The computer printouts titled "Leak Rate Based on Total Time Calculations" attached to the BN-TOP-1, Rev. 1 topical report are misleading in that the column titled "Calculated Leak Rate" actually has printed out the regression line values (based on all the measured leak rate data computed from the data sets received up until the last time listed on the printout). The calculated leak rate as a function of time (t_i) can only be calculated from data available up until that point in time, t_i. This is significant in that the calculated leak rate may be decreasing over time, despite a substantial positive slope in the last computed regression line. Extrapolation of the regression line is not required by the BN-TOP-1, Rev. 1 criteria to terminate a short duration test. What is required is that the calculated leak rate be decreasing over time or that an increasing calculated leak rate be extrapolated to 24 hours. The distinction between the regression line values and the calculated leak rate as a function of time is made in Section 6.4 of BN-TOP-1, Rev.1. Calculated leak rates, as a function of time, are correctly printed out in the "Trends Based on Total Time Calculations" computer printouts in Appendix B of BN-TOP-1, Rev. 1.

Associated with each calculated leak rate is statistically derived upper confidence limit. Just as the calculated leak rate in BN-TOP-1, Rev. 1 and the statistically averaged leak rate in the ANSI/ANS standards are not the same (and do not necessarily yield nearly equal values), the upper confidence limit calculations are greatly different. In the BN-TOP-1, Rev. 1 topical report the upper confidence limit is defined as the calculated leak rate plus the product of the two sided 97.5% T-distribution value (as opposed to the one-sided t-distribution used in the ANS/ANSI standard) and the standard deviation of the measured leak rate data about the computed regression line (which has no relationship to the value computed in the ANSI/ANS standards).

There are two important conclusions that can be derived from data analyzed using the BN-TOP-1, Rev. 1 method: 1) the upper confidence limit for the same measured leak rate data can be substantially greater than the value calculated using the ANSI/ANS method, and 2) the upper confidence limit does not converge to the calculated leak rate nearly as quickly as usually observed in the latter method as the number of data sets becomes large. With this in mind, the upper confidence limit can become the critical parameter for concluding a short duration test, even when the measured leak rate seems to be well under the maximum allowable leak rate. A graphical comparison of the two methods can be made by referring to Figure 3 for the BN-TOP-1 in Appendix F for the statistically averaged leak rate and upper confidence limit based on ANSI/ANS 56.8-1981. This data supports the contention of many that BN-TOP-1, while it may not give the best estimate of containment leakage, is a conservative method of testing. The ANSI/ANS 56.8 data contained in Appendix F is provided for information only. The reported test results are based on BN-TOP-1, only.

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 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 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.

B.3 Instrument Error Analysis

Instrument error analysis was not performed. For explanation and justification see Appendix D.

It is extremely important during a short duration test to quickly identify a failed sensor and in real time back the spurious data out of the calculated volume weighted containment temperature and vapor pressure. Failure to do so can cause the upper confidence limit value to place a short duration test in jeopardy. It has been the station's experience that sensor failures should be removed from all data collected, not just subsequent to the apparent failure, in order to minimize the discontinuity in computed values that are related to the sensor failure (not any real change in containment conditions). For this test, one instrument failure was encountered before the start of the test, and was removed from data collection prior to the start of the test.

SECTION C - SEQUENCE OF EVENTS

C.1 Test Preparation Chronology

The pretest preparation phase and containment inspection was completed on April 1, 1992 with no apparent structural deterioration being observed. Major preliminary steps included:

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

2) Installation of all IPCLRT test equipment in the suppression chamber.

3) Completion of all repairs and installations in the drywell affecting primary containment.

4) Venting of the reactor vessel to the drywell by opening the manual head vent line to the drywell equipment drain sump.

5) Installation of the IPCLRT data acquisition system including computer programs, instrument console, locating instruments in the drywell, and associated wiring.

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

This test was conducted at the end of the refuel outage to test the containment in an "As Left" condition with repairs and adjustments. The Station has an exemption to 10CFR50, Appendix J requirements to allow performing the test at the end of the refuel outage.

C.2 Test Pressurization and Stabilization Chronology

DATE	TIME	EVENT
4-1-92	1214	Began pressurizing containment.
	1430	MSIV room snooped. No leaks observed.
	1535	Top of Torus, Reactor Building basement, RHR, Core Spray, and HPCI rooms snooped. No leaks found.
	1809	Pressurization complete.
	2010	All accessible penetrations in Reactor Building snooped. No leaks observed.
	2020	Channel 48 (Dewcell #9) and Thermister #15 locked out. The sensor output from these channels were not representative of the output from other sensors in the same area.
	2335	Containment temperature stable, changing less than 0.5 degrees per hour for last 4 hours. Reactor water level change less than 1.25 inches per hour for last hour. Reactor water temperature change less than 2 degrees F per hour for last hour. All stabilization criteria satisfied.

C.3 Measured Leak Rate Phase Chronology

4-1-92	2335	Began measured phase. Base data set #67.
4-2-92	0030	Transformer 22 was inadvertantly deluged by fire suppression system resulting in loss of power to ILRT equipment and portions of Unit 2. Test suspended while plant status determined and conditions stabilized.
	0400	Operations department decision to abort test and begin containment depressurization due to Transformer 22 deluge.
	2130	Containment depressurization complete.

C.4 Retest Preparation Chronology

4-3-92	1100	ILRT preparations resumed. DAS channels previously locked out (15 and 48) were repaired and reinstated.

C.5 Retest Pressurization and Stabilization Chronology

DATE	TIME	EVENT
4-4-92	1812	Pretest preparation complete and containment pressurization began.
	2045	Snooped Reactor Building basement and corner rooms. No leaks found.
	2050	Top of torus snooped. No leaks observed.
	2130	Snooped Reactor Building penetrations, no leaks observed.
4-5-92	0039	Pressurization complete.
	0200 to 0300	Time change for daylight savings time.
	0500	Dewcell channel #48 locked out. Reading inaccurately. Prior to start of measured phase.
	1043	All stabilization criteria satisfied.

C.6 Retest - Measured Leak Rate Phase Chronology

	1043	Began measured phase. Base data set #252.
	1716	Terminated measured leak rate phase at 6 hours 33 minutes, base data set #291. Calculated leak rate was 0.1764 wt%/day and decreasing over time. The BN-TOP-1 upper confidence limit was 0.2458 wt%/day.

C.7 Induced Leakage Phase Chronology

4-5-92	1726	Valved in flowmeter at 8.5 SCFM and began induced phase stabilization with base data set #292.
	1826	Following the 1 hour stabilization required by BN-TOP-1, the induced phase of the test was began with base data set #298.
	2206	Terminated induced phase at data set #320, calculated leak rate of 1.0593 wt%/day.

C.8 Depressurization Phase Chronology

DATE	TIME	EVENT
4-5-92	2355	Began depressurization using procedure for venting through the Standby Gas Treatment System.
4-6-92	1030	Depressurization complete.
	1300	Technical Staff personnel entered drywell. No apparent structural damage and instruments still in place.

SECTION D - TYPE A TEST DATA

D.1 Measured Leak Rate Phase Data

A summary of the computed data using the BN-TOP-1, Rev. 1 test method for a short duration test can be found in Table 3. Graphic results of the test are found in Figures 3-7. For comparison purposes only, the statistically averaged leak rate and upper confidence limit using the ANS/ANSI 56.8-1981 standard are graphed in Figure F-1. A summary of the computed data using the ANS/ANSI standard is found in Appendix F.

D.2 Induced Leakage Phase Data

A summary of the computed data for the Induced Leakage Phase of the IPCLRT is found in Table 4. The calculated leak rate and upper confidence limit using the Mass BN-TOP-1, Rev. 1 method are shown in Figure 7. Containment conditions during the Induced Leakage Phase are presented graphically in Figures 8-10.

MEASURED LEAK RATE TEST RESULTS

TABLE 3

DATA SET	TIME	TEST DURATION	AVE. TEMP.	DRY AIR PRESSURE	MEAS. LEAK RATE	CALC. LEAK RATE	UPPER CONFIDENCE LIMIT
252	09:46:18	0.000	84.0	66.7122	---	---	---
253	09:56:18	0.167	84.0	66.7104	0.0439	---	---
254	10:06:18	0.333	84.0	66.7084	0.1183	---	---
255	10:16:18	0.500	84.0	66.7056	0.2193	0.2149	0.3191
256	10:26:18	0.667	84.0	66.7026	0.1986	0.2298	0.4354
257	10:36:18	0.833	84.0	66.7030	0.1487	0.2037	0.4376
258	10:46:04	1.000	84.0	66.6981	0.2501	0.2419	0.4191
259	10:56:18	1.167	84.0	66.6988	0.1674	0.2242	0.4043
260	11:06:18	1.333	84.0	66.6962	0.2017	0.2265	0.3858
261	11:16:18	1.500	84.0	66.6958	0.1605	0.2119	0.3683
262	11:26:18	1.667	84.0	66.6943	0.1686	0.2042	0.3513
263	11:36:18	1.833	84.0	66.6933	0.1743	0.2002	0.3377
264	11:46:18	2.000	83.9	66.6942	0.1210	0.1814	0.3212
265	11:56:18	2.167	84.0	66.6909	0.1704	0.1806	0.3116
266	12:06:18	2.333	83.9	66.6865	0.2116	0.1905	0.3150
267	12:16:18	2.500	84.0	66.6868	0.1834	0.1914	0.3095
268	12:26:18	2.667	83.9	66.6815	0.2277	0.2021	0.3159
269	12:36:18	2.833	83.9	66.6775	0.2031	0.2054	0.3141
270	12:46:18	3.000	83.9	66.6785	0.1778	0.2028	0.3083
271	12:56:18	3.167	83.9	66.6789	0.1762	0.2003	0.3029
272	13:06:18	3.333	83.9	66.6814	0.1506	0.1933	0.2955
273	13:16:18	3.500	83.9	66.6794	0.1658	0.1902	0.2899
274	13:26:18	3.667	84.0	66.6786	0.1813	0.1901	0.2867
275	13:36:18	3.833	84.0	66.6790	0.1700	0.1881	0.2824
276	13:46:18	4.000	84.0	66.6795	0.1638	0.1854	0.2777
277	13:56:18	4.167	84.0	66.6764	0.1871	0.1866	0.2764
278	14:06:18	4.333	84.0	66.6768	0.1761	0.1860	0.2736
279	14:16:18	4.500	84.0	66.6763	0.1712	0.1847	0.2705
280	14:26:18	4.667	84.0	66.6758	0.1743	0.1841	0.2679
281	14:36:18	4.833	84.0	66.6748	0.1840	0.1847	0.2667
282	14:46:18	5.000	84.0	66.6746	0.1785	0.1846	0.2649
283	14:56:18	5.167	84.0	66.6767	0.1574	0.1819	0.2612
284	15:06:18	5.333	84.0	66.6734	0.1719	0.1812	0.2590
285	15:16:18	5.500	84.0	66.6736	0.1685	0.1801	0.2566
286	15:26:18	5.667	84.0	66.6724	0.1732	0.1797	0.2549
287	15:36:18	5.833	84.0	66.6720	0.1688	0.1789	0.2528
288	15:46:18	6.000	84.0	66.6708	0.1700	0.1782	0.2509
289	15:56:18	6.167	84.0	66.6706	0.1713	0.1778	0.2493
290	16:06:18	6.333	84.1	66.6694	0.1717	0.1774	0.2478
291	16:16:18	6.500	84.1	66.6696	0.1651	0.1764	0.2458

INDUCED LEAKAGE PHASE TEST RESULTS

TABLE 4

DATA SET	TIME	TEST DURATION	AVE. TEMP.	DRY AIR PRESSURE	MEAS. LEAK RATE	CALC. LEAK RATE	UPPER CONFIDENCE LIMIT
298	17:26:18	0.000	84.1	66.6376	---	---	---
299	17:36:18	0.167	84.1	66.6339	0.7274	---	---
300	17:46:18	0.333	84.1	66.6267	1.0444	---	---
301	17:56:18	0.500	84.1	66.6218	1.1168	1.1575	2.1223
302	18:06:18	0.667	84.1	66.6159	1.1189	1.1889	1.7641
303	18:16:18	0.833	84.1	66.6114	1.0459	1.1531	1.6778
304	18:26:18	1.000	84.1	66.6062	1.0632	1.1398	1.5769
305	18:36:18	1.167	84.1	66.6008	1.0790	1.1374	1.5115
306	18:46:18	1.333	84.1	66.5957	1.0600	1.1265	1.4635
307	18:56:18	1.500	84.1	66.5909	1.0737	1.1233	1.4285
308	19:06:18	1.667	84.1	66.5849	1.0872	1.1250	1.4039
309	19:16:18	1.833	84.1	66.5796	1.0595	1.1168	1.3793
310	19:26:18	2.000	84.1	66.5746	1.0528	1.1083	1.3572
311	19:36:18	2.167	84.1	66.5692	1.0518	1.1013	1.3379
312	19:46:18	2.333	84.1	66.5645	1.0290	1.0897	1.3179
313	19:56:18	2.500	84.1	66.5600	1.0277	1.0801	1.2999
314	20:06:18	2.667	84.1	66.5537	1.0451	1.0763	1.2866
315	20:16:18	2.833	84.1	66.5497	1.0195	1.0675	1.2712
316	20:26:18	3.000	84.1	66.5426	1.0519	1.0670	1.2624
317	20:36:18	3.167	84.1	66.5371	1.0463	1.0653	1.2536
318	20:46:18	3.333	84.1	66.5307	1.0512	1.0648	1.2465
319	20:56:18	3.500	84.1	66.5271	1.0312	1.0607	1.2372
320	21:06:18	3.667	84.1	66.5208	1.0433	1.0593	1.2304

MEASURED LEAK RATE PHASE
GRAPH OF CALCULATED LEAK RATE
AND UPPER CONFIDENCE LIMIT

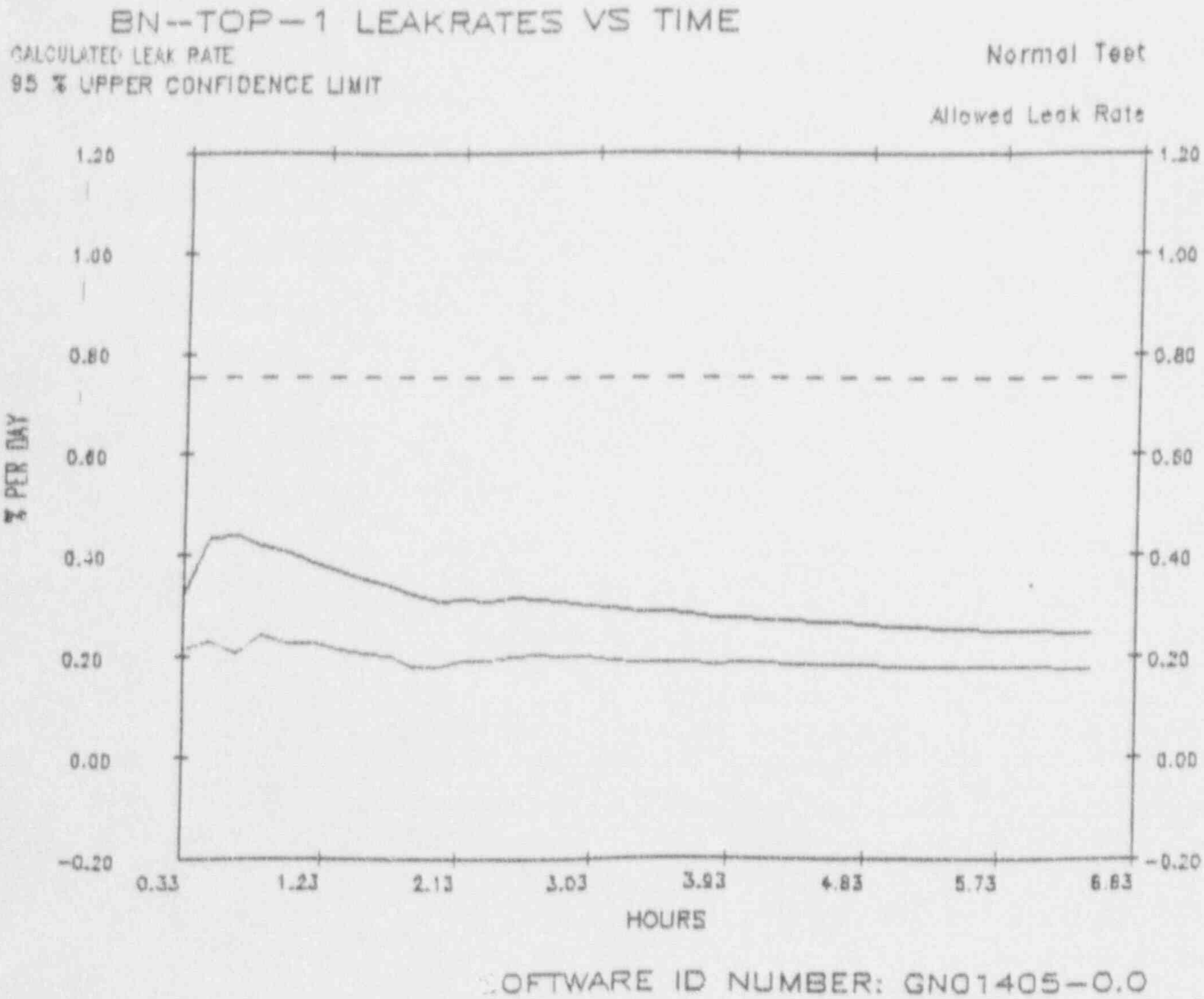

FIGURE 3

MEASURED LEAK RATE PHASE
GRAPH OF DRY AIR PRESSURE

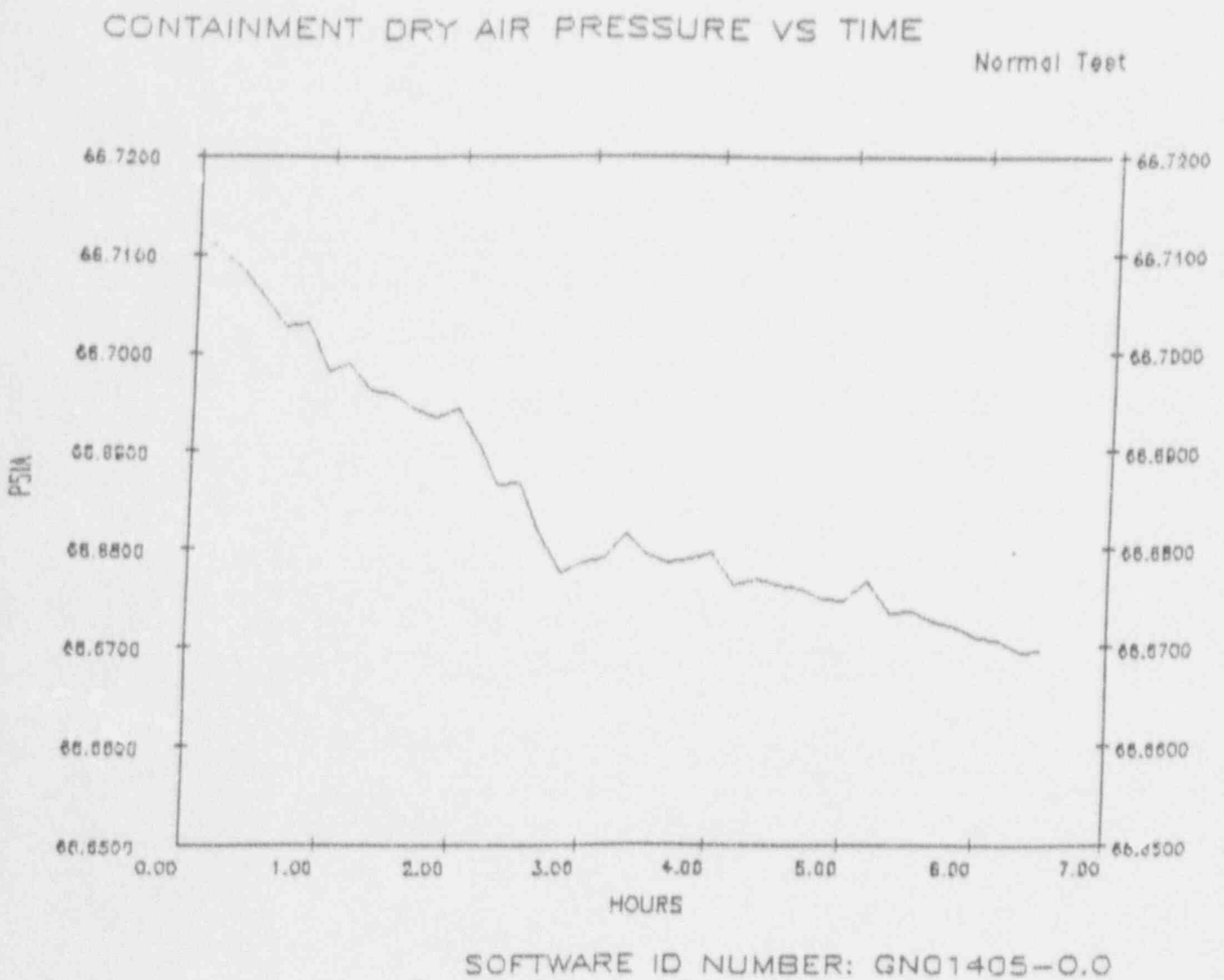

FIGURE 4

MEASURED LEAK RATE PHASE
GRAPH OF VOLUME WEIGHTED
AVERAGE CONTAINMENT VAPOR PRESSURE

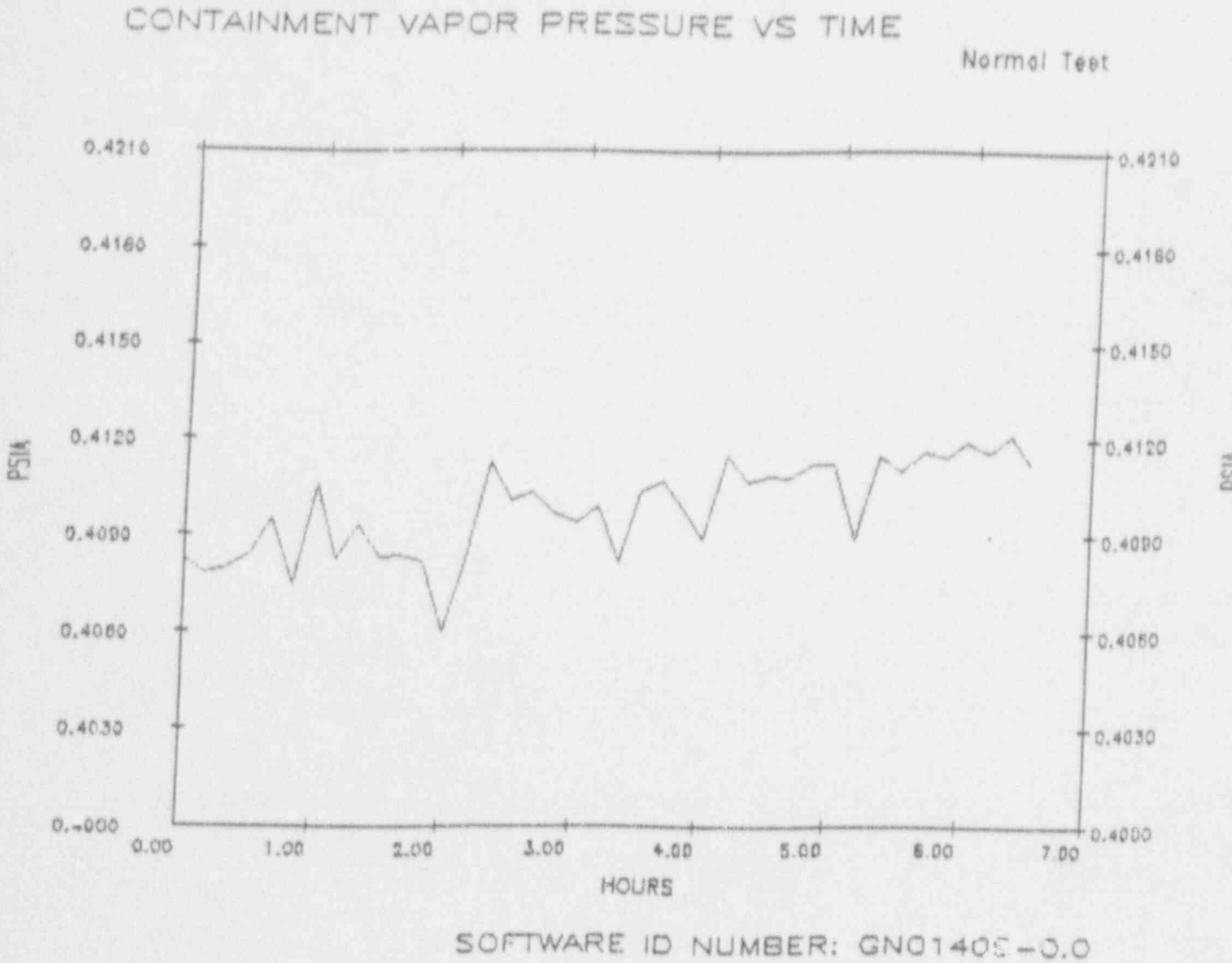

FIGURE 5

MEASURED LEAK RATE PHASE
GRAPH OF VOLUME
WEIGHTED AVERAGE CONTAINMENT TEMPERATURE

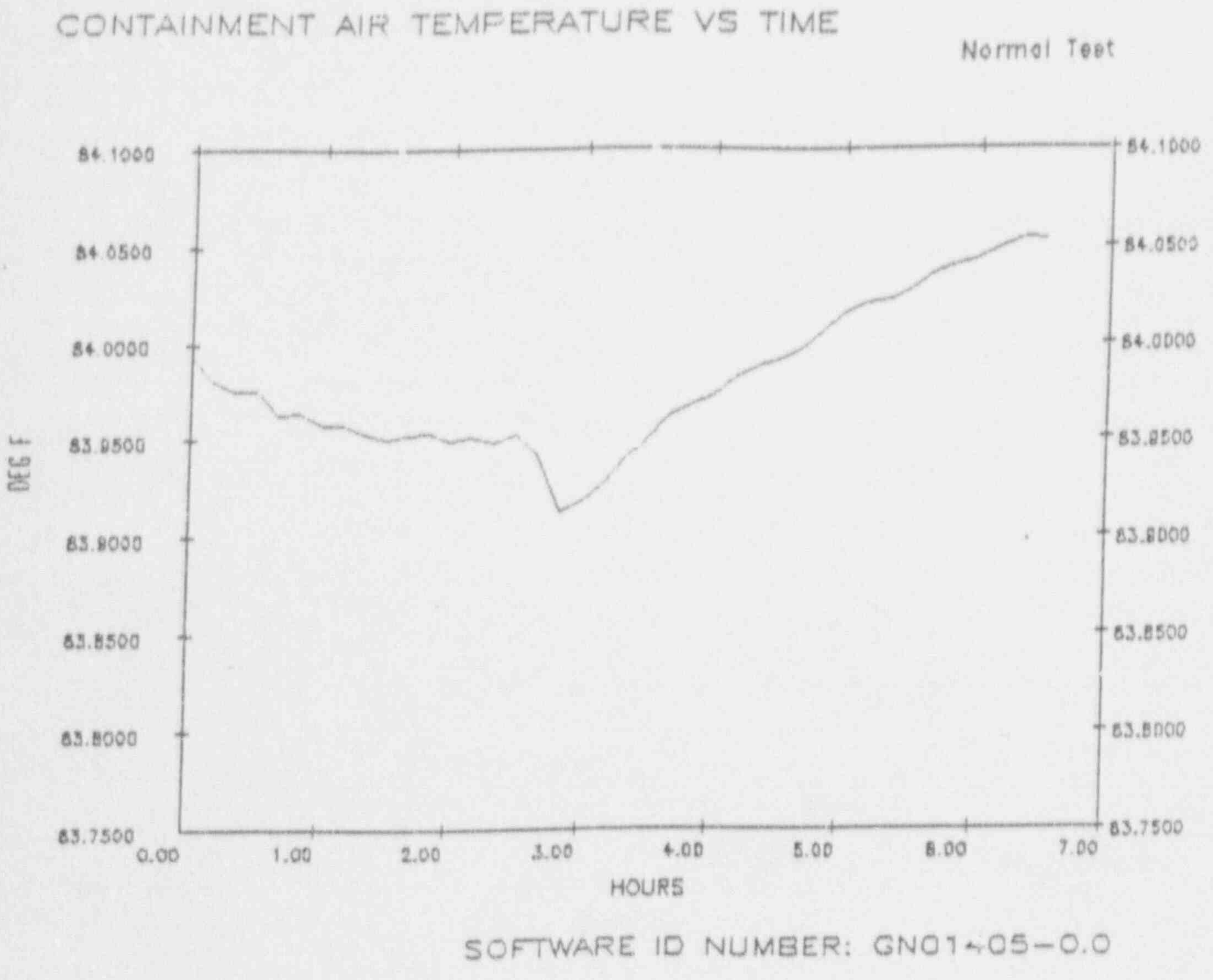

FIGURE 6

INDUCED LEAKAGE PHASE
GRAPH OF CALCULATED
LEAK RATE

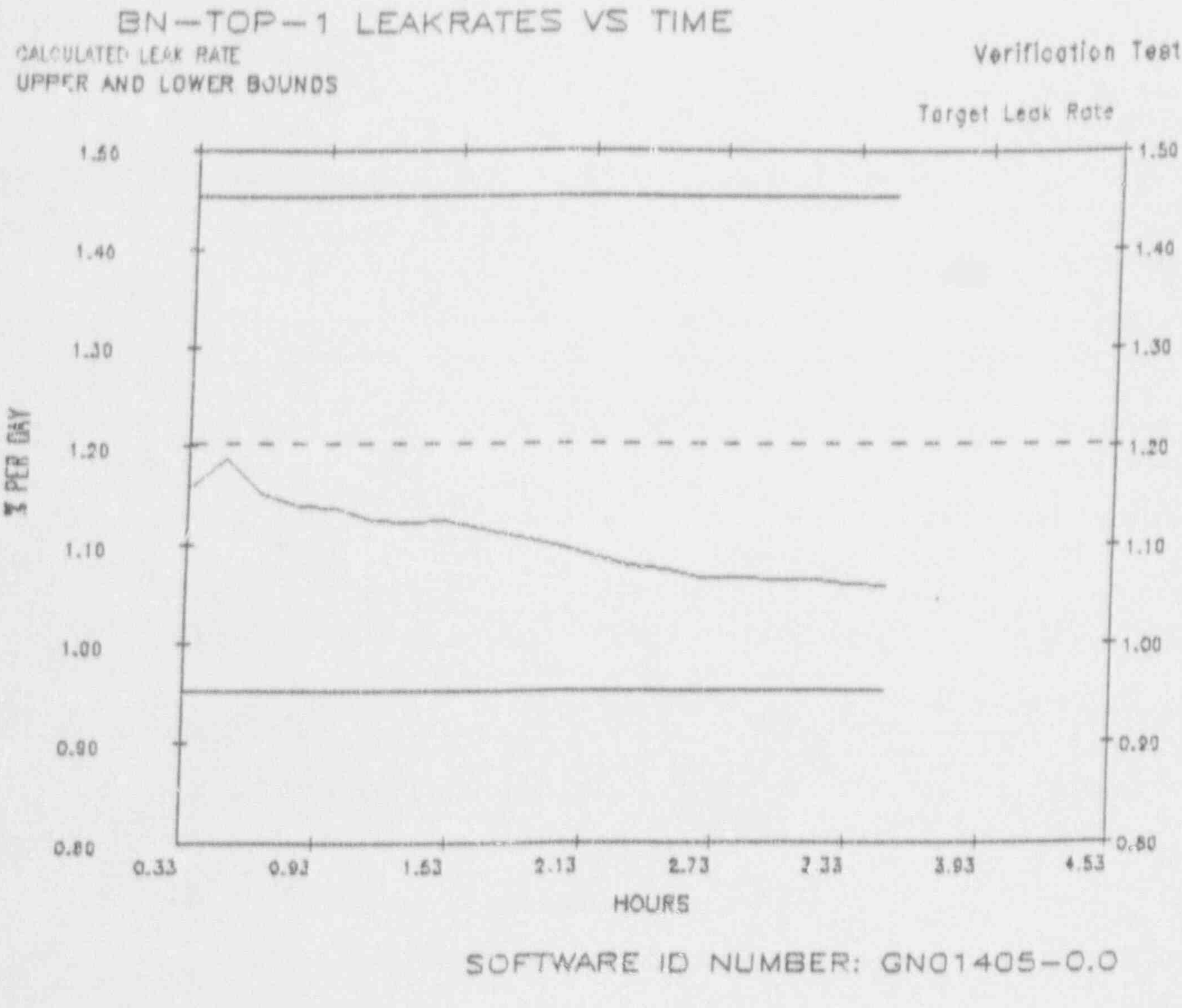

FIGURE 7

INDUCED LEAKAGE PHASE
GRAPH OF VOLUME
WEIGHTED AVERAGE CONTAINMENT TEMPERATURE

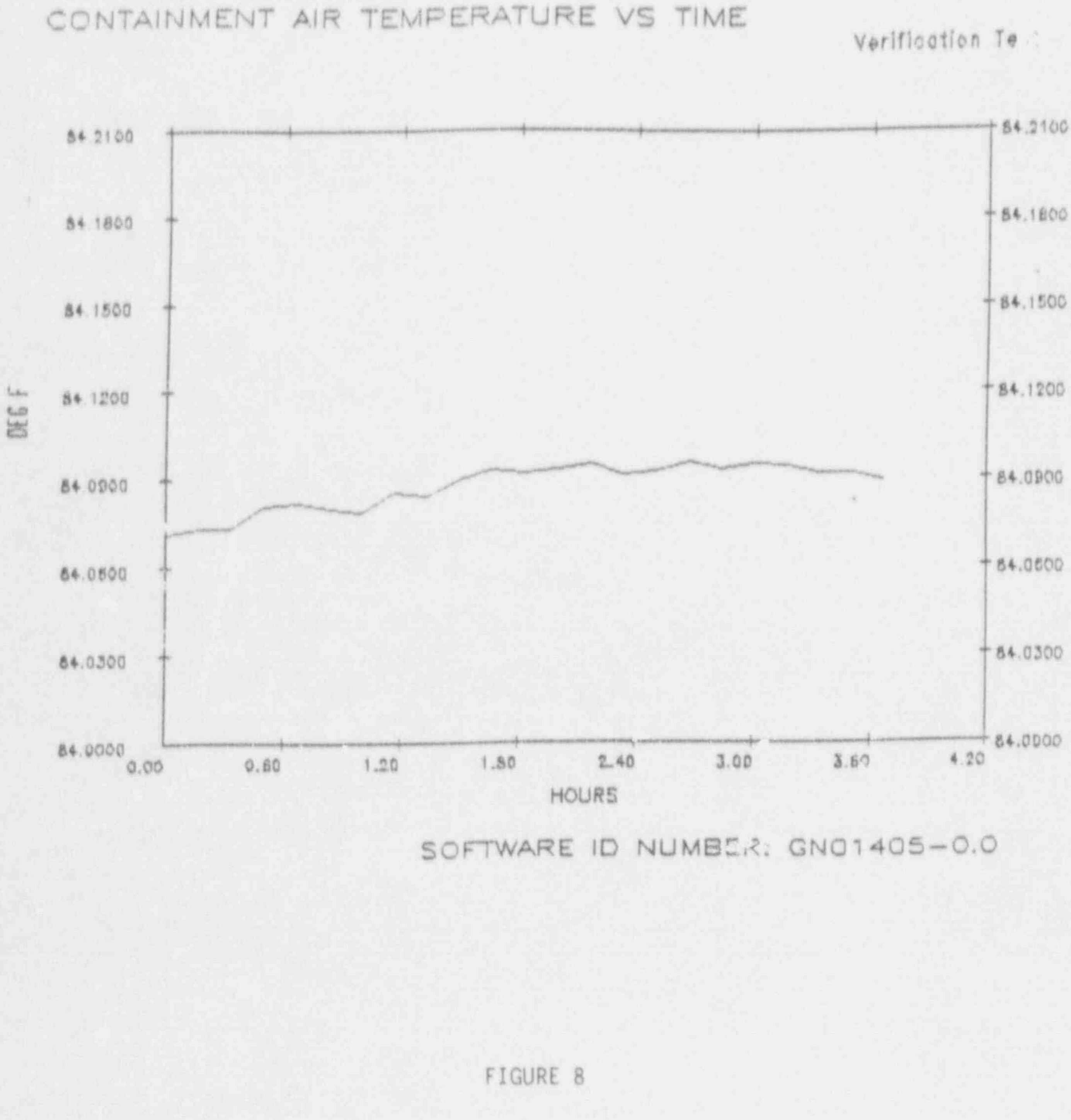

FIGURE 8

INDUCED LEAKAGE PHASE
GRAPH OF VOLUME
WEIGHTED AVERAGE CONTAINMENT VAPOR PRESSURE

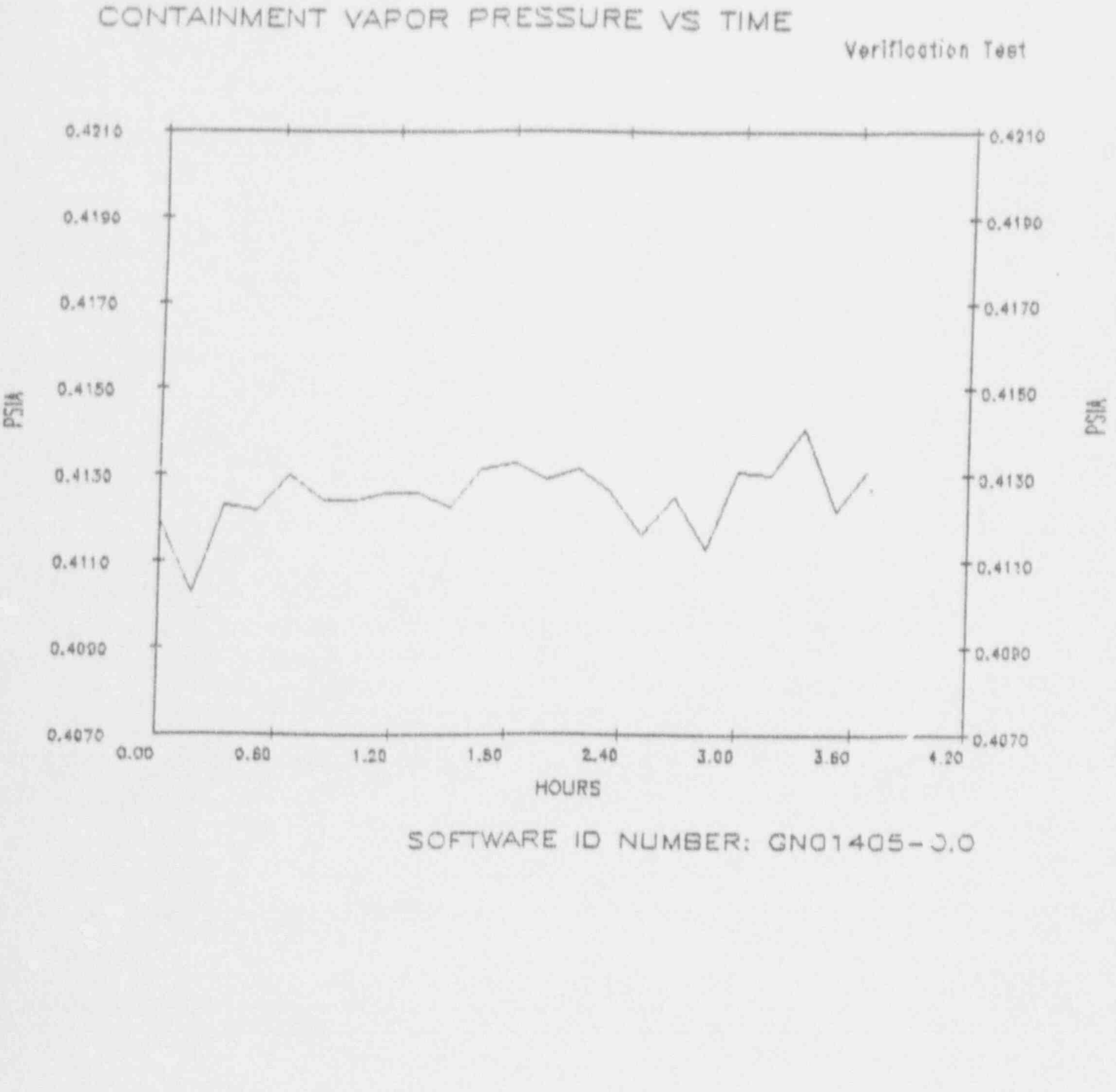

FIGURE 9

INDUCED LEAKAGE PHASE
GRAPH OF DRY AIR PRESSURE

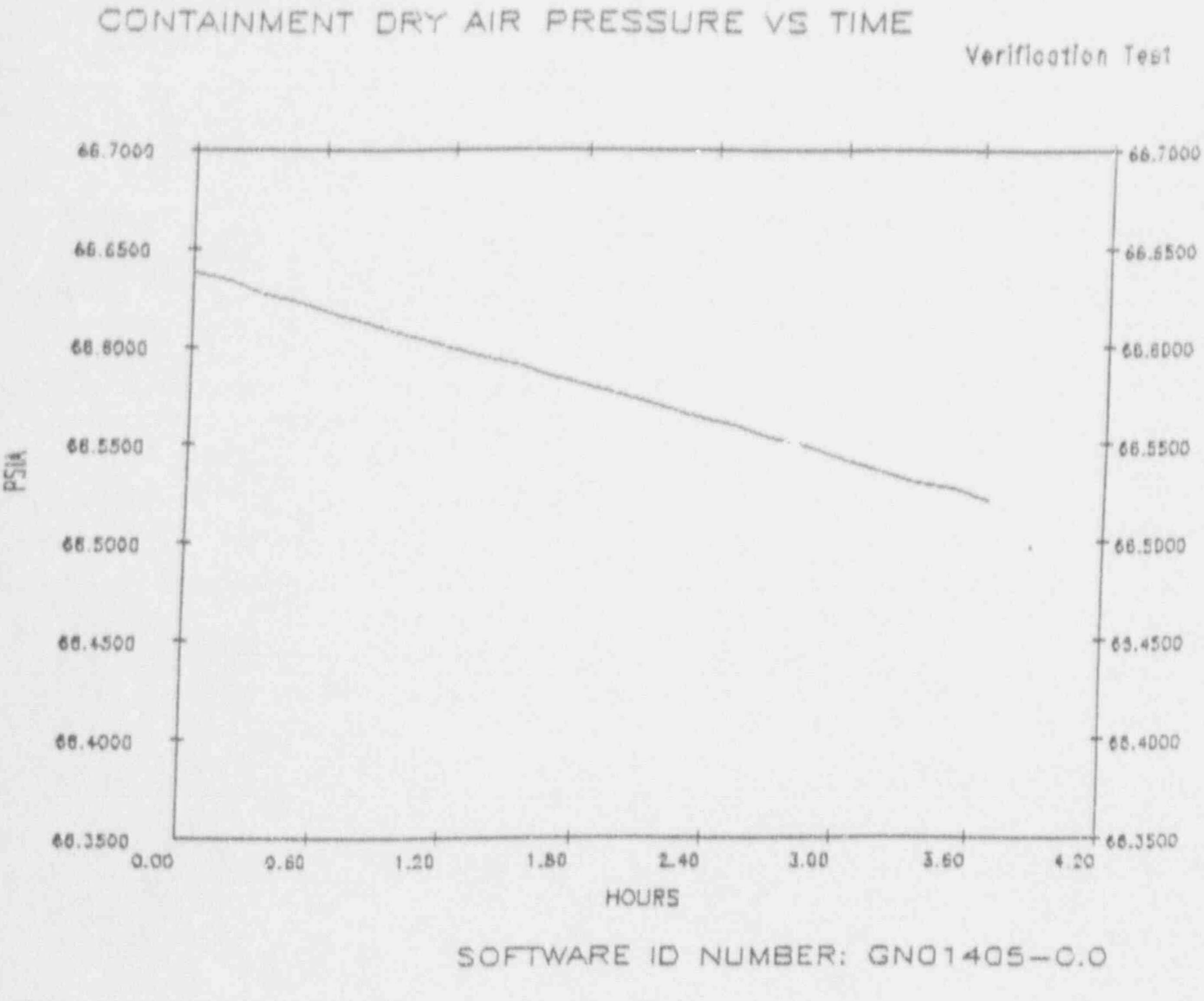

FIGURE 10

GRAPH OF REACTOR WATER LEVEL
THROUGH TESTING PERIOD

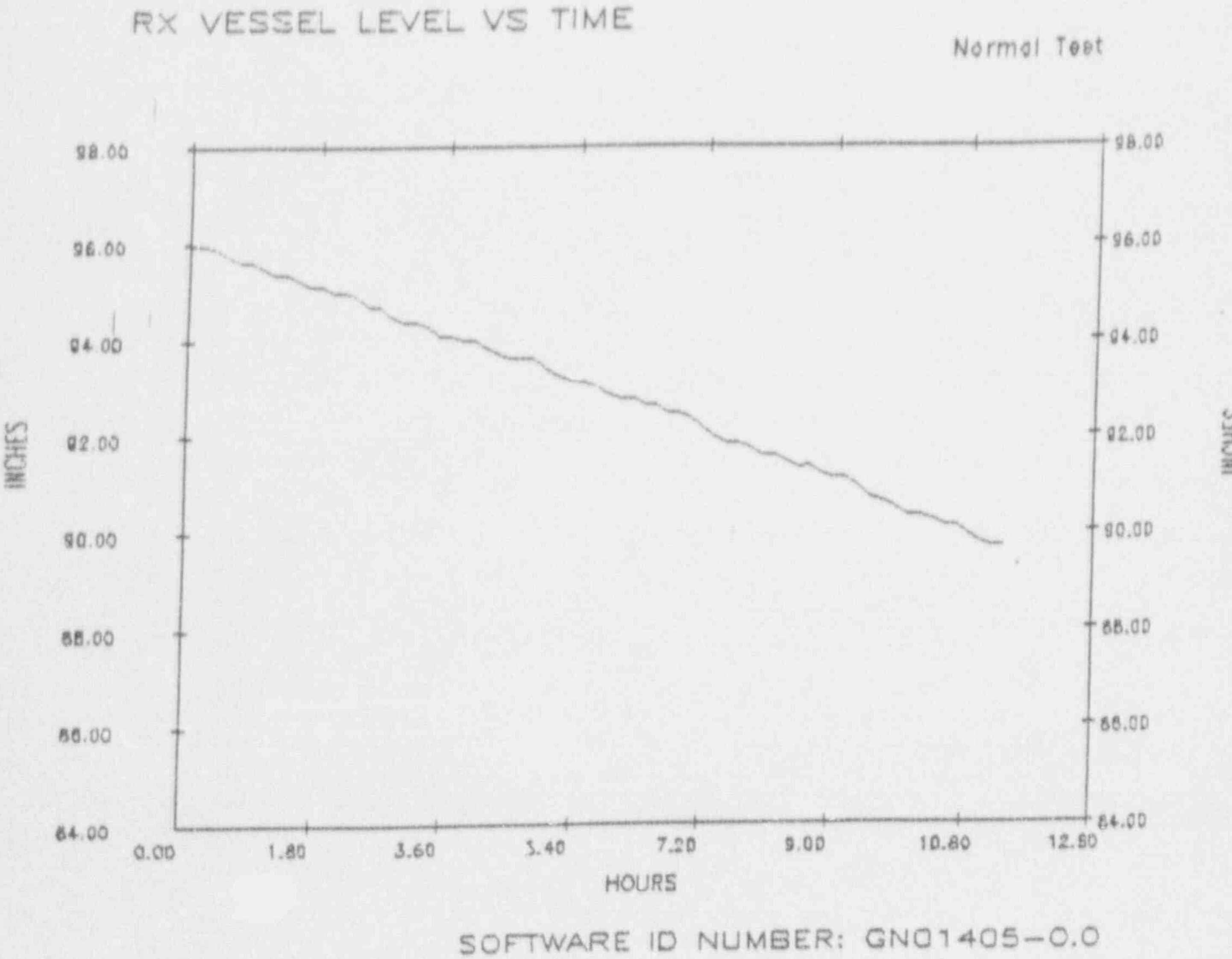

FIGURE 11

GRAPH OF TORUS WATER LEVEL
THROUGH TESTING PERIOD

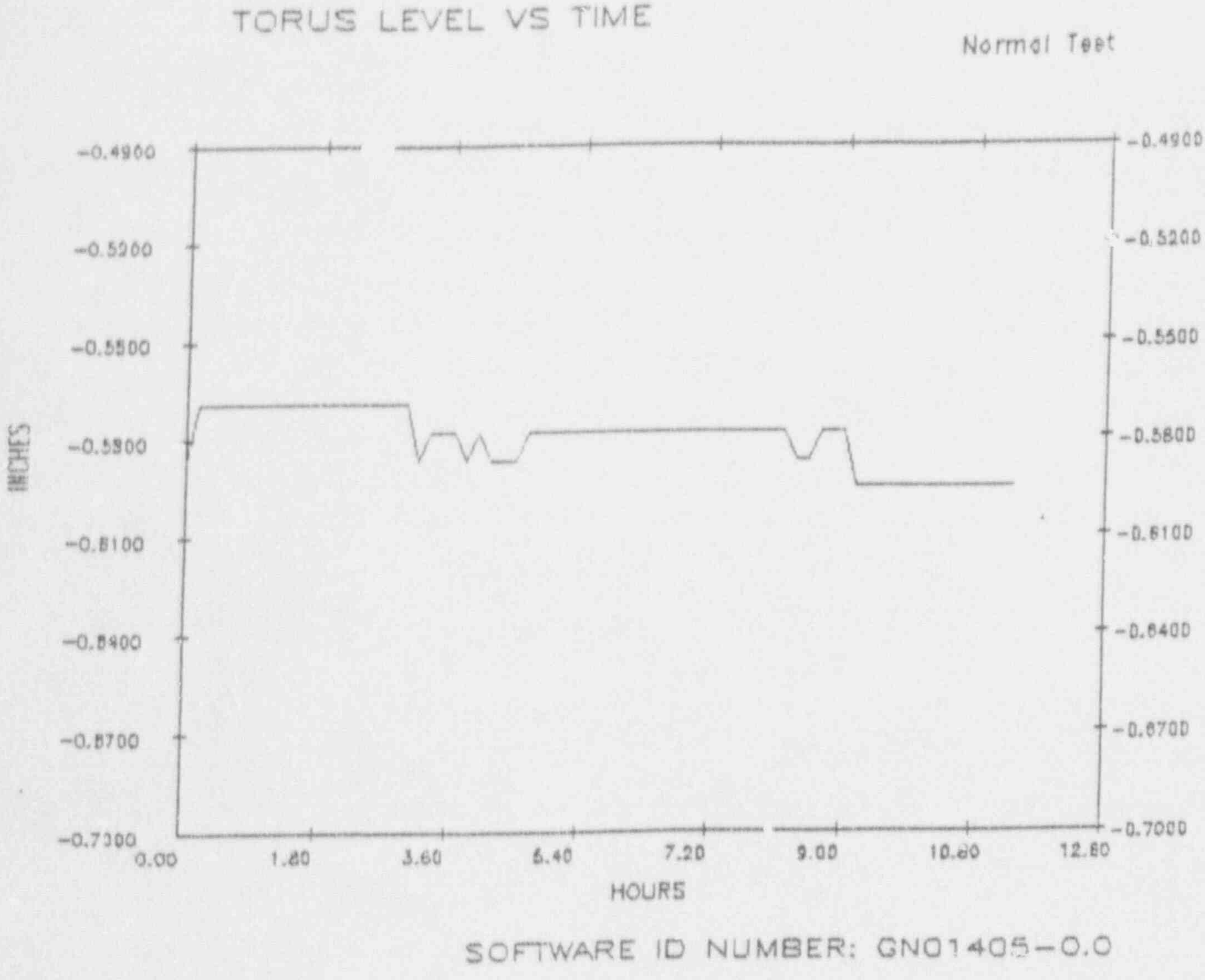

FIGURE 12

SECTION E - TEST CALCULATIONS

Calculations for the IPCLRT are based on the BN-TOP-1,Rev.1 test method and are found in the functional requirements specification CECo Generic ILRT computer code software ID No. GN1405-0.0, Document ID No. ILRT-FRS-0.0. A reproduction of the BN-TOP-1, Rev. 1 method can be found in Appendix C. In preparing for the first Quad Cities short duration test using BN-TOP-1, Rev. 1 a number of editorial errors and ambiguous statements in the topical report were identified. These errors are presented in Appendix E and are editorial in nature only. The Station has made no attempt to improve or deviate from the methodology outlined in the topical report.

Section 2.3 of BN-TOP-1, Rev. 1 gives the test duration criteria for a short duration test. By station procedure some of these duration criteria have been made more conservative and in some cases these changes may be required by regulations.

A. "Containment Atmosphere Stabilization"

Once the containment ia at test pressure the containment atmosphere shall be allowed to stabilize for about four hours (4 hours required by Quad Cities procedure and actual stabilization: 9 hrs, 3 min). The atmosphere is considered stabilized when:

1. The rate of change of average temperature is less than 1.0°F/hour averaged over the last two hours.

DATA SET*	AVE. CONTAINMENT TEMP.	ΔT
252	84.0	
246	84.1	0.10
240	84.1	0.00
	average	0.05°F/hour

* Approximate time interval between data sets is 10 minutes.

or

2. "The rate of change of temperature changes less than 0.5°F/hour/hour averaged over the last two hours."

(Not required if A.1 satisfied).

B. Data Recording and Analysis

1. "The Trend Report based on Total Time calculations shall indicate that the magnitude of the calculated leak rate is tending to stabilize at a value less than the maximum allowable leak rate (L_A)...".

By Quad Cities procedure the calculated leak rate must be less than 0.75 L_A. The actual value was 0.1764 L_A, stable, and decreasing (no extrapolation required).

and

TECH 584

2. "The end of the test upper 95% confidence limit for the calculated leak rate based on total time calculations shall be less than the maximum allowable leak rate".

   By Quad Cities procedure the upper confidence limit must be less than 0.75 L_A. The actual value was 0.2458 LA.

and

3. "The mean of the measured leak rates based on Total Time calculations over the la·ᵗ five hours of the test or last 20 data points, whichever provides the most data, shal. be less than the maximum allowable leak rate."

   By Quad Cities procedure this average must be less than 0.75 L_A. The actual value was 0.1779 L_A for the last five hours.

and

4. "Data shall be recorded at approximately equal intervals and in no case at intervals greater than one hour."

   At Quad Cities data scans are automatically performed on 10 minute intervals.

and

5. "At least twenty (20) data points shall be provided for proper statistical analysis."

   There were 39 data sets taken for this test.

and

6. "In no case shall the minimum test duration be less than six (6) hours."

   Quad Cities' procedure limits a short duration test to a minimum of six (6) hours. The data taken during this test supports the argument that a shorter duration test can be conducted. All of the above termination criteria were satisfied in six (6.0) hours.

SECTION F - TYPE A TEST RESULTS

F.1 Measured Leak Rate Test Results

Based on the data obtained during the short duration test, the following results were determined: (L_A = 1.0 wt %/day)

1) Calculated leak rate equals 0.1764 wt %/day and declining steadily over time (<0.7500 wt %/day).

2) Upper confidence limit equals 0.2458 wt %/day and declining (<.750 wt %/day).

3) Mean of the measured leak rates for the last 5 hours (37 data sets) equals .1779 wt %/day (<0.750 wt %/day).

4) Data sets were accumulated at approximately 10 minute time intervals and no intervals exceeded one hour.

5) There were 39 data sets accumulated in 6.5 hours measured phase.

6) The minimum test duration (by procedure) of 6 hours was successfully accomplished ($\geq$ 6 hours).

F.2 Induced Leakage Test Results

A leak rate of 8.5 scfm (1.0339 wt %/day) was induced on the primary containment for this phase of the test. The leak rates during this phase of the test were as follows.

BN-TOP-1 Calculated Leak Rate (Measured Leak Rate Phase)	0.1764	0.1764
Induced Leak (8.5 scfm)	1.0339	1.0339
Allowed Error Band	+0.2500	-0.2500
	1.4603	0.9603
BN-TOP-1 Calculated Leak Rate (Induced Leak Rate Phase)	1.0593 wt %/day	

The induced phase of the test has duration criteria given in Section 2.3.C of BN-TOP-1. The test duration requirements are listed below and were satisfied by the test procedure and the data analysis:

1. Containment atmospheric conditions shall be allowed to stabilize for about one hour after superimposing the known leak. (actual: 1 hour).

2. The verification test duration shall be approximately equal to half the integrated leak rate test duration. (actual: 3 hours, 40 minutes for a 6.5 hour test).

3. Results of this verification test shall be acceptable provided the correlation between the verification test data and the integrated leak rate test data demonstrate an agreement within plus or minus 25 percent. (actual: see results above).

F.3 Pre Operational Results vs Test Results

Past IPCLRT reports have compared the results of each test with the pre-operational IPCLRT, performed April 20-21, 1971. Over the last 16 years, different test equipment, sensor locations and number of sensors, test methods, and test duration have been used. This test yielded results that compare favorably with recent tests and demonstrate that there has been no substantial deterioration in containment integrity.

TEST DATA	TEST DURATION (HOURS)	CALCULATED LEAK RATE (BN-TOP-1)	STATISTICALLY AVE. LEAK RATE (ANSI/ANS)
August, 1971	24	Not Available	0.1112
1976	24	Not Available	0.327
1980	24	Not Available	0.449
1983	24	Not Available	0.464
February, 1984	24	Not Available	0.385
May, 1985	24	.3670	0.4071
October, 1986	8	.3225	0.3294
June, 1988	6	.4155	0.4141
April, 1990	6	.3344	0.3435
April, 1992	6	.1764	0.1689

F.4 TYPE A TEST PENALTIES

During the type A test, there were a number of systems that were not drained and vented outside the containment. The isolation valves for these systems or penetrations were not "challenged" by the type A test. Even though these systems would not be drained and vented during a DBA event, historically, penalties for these systems have been added to the type A test results.

	AS LEFT MINIMUM PATHWAY LEAKAGE SCFH	AS LEFT MINIMUM PATHWAY LEAKAGE WT%/DAY
Feedwater A & B	1.6	0.00327
RBCCW (Return)	0.44	0.00090
Core Spray A & B	2.8	0.00572
RHR A & B	18.55	0.03789
TIPS	3.42	0.00699
O_2 Analyzer	2.1	0.00429
RBCCW (Supply)	0.4	0.00082
ACAD	2.2	0.00449
HPCI (Steam Exhaust)	5.8	0.01185
Clean Demin	0.4	0.00082
SBLC	9.0	0.01838
Totals	46.71	0.0954

This penalty increases the type A test result to 0.2718 wt%/day with an upper confidence limit of 0.3412 wt%/day.

F.5 EVALUATION OF INSTRUMENT FAILURES

Prior to the start of the test one sensor was locked out due to failure. Dewcell number 9 was locked out on 04-05-92 at 0500 hours. There were no instrument failures during the test.

F.6 AS FOUND TYPE A TEST RESULTS

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. This is considered a passing "As Found" type A test. However, per 10CFR50, Appendix J, which requires an accelerated testing schedule be maintained until the performance of two consecutive passing "As Found" tests, the present schedule of performing a type A test every refuel outage must be maintained.

SUMMARY OF ALL CONTAINMENT LEAK RATE TESTING DURING UNIT TWO REFUEL OUTAGE SPRING, 1992

	AS FOUND (SCFH) MINIMUM PATHWAY LEAKAGE	AS LEFT (SCFH) MINIMUM PATHWAY LEAKAGE
(1) MSIV's @ 25 PSIG	11.42	7.33
(2) MSIV's converted to 48 PSIG*	19.76	12.68
(3) All Type C Tests (Except MSIV's)	162.28	76.04
(4) All Type B Tests	28.39	32.07
TOTAL (2 + 3 + 4)	210.43	120.79

(1) Type A Test Integrated Leak Rate Test)	= 0.1764 wt %/day
(2) Upper Confidence Limit of Type A Test Result	= 0.2458 wt %/day
(3) Correction for Unvented Volumes During Type A Test	= 0.0954 wt %/day
(4) Correction for Repairs Prior to Type A Test (As Found - As Left)**	= 0.2143 wt%/day
Total (2 + 3 + 4)	= 0.5555 wt%/day

* Leak Rate at 25 PSIG converts to Leak Rate at 48 PSIG using conversion ratio of 1.73. REFERENCE Leaking Characteristics of Steel Containment Vessels & the Analysis of Leakage Rate Determination, Division of Safety Standards, A.E.C. TID-20583, May 1964, pg. 76.

APPENDIX A
TYPE B AND C TESTS

Presented herin are the results of local leak rate tests conducted on all penetrations, double-gasketed seals, and isolation valves since the previous IPCLRT in April 1990. Total leakage for double gasketed seals and total leakage for all penetrations and isolation valves following repairs satisfied the Technical Specification limits.

UNIT 2 (Q2R11) 1/92 - 5/10/92
TEST DIRECTOR Dav'd P. Kunzmann
OPERATING ENG. [signature]
TECH STAFF SUPV. [signature]

REFUEL OUTAGE LOCAL
LEAK RATE TEST SUMMARY

QTS 100-S1
Revision 8
December 1989

DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH)				AS LEFT (SCFH)			
		DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
A MSIV	AO 203-1A,2A	1/1/92	5.19	2.6	5.19	1/1/92	5.19	2.6	5.19
B MSIV	AO 203-1B,2B	1/1/92	3.20	1.6	3.20	1/1/92	3.20	1.6	3.2
C MSIV	AO 203-1C,2C	1/1/92	5.99	3.0	5.99	1/1/92	5.99	3.0	5.99
D MSIV	AO 203-1D,2D	1/2/92	14.56	4.22	10.34	3/9/92	0.25	0.13	0.25
		TOTAL		11.42/24.72		TOTAL		7.33/14.03	
		TOTAL CORRECTED *		19.76/42.77		TOTAL CORRECTED *		12.68/25.31	
MSL DRAIN	MO 220-1,2	1/2/92	123	16	107	3/12/92	0.49	0.25	0.49
PRIMARY SAMPLE	AO 220-44,45	3/6/92	1.0	0.5	1.0	3/6/92	1.0	0.5	1.0
A FEEDWATER	CV 220-58A,62A	1/16/92	∞	7.0	∞	3/16/92	4.1	1.2	2.9
B FEEDWATER	CV 220-58B,62B	1/5/92	1.2	0.4	0.8	2/27/92	4.6	0.4	4.2
A DW SPRAY	MO 1001-23A,26A	1/20/92	6	3	6	1/20/92	6	3	6
A RHR RETURN	MO 1001-29A	1/20/92	1.8	1.8	1.8	1/20/92	1.8	1.8	1.8
A TORUS COOLING SPRAY	MO 1001-34,36,37A	1/20/92	2.8	1.4	2.8	2/25/92	4.2	2.1	4.2
B DW SPRAY	MO 1001-23B,26B	1/11/92	2.4	1.2	2.4	2/27/92	4.0	2.0	4.0
B RHR RETURN	MO 1001-29B	1/13/92	6.5	6.5	6.5	2/25/92	6.0	6.0	6.0
B TORUS COOLING/SPRAY	MO 1001-34,36,37B	1/13/92	1.75	0.9	1.75	2/25/92	2.8	1.4	2.8
SHUTDOWN COOLING	MO 1001-47,50	1/19/92	1.6	0.8	1.6	3/7/92	4.5	2.25	4.5
	PAGE TOTAL (EXCEPT MSIVs)	NA	∞	39.5	∞	NA	—	20.9	37.89

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UNIT Q2R11

REFUEL OUTAGE LOCAL
LEAK RATE TEST SUMMARY

QTS 100-S1
Revision 8

DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	AS LEFT (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
SBLC	CV 1101-15, 16	1/28/92	31.0	9.0	22	2/5/92	19.0	9.0	10.0
CLEAN UP SUCTION	MO 1201-2,5	1/7/92	14.96	7.48	14.96	3/16/92	1.8	0.9	1.8
RCIC STEAM SUPPLY	MO 1301-16,17	1/1/92	0.4	0.2	0.4	3/15/92	0.47	0.24	0.47
RCIC STEAM EXHAUST	CV 1301-41	1/3/92	12	12	12	1/3/92	12	12	12
RCIC VAC. PUMP EX.	CV 1301-40	1/2/92	1.85	1.85	1.85	1/2/92	1.85	1.85	1.85
A CORE SPRAY	MO 1402-24A, 25A	1/22/92	5.4	2.4	3.0	1/22/92	5.4	2.4	3.0
B CORE SPRAY	MO 1402-24B, 25B	1/4/92	0.4	0.2	0.4	1/31/92	4.6	0.4	4.2
DW/TORUS PURGE SUPPLY	AO 1601-21,22,55,56	2/15/92	1395.0	3.3 (1)	1391.7 (1)	3/23/92	9.0	1.0 (1)	8.0 (1)
DW/TORUS PURGE EXHAUST	AO 1601-23,24,60, 61,62,63	2/24/92	15.4	3.3 (2)	12.1 (2)	3/27/92	7.7	2.6 (2)	5.1 (2)
A TORUS/RB VACUUM BREAKER	AO 1601-20A, CV 1601-31A	2/15/92	9.2	3.7	5.5	3/23/92	3.7	0	3.7
B TORUS RB VACUUM BREAKER	AO 1601-20B, CV 1601-31B	2/15/92	2.9	1.4	1.5	2/15/92	2.9	1.4	1.5
DW/TORUS PURGE	AO 1601-57,58,59	2/15/92	25.2	1.5 (3)	23.7 (3)	3/23/92	4.2	0.8 (3)	3.4 (3)
DWFDS	AO 2001-3,4	2/5/92	∞	4.1	∞	3/13/92	0.88	0.44	0.44
DWEDS	AO 2001-15, 16	2/21/92	2.5	1.25	2.5	2/21/92	2.5	1.25	2.5
HPCI STEAM SUPPLY	MO 2301-4,5	1/1/92	3.0	1.5	3.0	3/26/92	5.5	2.5	3.0
HPCI STEAM EXHAUST	CV 2301-45	1/1/92	0.8	0.8	0.8	3/20/92	0.4	0.4	0.4
HPCI DRAIN POT EXHAUST	CV 2301-34	1/2/92	3.3	3.3	3.3	1/2/92	5.4	5.4	5.4
RBCCW SUPPLY	MO 3702, CV 3799-31	1/10/92	3.1	0.4	2.7	2/26/92	1.0	0.4	0.6
RBCCW RETURN	MO 3703, 3706	1/10/92	∞	50.0	∞	3/24/92	2.14	0.44	1.7
	PAGE TOTAL	NA	∞	107.68	∞	NA	90.44	43.42	69.06

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(1) min/max is the lesser/greater of 1601-21,56 or 22,55
(2) min/max is the lesser/greater of 1601-24,63 or 23,62,60,61
(3) min/max is the lesser/greater of 1601-58,59 or 57, Rv 4711

UNIT Q2R11

REFUEL OUTAGE LOCAL
LEAK RATE TEST SUMMARY

QTS 100-S1
Revision 8

DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	AS LEFT (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
CLEAN DEMIN	4399-45, CV 4399-46	1/11/92	60.4	0.4	60	3/13/92	1.6	0.4	1.2
SERVICE AIR	4699-46, CV 4699-47	1/15/92	20.4	0.4	20.0	2/20/92	1.4	0.4	1.0
DW PNEUMATIC	AO 4720, 4721	1/5/92	0.8	0.4	0.8	1/5/92	0.8	0.4	0.8
DW INSTRUMENT AIR	CV 4799-155, 156	1/15/92	3.9	1.5	2.4	2/13/92	2.8	1.3	1.5
TORUS INSTRUMENT AIR	CV 4799-158, 159	1/17/92	0.8	0.4	0.8	1/17/92	0.8	0.4	0.8
O_2ANALYZER	AO 8801A, 8802A	1/6/92	0.8	0.4	0.4	1/6/92	0.8	0.4	0.4
O_2ANALYZER	AO 8801B, 8802B	1/6/92	0.8	0.4	0.4	1/6/92	0.8	0.4	0.4
O_2ANALYZER	AO 8801C, 8802C	1/6/92	0.8	0.4	0.4	1/6/92	0.8	0.4	0.4
O_2ANALYZER	AO 8801D, 8802D	1/6/92	0.8	0.4	0.4	1/6/92	0.8	0.4	0.4
O_2ANALYZER	AO 8803, 8804	1/6/92	2.1	0.5	1.6	1/6/92	2.1	0.5	1.6
DRYWELL PARTICULATE SAMPLE LINES	LINES 8803B-V-1/2"-H	1/15/92	17.4	8.4	9.0	1/15/92	17.4	8.4	9.0
TIP BALL VALVE	733-1	1/4/92	0.4	0.4	0.4	4/10/92	0.6	0.6	0.6
TIP BALL VALVE	733-2	1/4/92	60	1.0	1.0	4/10/92	0.38	0.38	0.38
TIP BALL VALVE	733-3	1/4/92	0.4	0.4	0.4	4/10/92	0.21	0.21	0.21
TIP BALL VALVE	733-4	1/4/92	0.4	0.4	0.4	4/10/92	0.49	0.49	0.49
TIP BALL VALVE	733-5	1/4/92	0.4	0.4	0.4	4/10/92	1.7	1.7	1.7
TIP PURGE CHECK	700-743	1/4/92	2.2	2.2	2.2	1/27/92	0.04	0.04	0.04
CAM	SO 2499-1A,2A	1/1/92	0.4	0.2	0.4	2/26/92	0.4	0.2	0.4
CAM	SO 2499-1B,2B	1/1/92	0.4	0.2	0.4	2/19/92	0.04	0.02	0.04
CAM	SO 2499-3A,4A	1/1/92	0.4	0.2	0.4	2/26/92	0.4	0.2	0.4
CAM	SO 2499-3B,4B	1/1/92	0.4	0.2	0.4	2/19/92	0.8	0.4	0.8
	PAGE TOTAL	NA	—	19.2	—	NA	—	17.64	22.56

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UNIT *Q2R11*

REFUEL OUTAGE LOCAL LEAK RATE TEST SUMMARY

QTS 100-S1
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DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	AS LEFT (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
ACAD	AO 2599-2A,23A	1/18/92	1.2	0.1	1.1	1/18/92	1.2	0.1	1.1
ACAD	AO 2599-2B,23B	1/18/92	0.6	0.1	0.5	1/18/92	0.6	0.1	0.5
ACAD	AO 2599-3A,24A	1/18/92	1.5	0.1	1.4	1/18/92	1.5	0.1	1.4
ACAD	AO 2599-3B,24B	1/18/92	0.55	0.1	0.45	1/18/92	0.55	0.1	0.45
ACAD	AO 2599-4A,5A	3/24/92	4.5	1.5	3.0	3/27/92	5.6	0.1	5.5
ACAD	AO 2599-4B,5B	1/18/92	4.8	2.4	4.8	3/27/92	9.2	1.7	7.5
EQUIPMENT HATCH	X-1	1/1/92	0.4	0.2	0.4	3/31/92	0.04	0.02	0.04
DW ACCESS HATCH	X-4	1/13/92	0.4	0.2	0.4	3/11/92	0.34	0.17	0.34
CRD HATCH	X-6	1/1/92	0.4	0.2	0.4	3/26/92	0.04	0.02	0.04
TIP PENETRATION	X-35A	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TIP PENETRATION	X-35B	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TIP PENETRATION	X-35C	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TIP PENETRATION	X-35D	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TIP PENETRATION	X-35E	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TIP PENETRATION	X-35F	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TIP PENETRATION	X-35G	1/4/92	0.4	0.2	0.4	1/4/92	0.4	0.2	0.4
TORUS HATCH	X-200A	1/1/92	0.4	0.2	0.4	4/27/92	0.04	0.02	0.04
TORUS HATCH	X-200B	1/1/92	0.4	0.2	0.4	3/31/92	0.4	0.2	0.4
DRYWELL HEAD	----	1/1/92	1.7	0.9	1.7	3/31/92	0.04	0.02	0.04
SHEAR LUG INSP. HATCH	SL-1	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
SHEER LUG INSP. HATCH	SL-2	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
SHEAR LUG INSP. HATCH	SL-3	1/14/92	5.5	2.75	5.5	1/14/92	5.5	2.75	5.5
PAGE TOTAL		NA	—	10.75	—	NA	—	7.2	26.45

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DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	AS LEFT (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
SHEER LUG INSP. HATCH	SL-4	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
SHEAR LUG INSP. HATCH	SL-5	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
SHEER LUG INSP. HATCH	SL-6	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
SHEAR LUG INSP. HATCH	SL-7	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
SHEER LUG INSP. HATCH	SL-8	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
MECH. PENETRATION	X-7A	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-7B	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-7C	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-7D	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-8	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-9A	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-9B	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-10	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-11	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-12	2/21/92	1.1	1.1	1.1	2/21/92	1.1	1.1	1.1
MECH. PENETRATION	X-13A	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-13B	1/1/92	0.2	0.1	0.2	1/1/92	0.2	0.1	0.2
MECH. PENETRATION	X-14	1/1/92	1.2	0.6	1.2	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-23	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-24	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-25	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-26	1/1/92	0.1	0.05	0.1	1/1/92	0.1	0.05	0.1
	PAGE TOTAL	NA	—	3.5	5.9	NA	—	2.95	4.8

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REFUEL OUTAGE LOCAL
LEAK RATE TEST SUMMARY

QTS 100-S1
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UNIT Q2R11

DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	AS LEFT (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
MECH. PENETRATION	X-36	N/A	Capped	Penetration →					
MECH. PENETRATION	X-47	1/1/92	0.25	0.13	0.25	1/1/92	0.25	0.13	0.25
MECH. PENETRATION	X-17	N/A	Capped	Penetration →					
MECH. PENETRATION	X-16A	1/1/92	1.0	0.5	1.0	1/1/92	0.1	0.05	0.1
MECH. PENETRATION	X-16B	1/1/92	0.7	0.35	0.7	1/1/92	0.1	0.05	0.1
ELECTRICAL PENETRATION	X-100A u1 only	N/A	→						
ELECTRICAL PENETRATION	X-100B	2/26/92	0.4	0.2	0.4	2/26/92	0.4	0.2	0.4
ELECTRICAL PENETRATION	X-100C	1/12/92	0.4	0.2	0.4	1/13/92	0.4	0.2	0.4
ELECTRICAL PENETRATION (UNIT ONE ONLY)	X-100D	N/A	→						
ELECTRICAL PENETRATION	X-100E	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
ELECTRICAL PENETRATION	X-100F	1/29/92	0.04	0.02	0.04	1/29/92	0.04	0.02	0.04
ELECTRICAL PENETRATION	X-100G	1/29/92	0.04	0.02	0.04	1/29/92	0.04	0.02	0.04
ELECTRICAL PENETRATION	X-101A	2/27/92	0.4	0.2	0.4	2/27/92	0.4	0.2	0.4
ELECTRICAL PENETRATION	X-101B	2/27/92	0.5	0.25	0.5	2/27/92	0.5	0.25	0.5
ELECTRICAL PENETRATION	X-101D	1/29/92	0.04	0.02	0.04	1/29/92	0.04	0.02	0.04
ELECTRICAL PENETRATION	X-102A u1 only	→							
ELECTRICAL PENETRATION	X-102B	1/29/92	0.8	0.4	0.8	1/29/92	0.8	0.4	0.8
ELECTRICAL PENETRATION	X-103	1/29/92	0.04	0.02	0.04	1/29/92	0.04	0.02	0.04
ELECTRICAL PENETRATION (UNIT TWO ONLY)	X-104A	2/26/92	0.4	0.2	0.4	2/26/92	0.4	0.2	0.4
	PAGE TOTAL	NA	—	2.71	5.41	NA	—	1.96	3.91

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UNIT Q2R11

REFUEL OUTAGE LOCAL
LEAK RATE TEST SUMMARY

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DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH)				AS LEFT (SCFH)			
		DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
ELECTRICAL PENETRATION	X-104B	2/26/92	0.4	0.2	0.4	2/26/92	0.4	0.2	0.4
ELECTRICAL PENETRATION	X-104C	1/12/92	0.4	0.2	0.4	1/12/92	0.4	0.2	0.4
ELECTRICAL PENETRATION (UNIT TWO ONLY)	X-104D	1/12/92	0.4	0.2	0.4	1/12/92	0.4	0.2	0.4
ELECTRICAL PENETRATION	X-104F	1/29/92	0.04	0.02	0.04	1/29/92	0.04	0.02	0.04
ELECTRICAL PENETRATION	X-105A	2/26/92	0.4	0.2	0.4	3/4/92	0.39	0.20	0.39
ELECTRICAL PENETRATION (UNIT ONE ONLY)	X-105B	N/A							
ELECTRICAL PENETRATION	X-105C	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
ELECTRICAL PENETRATION (UNIT ONE ONLY)	X-105D	N/A							
ELECTRICAL PENETRATION (UNIT TWO ONLY)	X-106A	2/26/92	0.4	0.2	0.4	2/26/92	0.4	0.2	0.4
ELECTRICAL PENETRATION (UNIT TWO ONLY)	X-106B	2/27/92	0.9	0.45	0.9	2/27/92	0.9	0.45	0.9
ELECTRICAL PENETRATION	X-107A	1/14/92	0.4	0.2	0.4	1/14/92	0.4	0.2	0.4
ELECTRICAL PENETRATION (UNIT TWO ONLY)	X-107B	1/29/92	0.04	0.02	0.04	1/29/92	0.04	0.02	0.04
TORUS PENETRATION	X-227A	1/2/92	0.4	0.2	0.4	1/2/92	0.4	0.2	0.4
TORUS PENETRATION	X-227B	1/18/92	0.1	0.05	0.1	1/18/92	0.1	0.05	0.1
'A' TORUS LEVEL FLANGES	----	1/24/92	0.9	0.45	0.9	1/24/92	0.9	0.45	0.9
	PAGE TOTAL	NA	—	2.59	5.18	NA	—	2.59	5.17

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UNIT *Q2R11*

REFUEL OUTAGE LOCAL LEAK RATE TEST SUMMARY

QTS 100-S1
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DESCRIPTION	VALVE(S)/ PENETRATION	AS FOUND (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY	AS LEFT (SCFH) DATE	TOTAL	MINIMUM PATHWAY	MAXIMUM PATHWAY
'B' TORUS LEVEL FLANGES	----	1/24/92	1.0	0.5	1.0	1/24/92	1.0	0.5	1.0
SRM/IRM PURGE (UNIT TWO ONLY)	----	1/21/92	0.6	0.6	0.6	1/21/92	0.6	0.6	0.6
PERSONNEL INTERLOCK X-2	X-2	12/10/91	6.87	3.44	6.87	5/11/92	13.74	6.87	13.74
H_2/O_2 MONITORING SYSTEM (TOTAL)	---- A panel	1/3/92	0.7	0.1	0.6	3/13/92	2.8	1.4	2.8
	B panel	1/3/92	0.6	0.1	0.5	3/18/92	3.5	1.8	3.5
HPCI Exhaust Vacuum Breakers	2-2399-40, 41 *1	N/A	NA	NA	NA	3/24/92	0.6	0.28	0.32
	PAGE TOTAL	NA	—	4.74	9.57	NA	—	11.45	21.76
	TEST TOTAL +	NA	∞	190.67	∞ **	NA	—	108.11	191.8

*1 New valves installed Q2R11 Per Mod. M4-2-91-018 013B APR 4/6/92

*To determine the corrected leakage of the MSIVs (as if they had been tested at 48 PSIG), multiply by 1.73.

**When the maximum pathway leakage exceeds 0.6 La (293.75 SCFH), write an LER immediately.

+The test total is the sum of all page totals in the checklist (exclude MSIVs from all test totals).

Reference: QTS 150-8, "Determination of Total Containment Leak Rate."

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APPENDIX B

TEST CORRECTION FOR SUMP LEVEL CHANGES

The total time measure leak rate, given by the functional requirements specification CECo Generic ILRT Computer Code, Document ID No. GN01405-0.0, Document ID No. ILRT-FRS-0.0 (see Appendix C), assumes that the containment free air space is 280,327.5 ft^3 at a water level in the reactor of 35", torus water level is zero, and that any change in reactor water level is due to a water leakage from the containment changing the free air volume. If the water leakage is from the containment and due to the operation of the shutdown cooling mode of RHR to maintain reactor water temperature, this leakage would not be representative of accident conditions when shutdown cooling would be isolated.

During the stabilization phase of the test considerable effort went into reducing the rate of level decline to approximately 0.05 inches/hour that was experienced during the test. Since the leakage could not be reduced further and level indication for the suppression pool indicated that most of the water leaving the reactor was not entering the suppression pool, but leaving containment, the computer program option for including the vessel level in the leak rate calculation was selected.

A hand calculation, using a complete water balance, is included in this Appendix to show that the leak rate reported is not significantly affected by a more detailed analysis, including changing subvolume free air space due to water leaking from the reactor vessel to the drywell sumps and suppression pool.

To perform a leak rate calculation with a changing containment free air space, the dry air mass for each containment subvolume is calculated using the following equation:

$$W_i = \frac{2.6995 \times P_i \times V_i}{(T_i + 459.69)}$$

where P_i = dry air pressure in i^{th} subvolume,

V_i = free air space in the i^{th} subvolume, and

T = average temperature in the i^{th} subvolume.

The total containment dry air mass is given by the sum of the dry air masses for all of the subvolumes.

$$W^t = \sum_{i=1}^{11} W_i$$

The computed leak rate will be the total time leak rate and is given by:

$$L^t = -\frac{2400}{H} \times \frac{W^t - W^\circ}{W^\circ}$$

where W° = dry air mass of the containment at the start of the test.

W^t = dry air mass of the containment at time t,

H = duration of the test from start to time t in hours, and

L^t = total time leak rate at time t.

There are 3 subvolumes to consider in evaluating the effects of water leakage from the vessel: the vessel itself (subvolume 11), the suppression pool (subvolume 10), and the subvolume for the drywell equipment drain sump (DWEDS) and the drywell floor drain sump (DWFDS) (subvolume 9). Any water leaking from the vessel in excess of that added to the sumps and suppression pool will be assumed to have leaked from the containment through the shutdown cooling mode of RHR.

Over a 90 hour time period starting prior to the test and ending following completion of the test, 100 gallons of water leaked into the sumps. The sumps are assumed to have filled at a constant rate during this time period and each sump holds 1,200 gallons and is 42 inches deep.

Rate of water leakage into sumps: 1.111 gal./hr.
Rate of free air volume change: .152 ft^3/hr.

The following table gives the extrapolated values of the subvolume free air spaces using the above data:

6 HOUR TEST

SUBVOLUME NO. (i)	V_i t=0	V_i t=6
1	10,550	10,550
2	9,596	9,596
3	10,990	10,990
4	3,783	3,783
5	24,125	24,125
6	32,265	32,265
7	27,618	27,618
8	26,071	26,071
9*	9,489.6	9,488.7
10*	119,775	119,767
11*	5,047	5,130

* V_9 = 9,489.6 - (free air volume change over test duration)

$$V_{10} = 119{,}268 - 863.75 \left(\frac{ft^3}{in}\right) \times \text{torus level (in)}$$

$$V_{11} = 6{,}571.0 - 25\ (\text{level} - 35)$$

Using the subvolume vapor pressure, subvolume temperature, and the subvolume free air space, the dry air mass for each subvolume can now be calculated. The following table gives the necessary data for the start of the test (Data Set No. 252).

SUBVOLUME NO.	VAPOR PRESSURE (PSI)	DRY AIR PRESSURE (PSIA)	SUBVOLUME TEMPERATURE °F	DRY AIR MASS (lbs. mass)
1	.281	66.840	89.4	3466.80
2	.379	66.742	99.3	3092.92
3	.379	66.742	98.3	3548.57
4	.379	66.742	98.2	1221.72
5	.382	66.739	96.8	7810.39
6	.377	66.744	92.1	10535.46
7	.387	66.734	88.4	9077.60
8	.376	66.745	80.8	8691.05
9	.376	66.745	81.9	3157.03
10	.400	66.721	74.5	40384.65
11	1.747	65.374	121.1	1533.57

$$W^\circ = \sum_{i=1}^{11} W_i = 92{,}519.76$$

The following table gives the necessary data for the end of the 6 hour test (Data Set No. 291).

SUBVOLUME NO.	VAPOR PRESSURE (PSI)	DRY AIR PRESSURE (PSIA)	SUBVOLUME TEMPERATURE °F	DRY AIR MASS (lbs. mass)
1	.294	66.787	92.3	3445.85
2	.386	66.695	100.8	3082.47
3	.386	66.695	99.3	3539.73
4	.386	66.695	98.9	1219.33
5	.388	66.693	97.5	7795.21
6	.385	66.696	92.6	10518.35
7	.394	66.687	88.5	9069.55
8	.383	66.698	80.4	8691.36
9	.383	66.698	81.7	3155.68
10	.391	66.690	73.8	40416.15
11	1.913	65.168	124.4	1545.10

W^6 = 92,478.78

The leak rate for the 6 hour test is:

$$L^6 = - \frac{2400}{6.5} \times \frac{92,478.78 - 92,519.76}{92,519.76}$$

$L^6 = 0.1636$ wt % / d v (compared to 0.1651 computed ignoring sump level changes)

The above calculations show that the leakage from the reactor vessel did not significantly affect the reported leak rate. The difference between the leak rates computed using a complete correction for free air volume changes due to water leakage and the values computed ignoring the changes is less than 1%.

APPENDIX C

COMPUTATIONAL PROCEDURE

D. INPUT PROCESSING .

Calculations perfomed by the software are outlined below:

D.1 Average temperature of subvolume #i (T_i)
= The average of all RTD temps in subvolume #i

$$T_i = \frac{1}{N} \sum_{j=1}^{N} T_{i,j}$$

where N = The number of RTDs in subvolume #i

D.2 Average dew temperature of subvolume #i (D_i)
= The average of all dew cell dew temps in subvolume #i

$$D_i = \frac{1}{N} \sum_{j=1}^{N} D_{i,j}$$

where N = The number of RTDs in subvolume #i

D.3 Total corrected pressure #1, (P_1)

C_1 First correction factor for raw pressure #1, (from program initialization data set).

M_1 Second correction factor for raw pressure #1, (from program initialization data set).

Pr_1 Raw pressure #1, from BUFFILE.

$P_1 = C_1 + M_1 Pr_1/1000$, for 5 digit pressure transmitters

$P_1 = C_1 + M_1 Pr_1/10000$, for 6 digit pressure transmitters

D.4 Total corrected pressure #2, (P_2)

C_2 First correction factor for raw pressure #2, (from program initialization data set.

M_2 Second correction factor for raw pressure #2, (from program initialization data set.

Pr_2 Raw pressure #2, from BUFFILE.

$P_2 = C_2 + M_2 Pr_2/1000$, for 5 digit pressure transmitters

$P_2 = C_2 + M_2 Pr_2/10000$, for 6 digit pressure transmitters

D.5 Whole Containment Volume Weighted Average Temperature, (T_c)

Approximate Method
$$T_c = \sum_{i=1}^{N} f_i T_i$$

Exact Method
$$T_c = \frac{1}{\sum_{i=1}^{N} \frac{f_i}{T_i}}$$

where: f_i = The volume fraction of the i^{th} subvolume
N = The total # of subvolumes in containment

D.6 Average Vapor Pressure of Subvolume i, (Curve fit of ASME steam tables.) (Pv_i)

$$Pv_i = 0.01529125 + 0.001653476\, D_i - 1.44734 \times 10^{-6} (D_i)^2 + 7.081828 \times 10^{-7} (D_i)^3 - 2.28128 \times 10^{-9} (D_i)^4 + 3.03544 \times 10^{-11} (D_i)^5$$

D.7 Whole Containment Average Vapor Pressure, (Pv_c)

Approximate Method
$$Pv_c = \sum_{i=1}^{N} f_i Pv_i$$

Exact Method
$$Pv_c = T_c \sum_{i=1}^{N} \frac{f_i Pv_i}{T_i}$$

N = The total of subvolumes in containment
f_i = Volume fraction of the i^{th} subvolume

D.8 Whole Containment Average Dew Temperature, (D_c)

Approximate Method
$$D_c = \sum_{i=1}^{N} f_i D_i$$

Exact Method: The whole containment average vapor pressure, (Pv_c) calculated with the exact method is used to find D_c. An initial value of D_c is guessed and used with the equation in D.6 to calculate Pv_c. This value is then compared to the known value from D.7. A new value of D_c is guessed and the process is repeated until a value of D_c is found that results in a calculated value of Pv_c that is within .0001 psia of the value from D.7.

D.9 Average total containment pressure, (P)

$$P = (P_1 + P_2) / 2$$

Average total containment dry air pressure, (P_d)

$$P_d = P - Pv_c$$

D.10 Total Containment dry air mass, (M)

Type 1:

$$M = \frac{P_d \; V_c}{R \; T_c}$$

where: R = Perfect gas constant, V_c = Total containment free volume

Type 2: Type 2 dry air mass accounts for changes in Reactor Vessel level.

For uncorrected dry air mass, (Type 1) the below d 'initions apply.

$$V_c = \sum_{i=1}^{N} V_i \quad \text{and} \quad f_i = V_i/V_c$$

where V_i is the user entered free volume in subvolume i.

For corrected dry air mass, (Type 2) the same definitions for V_c and f_i apply, except that one of the V_is is corrected for changes in vessel level. If k is the subvolume number of the corrected subvolume then:

$$V_k = V_{ko} - a(C - b)$$

a is the number of cubic feet of free volume per inch of vessel level.

b is the base level of the reactor vessel, in inches.

C is the actual water level in the reactor vessel, in inches.

V_{ko} is the volume of the subvolume k when C equals b.

The volume fractions (f_i) are then calculated with the corrected volume, and all other calculations are subsequently performed as previously specified for Type 1 dry air mass.

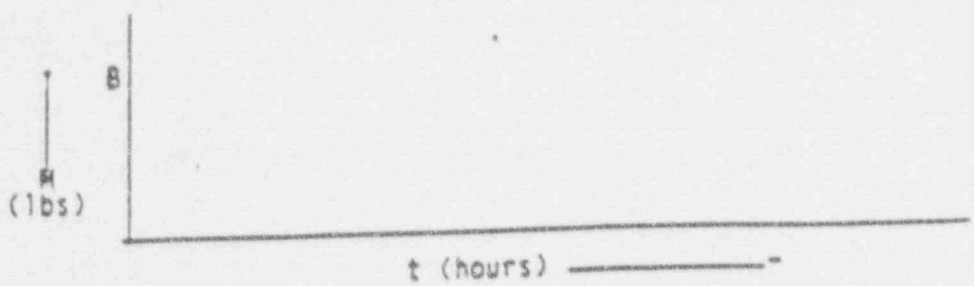
D.11 Leakrate Calculations using Mass-Plot Method:

This method assumes that the leakage rate is constant during the testing period, a plot of the measured contained dry air mass versus time would ideally yield a straight line with a negative slope.

Based on the least squares fit to the data obtained, the calculated containment leakage rate is obtained from the equation:

$$M = At + B$$

Where
- M = containment dry air mass at time t (lbs.)
- B = calculated dry air mass at time $t=0$ (lbs.)
- A = calculated leakage rate (lbs/hr)
- t = time interval since start of test (hours)



The values of the constants A and B such that the line is linear least squares best fitted to the leak rate data are:

$$A = \frac{N\Sigma(t_i)(M_i) - (\Sigma t_i)(\Sigma M_i)}{N\Sigma(t_i)^2 - (\Sigma t_i)^2}$$

$$B = \frac{\Sigma M_i - A\Sigma t_i}{N}$$

By definition, leakage out of the containment is considered positive leakage. Therefore, the statistically averaged least squares containment leakage rate in weight percent per day is given by:

$$L = (A)(2400)/B \qquad \text{(weight \%/day)}$$

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

$$\sigma = \left[\frac{1}{(N-2)} \; \frac{N\Sigma(M_i)^2 - (\Sigma M_i)^2}{N\Sigma(t_i)^2 - (\Sigma t_i)^2} - A^2 \right]^{1/2} \frac{(2400)}{B} \quad \text{(weight \% per day)}$$

$$UCL = L + \sigma (T)$$

where

$$T = \frac{1.6449(N-2) + 3.5283 + 0.85602/(N-2)}{(N-2) + 1.2209 - 1.5162/(N-2)}$$

N	=	Number of data sets	
t_i	=	test duration at the i^{th} data set	(hours)
σ	=	standard deviation of least squares slope	(weight%/day)
T	=	Value of the single-sided T-Distribution function with 2 degrees of freedom	
L	=	calculated leak rate in weight %/day	
UCL	=	95% upper confidence limit	(%/day)
B	=	calculated containment dry air mass at time t=0	(lbs.)

D.12 Point to Point Calculations

This method calculates the rate of change with respect to time of dry air mass using the Point to Point Method.

For every data set, the rate of change of dry air mass between the most recent, (t_i) and the previous time (t_{i-1}) is calculated using the two point method shown below:

$$\dot{M}_i = \frac{2400}{(t_i - t_{i-1})} (1 - M_i/M_{i-1})$$

Then the least square fit of the point to point leakrates is calculated as described for dry air masses in section D.11

D.13 Total Time Calculations

This method calculates the rate of change with respect to time of dry air mass using the Total Time Method

Initially, a reference time (t_r) is chosen. For every data set the rate of change of dry air mass between t_r and the most recent time, t_i is calculated using the two point method shown below.

$$\dot{M}_i = \frac{2400}{(t_i - t_r)} \quad (1 - M_i/M_r)$$

Then the least squares fit and 95% UCL of the Total Time leakrates are calculated as shown below:

$$B = \frac{\Sigma \dot{M}_i \, \Sigma(t_i)^2 - \Sigma t_i \, \Sigma \dot{M}_i t_i}{N \, \Sigma (t_i)^2 - (\Sigma t_i)^2}$$

$$A = \frac{(N \, \Sigma t_i \dot{M}_i - \Sigma t_i \, \Sigma \dot{M}_i)}{N \, \Sigma (t_i)^2 - (\Sigma t_i)^2}$$

$$L = B + At$$

$$T = \frac{1.6449(N-2) + 3.5283 + 0.85602/(N-2)}{(N-2) + 1.2209 - 1.5162/(N-2)}$$

Note: N is the number of data sets minus one.

$$F = \frac{1}{N} + \frac{(t_p - \Sigma (t_i) / N)^2}{\Sigma (t_i)^2 - (\Sigma t_i)^2 / N}$$

$$\sigma = \sqrt{\frac{F}{N}} \quad \sqrt{\Sigma (\dot{M}_i)^2 - B \Sigma \dot{M} - A \Sigma \dot{M}_i t_i}$$

$$UCL = L + T\sigma$$

Note: This equation is calculated for information only from the start of the test up to 24 hours, then it becomes the official leakrates for future times.

D.14 BN-TOP-1

This method calculates the rate of change with respect to the time of dry air mass using the Total Time Method.

Initially, a reference time (t_r) is chosen. For every data set the rate of change of the data item between t_r and the most recent time, (t_i) is calculated using the two point method shown below:

$$\dot{M}_i = \frac{2400}{(t_i - t_r)} (1 - M_i/M_r)$$

Then the least squares fit of the Total Time leakrates and the BN-TOP-1 95% UCLs are calculated as shown below

$$B = \frac{(\Sigma \dot{M}_i \, \Sigma(t_i)^2 - \Sigma t_i \, \Sigma \dot{M}_i t_i)}{N \Sigma (t_i)^2 - (\Sigma t_i)^2}$$

Note: N is the number of data sets minus one.

$$A = \frac{(N \Sigma t_i \dot{M}_i - \Sigma t_i \Sigma \dot{M}_i)}{N \Sigma (t_i)^2 - (\Sigma t_i)^2}$$

$$L = B + At$$

$$T = 1.95996 + \frac{2.37226}{(N - 2)} + \frac{2.8225}{(N - 2)^2}$$

$$F = 1 + \frac{1}{N} + \frac{(t_p - \Sigma (t_i) / N)^2}{\Sigma (t_i)^2 - (\Sigma t_i)^2 / N}$$

$$\sigma = \sqrt{\frac{F}{N}} \sqrt{\Sigma (\dot{M}_i)^2 - B \Sigma \dot{M}_i - A \Sigma \dot{M}_i t_i}$$

$$UCL = L + T\sigma$$

Note: This equation is calculated for information only from the start of the test up to 24 hours, then it becomes the official leakrates for future times.

D.15 Temperature stabilization checking per ANSI 56.8-1981

T_i Weighted average containment air temperature at hour i.

$T_{i,n}$ Rate of change of weighted average containment air temperature over an n hour period at hour i, using a two point backwards difference method.

$$T_{i,n} = \frac{T_i - T_{i-n}}{n}$$

Z_i is the ANSI 56.8-1981 Temperature stabilization criteria at hour i,

$$Z_i = | T_{i-4} - T_{i-1} | \quad i \text{ must be} \geq 4.$$

Per ANSI 56.8-1981, Z must be less than or equal to 0.5 °F/hr

NOTE: If the data sampling interval is less than one hour, then:

Option #1 Use data collected at hourly intervals

Option #2 Use average of data collected in previous hour for that hour's data.

D.16 Calculation of Instrument Selection Guide, (ISG)

$$ISG = \frac{2400}{t} \sqrt{\frac{2}{N_p}(e_p/p)^2 + \frac{2}{N_r}(e_r/T)^2 + \frac{2}{N_d}(e_d/p)^2}$$

where: t is the test time, in hours
p is test pressure, psia
T is the volume weighed average containment temperature, °R
N_p is the number of pressure transmitters
N_r is the number of RTDs
N_d is the number of dew cells
e_p is the combined pressure transmitters' error, psia
e_r is the combined RTDs' error, °R
e_d is the combined dew cells' error, °R

$$e_p = \sqrt{(S_p)^2 + (RP_p + RS_p)^2}$$

where: S_p is the sensitivity of a pressure transmitter
RP_p is the repeatability of a pressure transmitter
RS_p is the resolution of pressure transmitter

$$e_r = \sqrt{(S_r)^2 + (RP_r + RS_r)^2}$$

where: S_r is the sensitivity of an RTD
RP_r is the repeatability of an RTD
RS_p is the resolution of an RTD

$$e_d = \frac{\Delta P_v}{\Delta T_d}\bigg|_{T_d} \sqrt{(S_d)^2 + (RP_d + RS_d)^2}$$

where: S_d is the sensitivity of a dew cell
RP_d is the repeatability of a dew cell
RS_d is the resolution of a dew cell

$$\frac{\Delta P_v}{\Delta T_d}\bigg|_{T_d} = \frac{\text{change in vapor pressure}}{\text{change in saturation temperature}}$$

The above ratio is from ASME steam tables and evaluated at the containment's saturation temperature at that time.

D.17 BN-TOP-1 Temperature Stabilization Criteria Calculation

A. The rate of change of temperature is less than 1 °F/Hr averaged over the last two hours.

$K_1 = |T_i - T_{i-1}|$ $K_2 = |T_{i-1} - T_{i-2}|$
K_1 and K_2 must both be less than 1 to meet the criteria listed in A.

B. The rate of change of temperature changes less than 0.5 °F/hour/hour averaged over the last two hours.

$$K_1 = (T_i - T_{i-1})/(t_i - t_{i-1})$$
$$K_2 = (T_{i-1} - T_{i-2})/(t_{i-1} - t_{i-2})$$
$$Z = |(K_1 - K_2)/(t_i - t_{i-1})|$$

Z must be less than 0.5 to meet the criteria listed in B.

D.18 Reactor Vessel Free Volume Mass Calculation

As shown in section D.10, the free volume of the Reactor Vessel subvolume κ is given by the below equation.

$$V_\kappa = V_{\kappa o} - a\,(c-b)$$

The dry air mass in subvolume κ can then be written as:

$$M_\kappa = 144\,(\bar{P}-\bar{P}_{v\kappa})\,V_\kappa/R\bar{T}_\kappa$$

Where: M_κ is the dry air mass in subvolume κ, (lbm)

R is the gas constant of air

$\overline{T_\kappa}$ is the average temperature of subvolume κ, (°R)

$\overline{P_{v\kappa}}$ is the average vapor pressure of subvolume κ, (pisa)

$\bar{P}$ is the average containment pressure, (psia)

V_κ is the free air volume in subvolume κ, (ft^3)

D.19 Torus Free Volume Calculation

Free volume calculations of the Torus rely upon narrow range Torus water level inputs. These values range between plus and minus five inches. It is assumed that the Torus subvolume free air volume is that subvolume's volume when the Torus level equals zero. The user may enter three constants to model the variation of Torus air volume with water level.

The equations for Torus free volume in subvolume t are given:

$$V_t = V_{to} - (aL + bL + cL^3) \text{ when } L \geq 0$$
$$V_t = V_{to} + (-aL + bL^2 - cL^3) \text{ when } L \leq 0$$

The dry air mass in subvolume t can then be written as:

$$M_t = 144\ (\bar{P} - \bar{P}_{vt})\ V_t / R\bar{T}_t$$

Where: Mt is the dry air mass in subvolume t, (lbm)

$\bar{P}$ is the average containment pressure, (psia)

$\overline{P_{vt}}$ is the average vapor pressure of subvolume t (pisa)

V_t is the free volume in subvolume t, (ft^3)

R is the gas constant of air

T_t is the average temperature in subvolume t (^oR)

L is the Torus level, (inches)

a,b,c are Torus level constants

V_{to} is the free volume in subvolume T when L equals zero, taken from standard free volume inputs, (ft^3)

E. OUTPUTS

E.1 OUTPUT DEVICE TYPES: The below output devices shall be supported. There are no special constraints on output device locations.

PRINTERS:	PRIME High Speed Line Printer	
	OKIDATA 2410	
	OKIDATA 93	
	LA120	
PLOTTERS:	Hewlet Packard	7475A 8.5" X 11"
	Hewlet Packard	7585A 8.5" X 11"
	Hewlet Packard	7585A 11" X 17"
CRTs:	Wyse Wy75	
	View Point 60	
	Ampex Dialogue 80 & 81	
	PRIME	PT200
GRAPHICS TERMINALS:	RamTech	6200
	RamTech	6211
	Tektronix	4107
	Tektronix	4208
	Tektronix	4014

APPENDIX D

INSTRUMENT ERROR ANALYSIS

July 8, 1992

To: D. Nyman
D. Schumacher
S. Gupta
J. Kuznicki
R. Salmi
H. King

Subject: Calculation Of The Instrument Selection Guide For ILRT Instrumentation Systems

10CFR50-Appendix J specifies that all Type A tests be conducted in accordance with the provisions of the American National Standard N45.4-1972. Section 6.4 of that standard requires that the combined precision of all instruments used to perform a Type A test be such that the accuracy of the collected data is consistent with the magnitude of the specified leakage rate.

The Instrument Selection Guide,(ISG) formulation defined in Appendix G of the 1987 Standard, ANSI/ANS-56.8 is an acceptable means of determining the ability of the Type A test instrumentation system to measure the integrated leakage rate of a primary reactor containment system. This rather long formulation is labor intensive to calculate either by hand or by computer.

Section 5.4 of NO Directive NOD-TS.13 specifies that all CECo plants shall use a standardized instrumentation system for Type A testing. Attachment A lists the resolutions, repeatabilities, and sensitivities which may be expected when the standardized system is used. Also listed are the recommended minimum numbers of each type of sensor.

It is shown in Attachment B, that if the standard Type A test instrumentation specifications and the minimum sensor numbers are met, then the ANS-56.8 ISG acceptance criteria is always satisfied. This eliminates the need to demonstrate by calculation in station procedures that the ISG acceptance criteria is meet.

The requirement to calculate Type A Test instrumentation system ISG values may be eliminated from the ILRT procedures of each CECo station. Instead, the instrumentation requirements listed in Attachment A need be included. This letter along with the attachments may be referenced as the basis for that procedure change.

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ATTACHMENT A

ILRT INSTRUMENTATION SYSTEM SPECIFICATIONS

Pressure Transmitters:	Resolution	0.0001 psi
	Repeatability	0.001 psi
	Sensitivity	0.0001 psi
	Minimum Number	1
Temperature Channels:	Resolution	0.01 °F
	Repeatability	0.02 °F
	Sensitivity	0.01 °F
	Minimum Number	15
Dew Temperature Channels:	Resolution	0.01 °F
	Repeatability	0.1 °F
	Sensitivity	0.1 °F
	Minimum Number	5

Instrument Parameter Defintions From ANSI/ANS 56.8-1987

Repeatability: The capability of the measurement system to reproduce a given reading from a constant source.

Resolution: The least unit discernible on the display mechanism.

Sensitivity: The capability of a measurement system to respond to change in the measured parameter.

ATTACHMENT B

INSTRUMENT SELECTION GUIDE CALCULATIONS FOR ILRT INSTRUMENTATION

"These calculations are based upon the equations listed in Appendix G of ANSI/ANS 56.8-1987"

Pressure Transmitter Parameters			Temperature Parameters			Dew Temperature Parameters		
Sensitivity	$Sp := 0.0001$	psi	Sensitivity	$Sr := 0.01$	F	Sensitivity	$Sd := 0.1$	F
Repeatability	$RPp \equiv 0.001$	psi	Repeatability	$RPr \equiv 0.02$	F	Repeatability	$RPd \equiv 0.1$	F
Resolution	$RSp := 0.0001$	psi	Resolution	$RSr := 0.01$	F	Resolution	$RSd := 0.01$	F
Number	$Np \equiv 1$		Number	$Nr \equiv 15$		Number	$Nd \equiv 5$	
Pressure	$P := 44.$	psig	Temperature	$T := 95$	F	Dew Temp	$Td := 95.$	F

TEST DURATION $t := 8$

Pressure Error Calculation

Measurement System Error $Pmse := RPp + RSp$ $Pmse = 0.0011$

Pressure Error $$Pe := \frac{\left(Pmse^2 + Sp^2\right)^{0.5}}{Np^{.5}}$$ $Pe = 0.0011$

Temperature Measurement Error

Measurement System Error $Tmse := RPr + RSr$ $Tmse = 0.03$

Temperature Error $$Te := \frac{\left(Tmse^2 + Sr^2\right)^{0.5}}{Nr^{0.5}}$$ $Te = 0.0082$

Dew Temperature Measurement Error

Measurement System Error $Tdmse \equiv RPd + RSd$ $Tdmse = 0.11$

Calculate the vapor pressure rate of change with dew temp from steam tables

$A := 0.0886717535$ $B := 22.452$ $C := 490.59$

$$Z := \frac{d}{dTd}\left[A \cdot \exp\left[B \cdot \frac{Td - 32}{(Td - 32 + C)}\right]\right]$$ $Z = 0.041$

Measurement System Error $Dmse := Z \cdot (RPd + RSd)$ $Dmse = 0.0045$

Dew Temperature Error $$De := \frac{\left[Dmse^2 + (Z \cdot Sd)^2\right]^{0.5}}{Nd^{0.5}}$$ $De = 0.0027$

Pressue Error Term $PE := 2 \cdot \left[\frac{Pe}{(P + 14.7)}\right]^2$ $PE = 7.0813 \cdot 10^{-10}$

Temperature Error Term $TE := 2 \cdot \left[\frac{Te}{(T + 459.68)}\right]^2$ $TE = 4.3336 \cdot 10^{-10}$

Dew Temperature Error Term $DTE := 2 \cdot \left[\frac{De}{(P + 14.7)}\right]^2$ $DTE = 4.3179 \cdot 10^{-9}$

$ISG := \frac{2400.0}{t} \cdot (PE + TE + DTE)^{0.5}$ $ISG = 0.0222$

ANSI/ANS 56.8 requires that the ISG be less than 0.25La to be acceptable

STATION	La	0.25La
DRESDEN	1.6	0.4
ZION	0.1	0.025
BYRON	0.1	0.025
BRAIDWOOD	0.1	0.025
QUAD CITIES	1.0	0.25
LASALLE	0.635	0.156

APPENDIX E

BN-TOP-1, REV. 1 ERRATA

APPENDIX E

BN-TOP-1, REV. 1 ERRATA

The Commission has approved short duration testing for the IPCLRT provided the Station uses the general test method outlined in the BN-TOP-1, Rev. 1 topical report. The primary difference between that method and the ones previously used is in the statistical analysis of the measured leak rate data.

Without making any judgments concerning the validity of this test method, certain errors in the editing of the mathematical expressions were discovered. The intent here is not to change the test method, but rather to clarify the method in a mathematically precise manner that allows its implementation. The errors are listed below.

<u>EQUATION 3A, SECTION 6.2</u>

Reads: $L_i = A + B\ t_i$

Should Read: $L_i = A_i + B_i\ t_i$

Reason: The calculated leak rate (L_i) at time t_i is computed using the regression line constants A_i, B_i (computed using equations 6 and 7). The summation signs in equation 6 are defined as $\Sigma = \sum_{i=1}^{n}$, where n is the number of data sets up until time t_i. The regression line constants change each time a new data set is received. The calculated leak rate is not a linear function of time.

<u>PARAGRAPH FOLLOWING EQ. 3A, SECTION 6.2</u>

Reads: The deviation of the measured leak rate (M) from the calculated leak rate (L) is shown graphically on Figure A.1 in Appendix A and is expressed as:

Deviation $= M_i - L_i$

Should Read: The deviation of the measured leak rate (M_i) from the regression line (N_i) is shown graphically on Figure A.1 in Appendix A and is expressed as:

Deviation $= M_i - N_i$

where $N_i = A_p + B_p * t_i$,

A_p, B_p = Regression line constants computed from all data sets available from the start of the test to the last data set at time t_p,

t_i = time from the start of the test to the ith data set.

Reason: The calculated leak rate as a function of time during the test is based on a regression line. The regression line constants, A_i and B_i, are changing as each additional data set is received. Equation 3A is used later in the test to compute the upper confidence limit as a function of time. For the purpose of this calculation, it is the deviation from the last computed regression line at time t_p that is important.

EQUATION 4, SECTION 6.2

Reads: $SSQ = \Sigma (M_i - L_i)^2$

Should Read: $SSQ = \Sigma (M_i - N_i)^2$

Reason: Same As Above

EQUATION 5, SECTION 6.2

Reads: $SSQ = \Sigma [M_i - (A + Bt_i)]^2$

Should Read: $SSQ = \Sigma [M_i - (A_p + B_p * t_i)]^2$

Reason: Same As Above

EQUATION ABOVE EQUATION 6, SECTION 6.2

Reads:
$$B = \frac{(t_i - \bar{t})(M_i - \bar{M})}{\Sigma(t_i - t)^2}$$

Should Read:
$$B_i = \frac{\Sigma[(t_i - \bar{t})(M_i - \bar{M})]}{\Sigma(t_i - \bar{t})^2}$$

Reason: Regression line constant B_i changes over time (as a function of t_p) as each additional data set is received. Bar of "t" left out of denominator. Summation signs omitted.

EQUATION 6, SECTION 6.2

Reads:
$$B = \frac{n \Sigma t_i M_i - (\Sigma t_i)(\Sigma M_i)}{n \Sigma t_i^2 - (\Sigma t_i)^2}$$

Should Read:
$$B_i = \frac{n \Sigma t_i M_i - (\Sigma t_i)(\Sigma M_i)}{n \Sigma t_i^2 - (\Sigma t_i)^2}$$

Reason: Same As Above

EQUATION 7, SECTION 6.2

Reads: $A = \bar{M} - B\,\bar{t}$

Should Read: $A_i = \bar{M} - B_i\,\bar{t}$

Reason: Same As Above

EQUATION 10, SECTION 6.2

Reads:

$$A = \frac{(\Sigma M_i)(\Sigma t_i^2) - (\Sigma t_i)(\Sigma t_i M_i)}{n \Sigma t_i^2 - (\Sigma t_i)^2}$$

Should Read:

$$A_i = \frac{(\Sigma M_i)(\Sigma t_i^2) - (\Sigma t_i)(\Sigma t_i M_i)}{n \Sigma t_i^2 - (\Sigma t_i)^2}$$

Reason: Same As Above

EQUATION 13, SECTION 6.3

Reads:

$$\sigma^2 = s^2 \left[1 + \frac{1}{n} + \frac{(t_p - t)^2}{(t_i - t)^2}\right]$$

Should Read:

$$\sigma^2 = s^2 \left[1 + \frac{1}{n} + \frac{(t_p - \bar{t})^2}{\Sigma (t_i - \bar{t})^2}\right]$$

where t_p = time from the start of the test of the last data set for which the standard deviation of the measured leak rates (M_i) from the regression line (N_i) is being computed;

t_i = time from the start of the test of the i^{th} data set;

n = number of data sets to time t_p;

$\Sigma = \sum_{i=1}^{n}$; and

$\bar{t} = \frac{1}{n} \Sigma t_i$.

Reason: Appears to be error in editing of the report. Report does a poor job of defining variables.

EQUATION 14, SECTION 6.3

Reads: $\sigma = s \left[1 + \frac{1}{n} + \frac{(t_p - t)^2}{(t_i - t)^2} \right]$

Should Read: $\sigma = s \left[1 + \frac{1}{n} + \frac{(t_p - \bar{t})^2}{\Sigma (t_i - \bar{t})^2} \right]$

Reason: Same As Above

EQUATION 15, SECTION 6.3

Reads: Confidence Limit = L ± T

Should Read: Confidence Limits = L ± T x σ

where L = calculated leak rate at time t_p,

T = T distribution value based on n, the number of data sets received up until time t_p;

σ = standard deviation of measured leak rate values (M_i) about the regression line based on data from the start of the test until time t_p.

Reason: Same As Above ·

EQUATION 16, SECTION 6.3

Reads: UCL = L + T

Should Read: UCL = L + T * σ

Reason: Same As Above

EQUATION 17, SECTION 6.3

Reads: LCL = L - T

Should Read: LCL = L - T * σ

Reason: Same As Above

APPENDIX F

TYPE A TEST RESULTS USING MASS-PLOT METHOD (ANS/ANSI 56.8)

TYPE A TEST RESULTS
USING MASS - PLOT METHOD
MEASURED LEAK RATE PHASE

DATA SET #	DATA SET TIME DAY HH MM SS	TEST TIME, (HR)	DRY AIR MASS, (LBM)	LEAK RATE (%/D)	95% UP CONF LIMIT, (%/D)
252	096 09:46:18	0.000	0.92353828E+05	---	---
253	096 09:56:18	0.167	0.92353547E+05	---	---
254	096 10:06:18	0.333	0.92352312E+05	0.1183E+00	0.4857E+00
255	096 10:16:18	0.500	0.92349609E+05	0.2167E+00	0.3928E+00
256	096 10:26:18	0.667	0.92348734E+05	0.2203E+00	0.3018E+00
257	096 10:36:18	0.833	0.92349062E+05	0.1826E+00	0.2496E+00
258	096 10:46:18	1.000	0.92344203E+05	0.2307E+00	0.3024E+00
259	096 10:56:18	1.167	0.92346312E+05	0.2041E+00	0.2636E+00
260	096 11:06:18	1.333	0.92343484E+05	0.2075E+00	0.2526E+00
261	096 11:16:18	1.500	0.92344562E+05	0.1887E+00	0.2294E+00
262	096 11:26:18	1.667	0.92343015E+05	0.1809E+00	0.2147E+00
263	096 11:36:18	1.833	0.92341531E+05	0.1783E+00	0.2062E+00
264	096 11:46:18	2.000	0.92344515E+05	0.1555E+00	0.1888E+00
265	096 11:56:18	2.167	0.92339625E+05	0.1585E+00	0.1870E+00
266	096 12:06:18	2.333	0.92334828E+05	0.1753E+00	0.2051E+00
267	096 12:16:18	2.500	0.92336187E+05	0.1779E+00	0.2040E+00
268	096 12:26:18	2.667	0.92330469E+05	0.1937E+00	0.2216E+00
269	096 12:36:18	2.833	0.92331687E+05	0.1980E+00	0.2231E+00
270	096 12:46:18	3.000	0.92333297E+05	0.1941E+00	0.2168E+00
271	096 12:56:18	3.167	0.92332359E+05	0.1905E+00	0.2112E+00
272	096 13:06:18	3.333	0.92334515E+05	0.1810E+00	0.2019E+00
273	096 13:16:18	3.500	0.92331500E+05	0.1773E+00	0.1966E+00
274	096 13:26:18	3.667	0.92328250E+05	0.1781E+00	0.1957E+00
275	096 13:36:18	3.833	0.92328750E+05	0.1761E+00	0.1923E+00
276	096 13:46:18	4.000	0.92328609E+05	0.1732E+00	0.1883E+00
277	096 13:56:18	4.167	0.92323828E+05	0.1757E+00	0.1899E+00
278	096 14:06:18	4.333	0.92324468E+05	0.1756E+00	0.1887E+00
279	096 14:16:18	4.500	0.92324187E+05	0.1745E+00	0.1867E+00
280	096 14:26:18	4.667	0.92322531E+05	0.1742E+00	0.1856E+00
281	096 14:36:18	4.833	0.92319609E+05	0.1757E+00	0.1865E+00
282	096 14:46:18	5.000	0.92319484E+05	0.1761E+00	0.1861E+00
283	096 14:56:18	5.167	0.92322531E+05	0.1727E+00	0.1826E+00
284	096 15:06:18	5.333	0.92318547E+05	0.1722E+00	0.1816E+00
285	096 15:16:18	5.500	0.92318172E+05	0.1713E+00	0.1801E+00
286	096 15:26:18	5.667	0.92316062E+05	0.1713E+00	0.1796E+00
287	096 15:36:18	5.833	0.92315937E+05	0.1705E+00	0.1784E+00
288	096 15:46:18	6.000	0.92314578E+05	0.1701E+00	0.1776E+00
289	096 15:56:18	6.167	0.92313187E+05	0.1699E+00	0.1770E+00
290	096 16:06:18	6.333	0.92311984E+05	0.1699E+00	0.1766E+00
291	096 16:16:18	6.500	0.92312531E+05	0.1689E+00	0.1753E+00

TYPE A TEST RESULTS
USING MASS - PLOT METHOD
INDUCED LEAK RATE PHASE

DATA SET #	DATA SET TIME DAY HH MM SS	TEST TIME, (HR)	DRY AIR MASS, (LBM)	LEAK RATE (%/D)	95% UP CONF LIMIT, (%/D)
298	096 17:26:18	0.000	0.92271344E+05	---	---
299	096 17:36:18	0.167	0.92266687E+05	---	---
300	096 17:46:18	0.333	0.92257953E+05	0.1045E+00	0.2608E+01
301	096 17:56:18	0.500	0.92249875E+05	0.1141E+00	0.1433E+01
302	096 18:06:18	0.667	0.92242672E+05	0.1157E+00	0.1294E+01
303	096 18:16:18	0.833	0.92237828E+05	0.1104E+00	0.1208E+01
304	096 18:26:18	1.000	0.92230469E+05	0.1090E+00	0.1162E+01
305	096 18:36:18	1.167	0.92222953E+05	0.1091E+00	0.1143E+01
306	096 18:46:18	1.333	0.92217000E+05	0.1081E+00	0.1121E+01
307	096 18:56:18	1.500	0.92209422E+05	0.1081E+00	0.1113E+01
308	096 19:06:18	1.667	0.92201687E+05	0.1087E+00	0.1113E+01
309	096 19:16:18	1.833	0.92196656E+05	0.1079E+00	0.1102E+01
310	096 19:26:18	2.000	0.92190390E+05	0.1071E+00	0.1092E+01
311	096 19:36:18	2.167	0.92183734E+05	0.1064E+00	0.1084E+01
312	096 19:46:18	2.333	0.92179031E+05	0.1052E+00	0.1073E+01
313	096 19:56:18	2.500	0.92172562E+05	0.1043E+00	0.1063E+01
314	096 20:06:18	2.667	0.92164203E+05	0.1042E+00	0.1060E+01
315	096 20:16:18	2.833	0.92160281E+05	0.1034E+00	0.1051E+01
316	096 20:26:18	3.000	0.92150015E+05	0.1037E+00	0.1053E+01
317	096 20:36:18	3.167	0.92143969E+05	0.1037E+00	0.1052E+01
318	096 20:46:18	3.333	0.92136625E+05	0.1039E+00	0.1053E+01
319	096 20:56:18	3.500	0.92132578E+05	0.1036E+00	0.1049E+01
320	096 21:06:18	3.667	0.92124281E+05	0.1037E+00	0.1048E+01

MASS PLOT LEAKRATES VS TIME

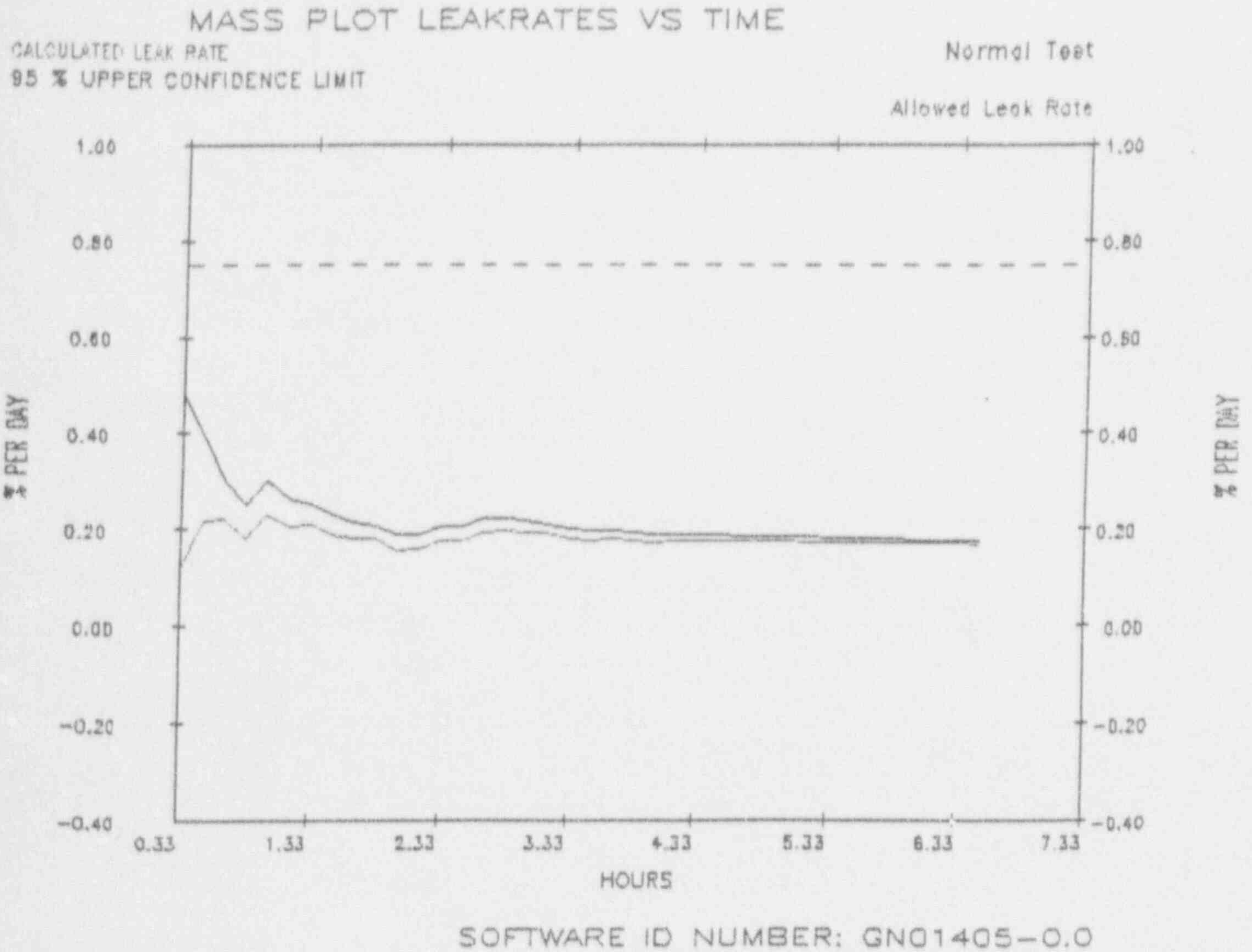

FIGURE 1

MASS PLOT LEAKRATES VS TIME

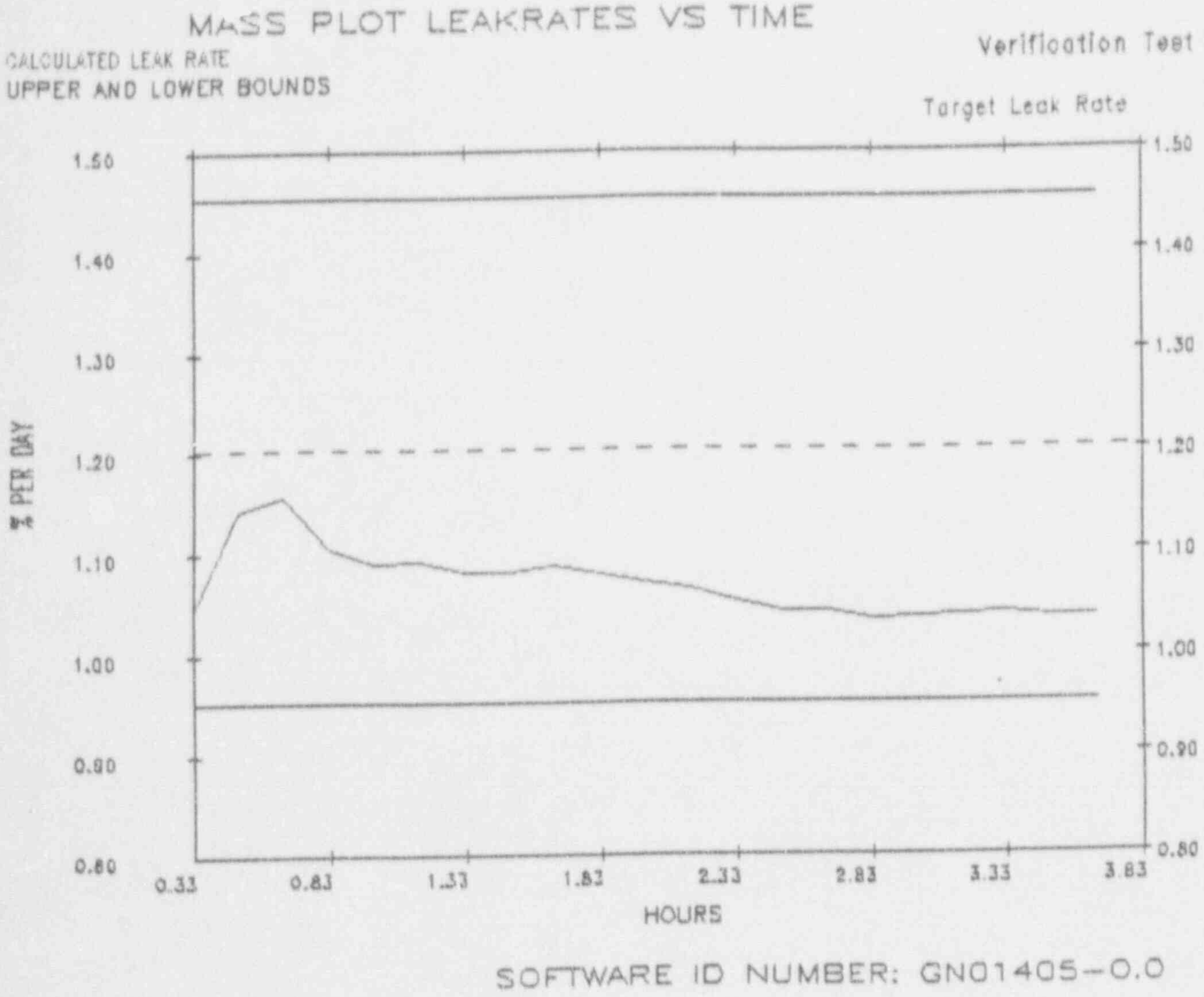

FIGURE 2