DRESDEN UNIT 2 REACTOR CONTAINMENT
BUILDING INTEGRATED
LEAK RATE TEST

April 17-22, 1983

DRESDEN UNIT 2 1983 ILRT

Abstract

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The 1983 Dresden Unit 2 Primary Containment Integrated Leak Rate Test (ILRT) was performed in accordance with the requirements of 10 CFR 50, Appendix J, Section V.B.3, from April 17 to April 22. For the first time, a "short duration" (less than 24 hours) test was conducted using the methods outlined in Bechtel Topical Report BN-TOP-1, Revision 1, dated November 1, 1972. Initial pressurization of the containment on April 17 resulted in excessive leakage coming from several torus-to-drywell vacuum breaker actuating arm seals. For this reason, the ILRT was terminated and the containment vented. Local leak rate tests were then performed, and the leakage was found to be 1778.28 SCFH, or 3.462 weight %/day. This exceeded the Unit 2 Technical Specification 3.7.A.2.b.(1).(a) operational limit of 1.2 weight %/day, and was reported on Licensee Event Report #83-29 (Docket 50-237).

The vacuum breaker actuating arm seals were repaired and the ILRT restarted. Total containment leakage upon successful completion of the ILRT was 0.278 weight %/day, including local leak rate test results for several systems that were not vented or drained during the ILRT. A supplemental induced phase verification test was performed in order to prove the accuracy of the computerized measurement system. The difference between the induced phase calculated leak rate and the sum of the measured phase calculated leak rate and the superimposed leak rate was 0.0003 weight %/day, which was well below the Technical Specification 4.7.A.2.d.(1). accuracy requirement of 0.4 weight %/day.

A. INTRODUCTION

A.1 Purpose of Test

The purpose of the Dresden Unit 2 Primary Containment Integrated Leak Rate Test was to measure the primary containment leak rate while at a test pressure equal to that postulated to occur during loss-of-coolant accident (LOCA) conditions. The system lineups for the ILRT are intended to provide the normal isolations that are available under operation to prevent primary containment leakage should such conditions develop. This report is provided in order to give a detailed description of the test method and the final results. These results are reported in accordance with 10 CFR 50, Appendix J, "Primary Containment Leakage Testing for Water Cooled Power Reactors."

A.2 Test Requirements

All leak rate tests performed during the recent refueling outage were done in accordance with schedules and acceptance criteria established by 10 CFR 50, Appendix J, American National Standard ANSI N45.4 1972, and by the Dresden Unit 2 Technical Specifications. The maximum acceptable leak rates, as stated in the Technical Specifications are as follows:

Type "A" test (ILRT @ greater than 48 psig)

a. Measured Phase

1. 1.6 weight %/day (La) maximum allowable

2. 1.2 weight %/day (Lt) maximum operational

b. Supplemental Verification Phase

± 0.4 weight %/day (0.25 La)

Type "B" and "C" Tests (Local Leak Rate Tests)

a. Testable penetrations and isolation valves must have a total combined leakage of less than or equal to 60 percent of La except for main steam isolation valves.

b. Any one air lock must have a leakage rate of less than or equal to 3.75 percent of La when pressurized to 10 psig.

c. Any one main steam isolation valve must have a leakage of less than or equal to 11.5 scfm when pressurized to 25 psig.

The Type "A" test was conducted in accordance with Technical Staff Surveillance Procedure DTS 1600-7, Rev. 6. This procedure incorporates all the test requirements.

A.3 Summary of Results

The Dresden Unit 2 Primary Containment Leak Rate was found to be 0.278 weight/% day (or 145.91 scfh) at a test pressure of 48 psig minimum. This total leak rate includes the 12-hour phase Type A calculated test result and several Type C test results for process lines not drained and vented as required by 10 CFR 50, Appendix J. The associated upper 95% confidence limit was 0.577 weight %/day.

The supplemental test result was 1.9073 weight %/day with an upper 95% confidence limit of 2.0155 weight %/day. This result was compared with the sum of the 12-hour phase result of 0.1890 weight %/day and an induced leakage of 1.718 weight %/day.

B. TEST METHOD

B.1 Basic Technique

The Absolute Method was used to perform the Type A test. The Absolute Method, which was also used on the most recent Unit 2 Type A test, uses the ideal gas law to calculate changes in dry air mass as a function of pressure and temperature. Compensation for water vapor pressure is taken into account when the dry air mass within the containment is calculated. Leakage of mass (which is assumed to be constant) from the containment during the Type A test interval can be determined by establishing the rate of mass loss.

B.2 Supplemental Verification Test

The verification test (induced leakage) was performed by intentionally inducing a controlled leak of magnitude approximately equal to the maximum allowable leakage (107.4% of La). This induced leak was superimposed on the previously determined leak rate. The degree of detectability of the combined leakage provided a basis for resolving any uncertainties associated with the 24-hour phase of the test.

B.3 Linear Regression Analysis

Since it is assumed that the leak 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 (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.

A "Least Square" statistical analysis was performed to establish a regression line for the mass versus time parameters after each set of data was obtained. The slope of the regression line is called the statistically averaged leak rate. It was this quantity that was compared to the Technical Specification Limit La.

Associated with the statistical leak rate is the upper 95% confidence leak rate. The calculation of this upper limit is based on the standard deviation of the regression lines and the one-sided Student's T-Distribution function. A procedural requirement specified that the 95% confidence limit was to be less than 75% of the Technical Specification Limit La.

Both the regression line and the associated confidence limit were calculated after each set of data was obtained.

B.4 Short Duration Test

Although in the past it has been customary to conduct Primary Containment Leak Rate Tests for a duration of at least 24 hours at test pressure, this test was conducted for a shorter duration following the methods outlined in Bechtel Topical Report BN-TOP-1, Revision 1, November, 1972. During the 1982 Unit 3 ILRT, which utilized the 24-hour method, calculations were performed showing the containment volume stabilized much earlier. The BN-TOP-1 method has been approved by the NRC.

A measured test phase of 12 hours was utilized, as was agreed upon at a meeting held between the Station and the NRC on March 3, 1983, at the Region III offices. Also, the Supplemental Verification Test was conducted for a period of 6 hours, or one-half that of the measured phase.

C. TEST INSTRUMENTATION AND CALIBRATION

C.1 Types of Sensors Used

Two types of sensors were placed inside of the primary containment during the test. The first type of sensor used was a Resistance Temperature Device (RTD) designed to measure dry bulb temperature. The RTD detects a change in temperature through varying amounts of resistance within a platinum wire. The second type of sensor used was designed to measure dewpoint, using a Lithium Chloride Detector and heating element in conjunction with an internal RTD. There were 30 RTD's and 10 dewcells installed for the ILRT.

C.2 ILRT Console

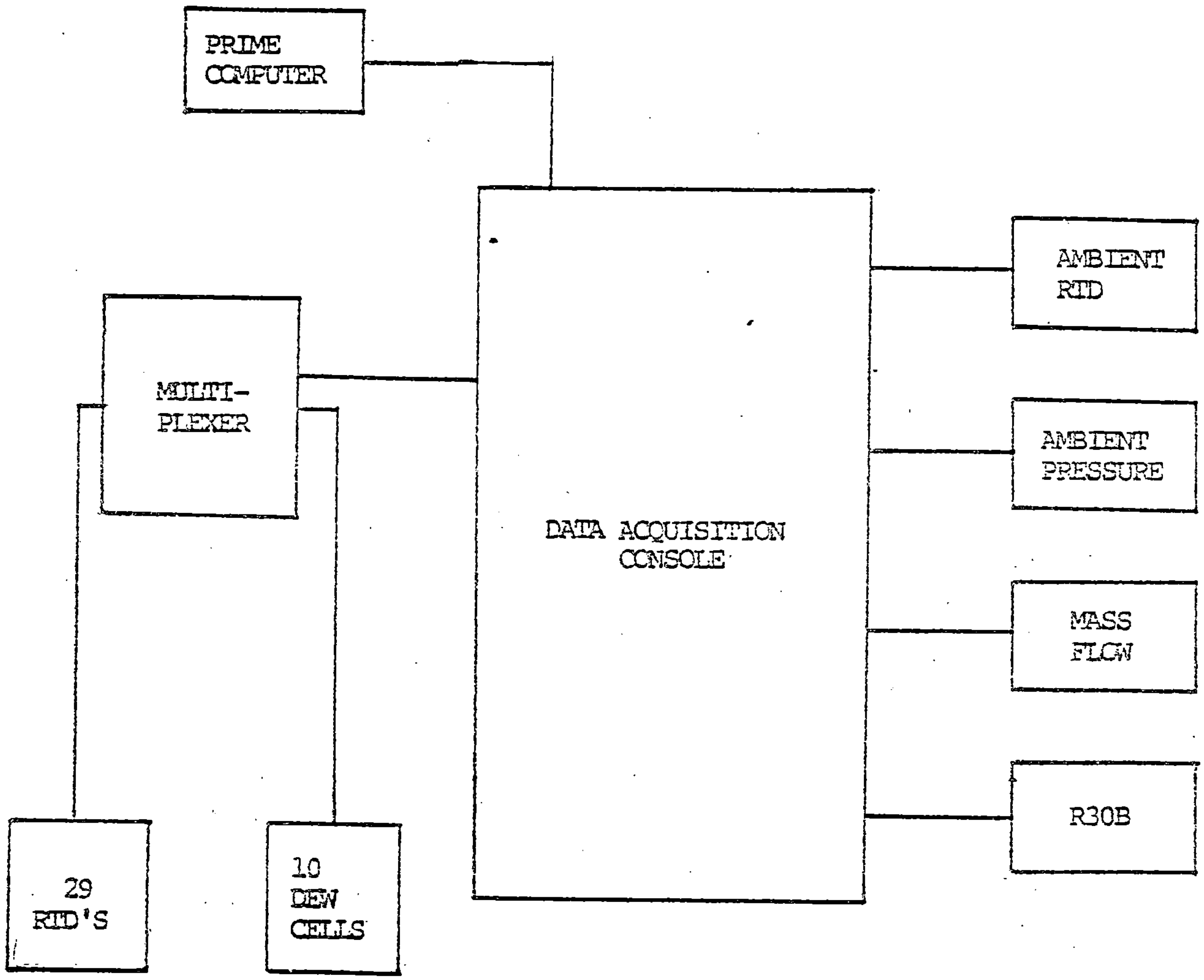
All the raw test data was digitally displayed on the Volumetrics Console 14627. LED displays enabled the console operator to visually monitor the raw data as it appeared at regular 10-minute scan intervals or manually select specific channels for specific data. This console also printed the data at each scan interval.

The test calculations were performed by an on-site Prime computer system, which received data from the Volumetrics Console via permanent cables installed for this purpose. The data was manually verified on display terminals in the Technical Support Center before being released for calculations, disk storage, and printing.

In addition to the display electronics enclosed in the console, there were two precision pressure gages and two clocks. The clocks and pressure gages were redundant features included within the console to insure reliability. A diagram of the ILRT Console and related electronics is shown in Figure C.2.a.

C.3 Data Acquisition System

The ILRT Volumetric Console, sensors, and multiplexer comprise the ILRT Data Acquisition System which was used to perform the Type A test at



ILRT CONSOLE AND INPUT SYSTEMS

FIGURE C.2.a.

Dresden. A description of the ILRT Console and sensors was given in Section C.1 and C.2. The system also included a multiplexer, which was located within the containment throughout the test.

In order to minimize the number of conductors penetrating the primary containment, the Data Acquisition System Instrumentation was subdivided into two major parts. The multiplexer unit was the focal point for all the Resistance Temperature Detectors (RTD) and the dewcells. This subsystem consisted of the solid state signal conditioning bridge circuit boards that are used to calibrate the system and the dual redundant electronic scanners which feed the sensor signal through the primary containment to the console outside.

These components, seen as a whole system, provide a full automatic multipoint data measuring and processing system capable of measuring absolute pressure, dewpoint temperature, dry bulb temperature, and test duration. During the supplemental test, it also monitored the induced leak rate. (See Figure C.3.a for a block diagram of the system interconnections.)

C.4 Instrument Calibration

A major portion of the time spent in preparation for the U-2 ILRT was devoted to instrument calibration. All RTD's were calibrated to within $\pm$ 1.0^{0}F of actual temperature by using a water bath and an RTD standard which is traceable to the National Bureau of Standards (NBS). The dewcells were calibrated to within $\pm$ 5.0^{0}F of actual temperature by using a standard RTD (traceable to NBS) and a water bath which provided various dewpoints.

The precision pressure gages were calibrated to within $\pm$ 0.015 psig of actual pressure using a portable standard traceable to NBS.

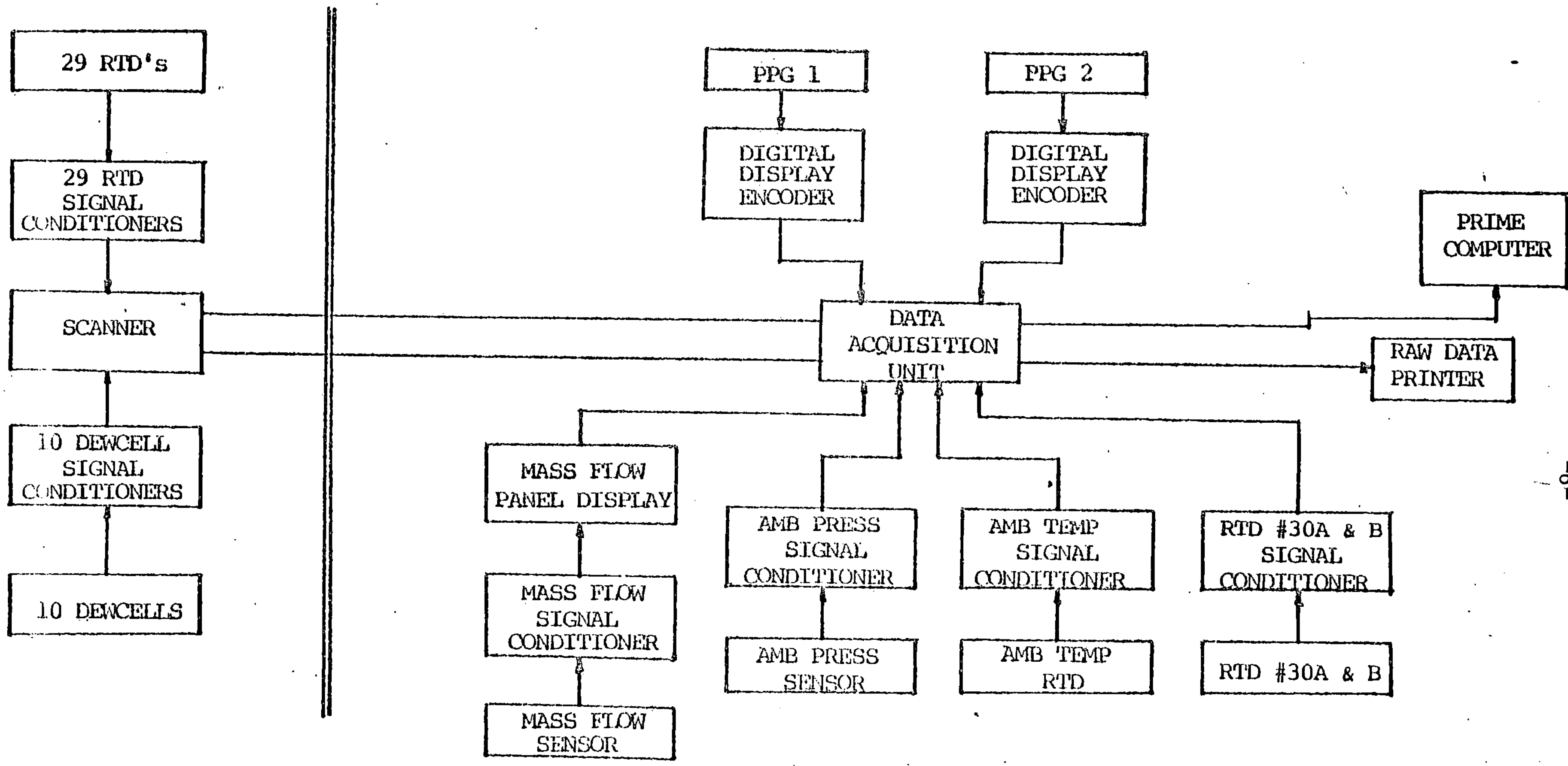
The flowmeter used for the induced leakage portion of the ILRT was calibrated using a transfer standard which was traceable to NBS and accurate to within 1% of full scale.

Table C.4.a shows the specifications for the instrumentation utilized in the Type A test. All of the instruments were calibrated prior to use, as required by ANSI/ANS-56.8-1981. The quantity of sensors used was based on the containment size and the system error analysis.

Throughout the test, ambient atmospheric conditions were monitored as required by ANSI/ANS-56.8-1981. All of the instruments used were calibrated prior to the test and were calibrated using a minimum of 3 reference points to establish an accurate calibration curve.

C.5 Instrumentation Error Analysis - Application

To ensure that the instrumentation used during the ILRT was accurate enough to measure minute changes in containment mass, an instrumentation error analysis was performed prior to the test in accordance with BN-TOP-1. The instrumentation system error was calculated in two parts. The first, and most important calculation, was performed to determine the error due to system repeatability; the second, to determine the error due to system



ILRT SYSTEM BLOCK DIAGRAM

Figure C.3.a

Table C.4.a

INSTRUMENT	QUANTITY/USAGE	RANGE	ACCURACY	REPEATABILITY
Precision Pressure Gage	2 - Containment Pressure	0-100 psia	± 0.015 psia	± 0.001 psia
RTD	30 - Containment Temp.	50-200^{0}F	± 0.54^{0}F	± 0.01^{0}F
Dewcell	8 - Containment Dewpoint	-50-140^{0}F	± 2.5^{0}F	± 0.03^{0}F
Flow Meter	1 - Induced Leak Rate	2-20 scfm	± 0.2 scfm	± 0.02 scfm
Ambient Temp. RTD	1 - Ambient Temp.	50-200^{0}F	± 0.54^{0}F	± 0.01^{0}F
Ambient Pressure	1 - Ambient Pressure	0-20 psia	---	---
Humidity	1 - Relative Humidity	0-100% R.H.	---	---

accuracy. The results were 0.071672 weight %/day and ± 0.0956 weight %/day, respectively. Combining these two errors yielded a total system error of 0.16727 weight %/day.

The instrumentation error is used only to illustrate the system's capability to measure the required parameters that are necessary for calculation of the primary containment leak rate. The instrumentation error is always present in the data and is incorporated in the 95% confidence limit in the form of data scatter. Procedures required that the error due to accuracy and repeatability be less than 0.25 La (0.4 weight %/day).

D. CONTAINMENT REPRESENTATION

D.1 Structural Data

The Unit 2 primary containment provides a multibarrier pressure suppression containment employing containment-in-depth principles in design. The containment systems are composed of a primary containment and the Pressure Suppression System, which when taken together enclosed a total free air space of 288966 ft^3. The primary containment consists of a drywell, which encloses a reactor vessel, a pressure suppression chamber which stores a large volume of water, a connecting vent system between the drywell and the water pool, isolation valves, containment cooling systems, and other service equipment. (See Figure D.2.a.)

The performance objectives of the primary containment system are: (1) to provide a barrier which in the unlikely event of a loss-of-coolant accident, which will control the release of fisson products to the secondary containment, and (2) to rapidly reduce the pressure in the containment resulting from the loss-of-coolant accident. In order to meet these objectives, the containment was designed to withstand a design pressure of 62 psig with a leak rate of 0.5 weight %/day. To assure that the containment could structurally meet these criteria, the drywell was designed using a steel pressure vessel with a spherical lower portion and a cylindrical upper portion. (See Figure D.2.a.) The steel head and shell of the drywell are fabricated of SA-212 GRB plate manufactured to A-300 requirements. The top head closure is made with a double tongue and grove seal, which will permit periodic checks for tightness without pressurizing the entire vessel. The drywell is enclosed in reinforced concrete for shielding purposes and to provide additional resistance to deformation and buckling of the drywell over areas where concrete backs up the steel shell.

An integral part of the containment is the pressure suppression chamber, which is also pressurized during the ILRT. The pressure suppression chamber is a steel pressure vessel in the shape of a torus below and encircling the drywell which contains 112,203 ft^3 of water in its 109 ft. major diameter. The torus free air volume is 118529 ft^3.

D.2 Containment Survey

In order to establish the containment temperature and humidity tendencies for regional variations, an area survey was performed. This survey complied with ANSI/ANS 56.8-1981 and was performed by Technical Staff personnel as part of a previous ILRT. The sensor locations are indicated in Table D.2.a.(Refer to Figure D.2.a for an idealized view of the containment structure and the zoning configuration used).

D.3 Instrumentation Placement

Figures D.3.a through D.3.g indicate exactly where the RTD's and dew cells were placed within the primary containment. The dewcell placement is indicated by the initial D, and the RTD placement is indicated by the initial R.

To avoid local temperature variations, all RTD's and dewcells were placed at least three feet away from any pipe, wall, pump, motor, etc.

All sensors were placed in the containment immediately before the ILRT to minimize the possibility of sensor wire or sensor damage due to maintenance and clean-up work being performed while the containment was open.

A special effort was made to place two RTD's in that subvolume between the reactor and the biological shield. See Figure D.3.b. This was done to minimize the transients in test data caused by ΔT change, in that subvolume due to changes in reactor temperature.

Two fans were placed inside the torus as indicated in Figure D.3.g. To ensure that RTD 25 and RTD 28 were not affected by the draft caused by the fans, they were placed off to the side of the fans at a distance greater than 3 feet.

Due to the impracticality of installing temperature and humidity sensors inside the vessel (Subvolume 10), several assumptions were made concerning the air space within. The reactor vessel air space was assumed to be saturated and at an equilibrium temperature with the water. To measure the reactor water temperature, an RTD was placed in the shutdown cooling loop between the shutdown cooling pump and the heat exchanger. This temperature was then used as the drybulb and wetbulb temperature for subvolume 10.

D.4 Pressurization System

Primary containment pressurization was accomplished with a 2500 scfm electric compressor connected to a 4" pressurization line.

The air compressor was located outside the Reactor Building. Refer to Figure D.4.s for a plan view.

E. CALCULATIONS PERFORMED

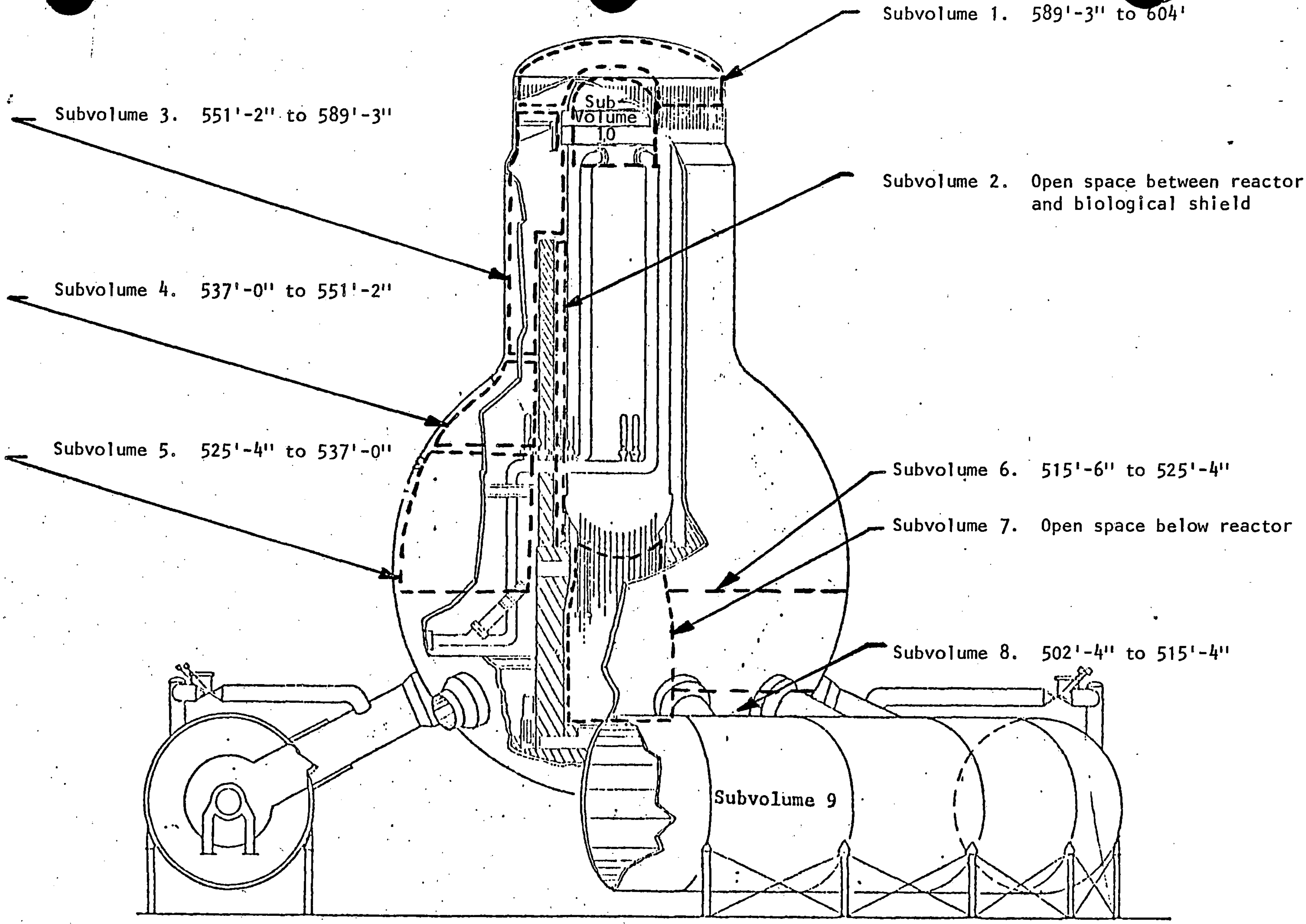
E.1. Volume Weighting Factors

Due to size and shape of the primary containment, a mathematical model was developed to account for the effects of temperature stratification and local temperature variations. The containment volume was theoretically divided into ten subvolumes with weighting factors assigned to each. (The value of the weighting factor is equivalent to the fractional part of the total containment volume occupied by the associated subvolume.)

Table D.2.a

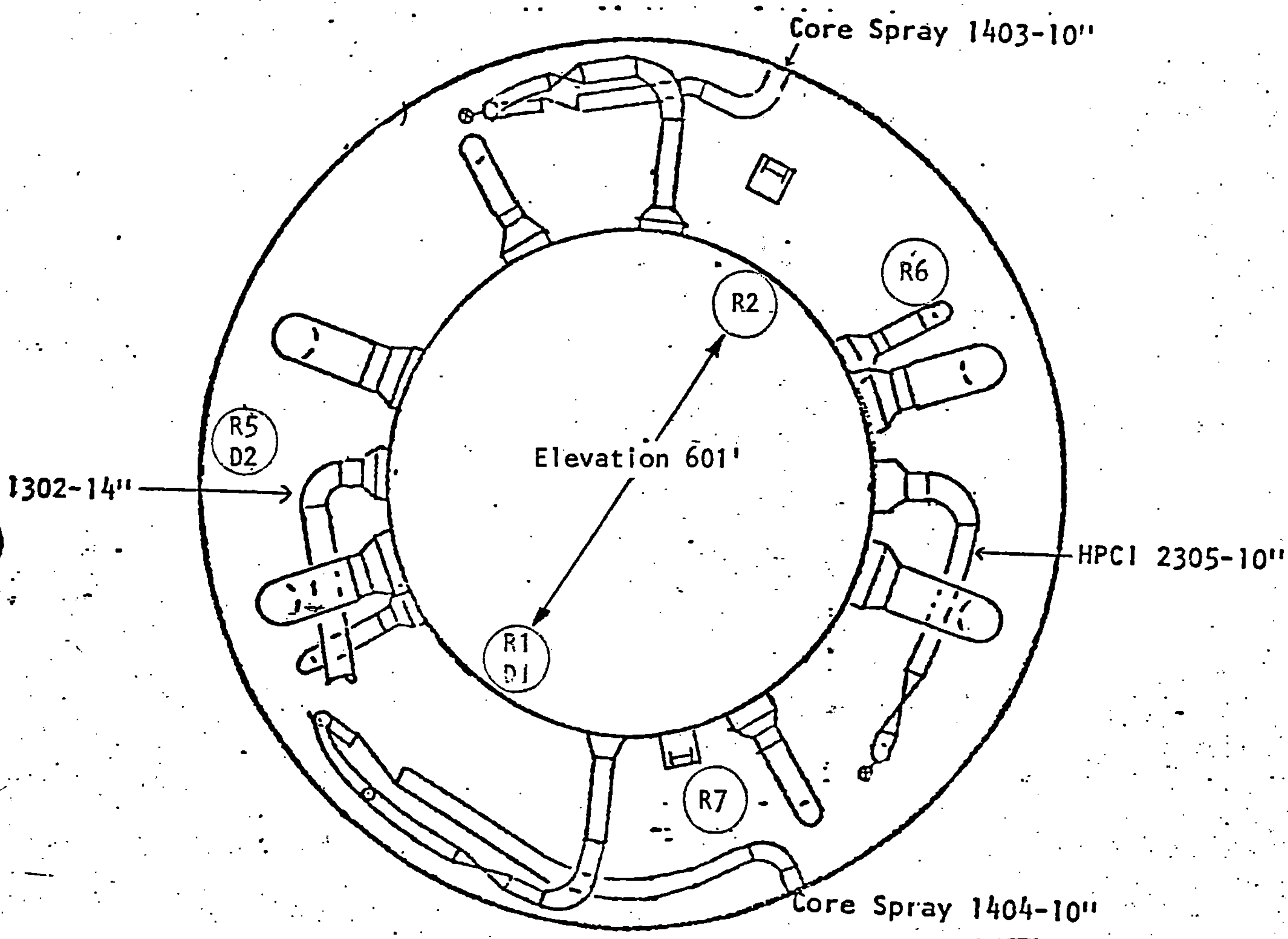
Dresden U-2 1983 ILRT Sensor Locations

SENSOR TYPE	I.D. NUMBER	SUBVOLUME ZONE	ELEVATION	AZIMUTH
RTD	R1	1	601'	190°
RTD	R2	1	601'	10°
Dewcell	D1	1	601'	190°
RTD	R3	2	556'	330°
RTD	R4	2	556'	150°
RDT	R5	3	574'	270°
RTD	R6	3	574'	30°
RTD	R7	3	574'	150°
Dewcell	D2	3	574'	270°
RTD	R8	4	545'	350°
RTD	R9	4	545'	220°
RTD	R10	4	545'	120°
Dewcell	D4	4	545'	120°
RTD	R11	5	531'	270°
RTD	R12	5	531'	180°
RTD	R13	5	531'	90°
RTD	R14	5	531'	0°
Dewcell	D3	5	531'	90°
Dewcell	D5	5	531'	260°
RTD	R15	6	520'	165°
RTD	R16	6	520'	60°
RTD	R17	6	520'	300°
Dewcell	D6	6	520'	165°
RTD	R18	7	505'	5°
RTD	R19	7	505'	185°
RTD	R20	8	509'	140°
RTD	R21	8	509'	230°
RTD	R22	8	509'	50°
RTD	R23	8	509'	320°
Dewcell	D7	8	509'	50°
Dewcell	D8	8	509'	230°
RTD	R24	9	504'	150°
RTD	R25	9	504'	90°
RTD	R26	9	504'	40°
RTD	R27	9	504'	220°
RTD	R28	9	504'	270°
RTD	R29	9	504'	330°
Dewcell	D9	9	504'	330°
Dewcell	D10	9	504'	150°
RTD	R30A	10	Located in Shutdown Cooling Pump A	
RTD	R30B	10	Located in Shutdown Cooling Pump B	



UNIT 2. PRESSURE SUPPRESSION CONTAINMENT SYSTEM

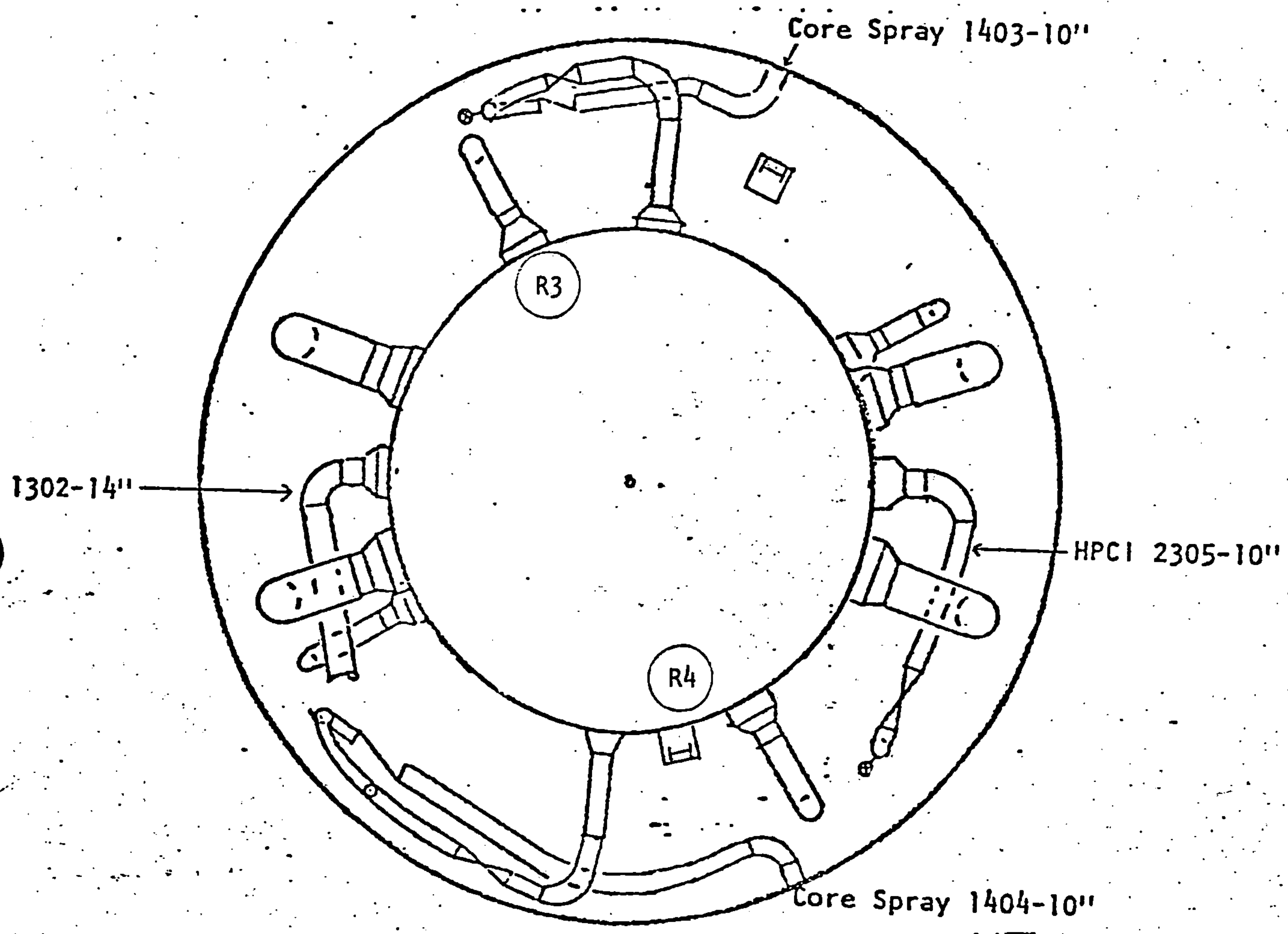
FIGURE D.2.a



UNIT 2 DRYWELL

ELEVATION 574'

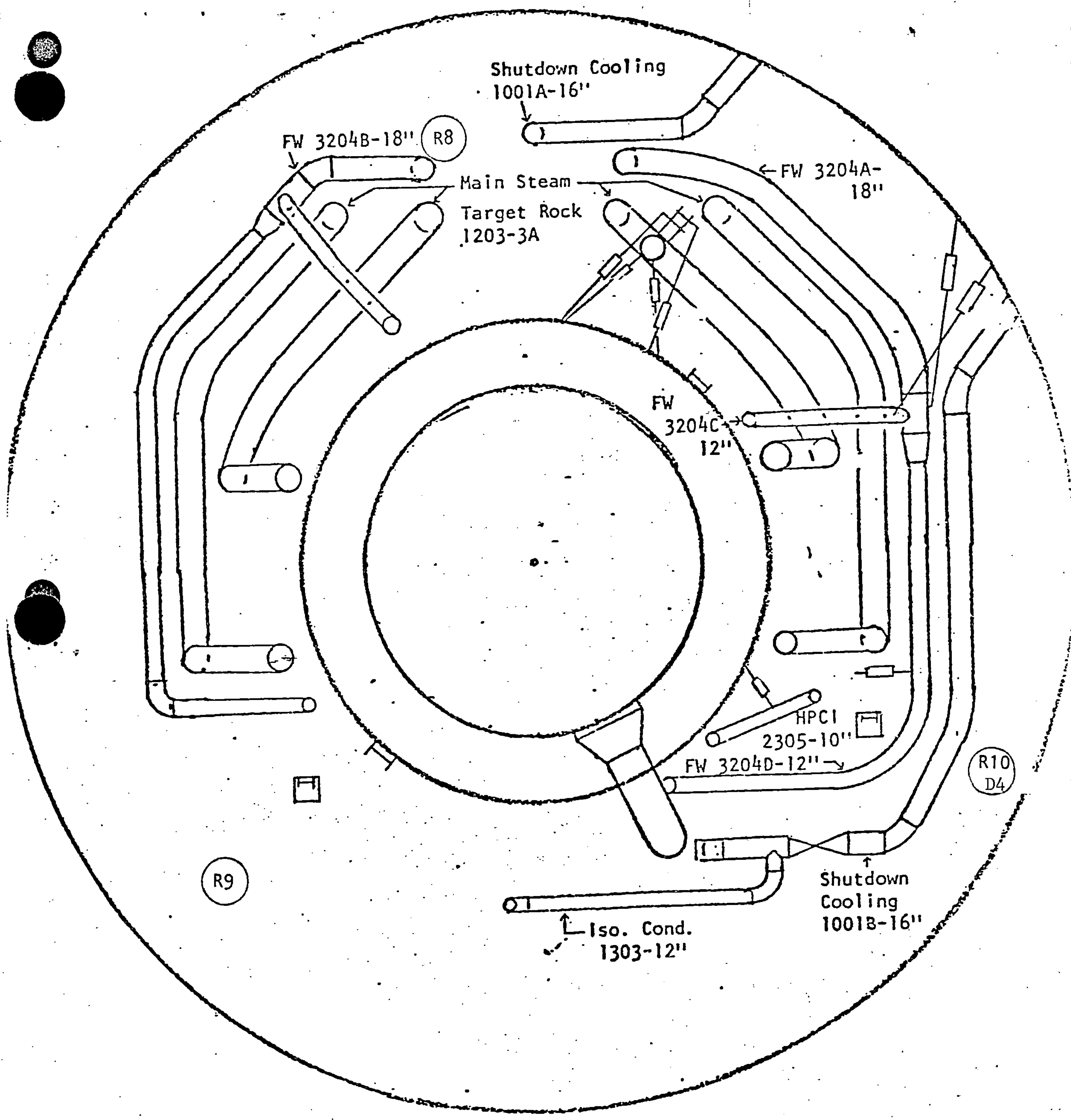
FIGURE D.3.a



UNIT 2 DRYWELL

ELEVATION 556'

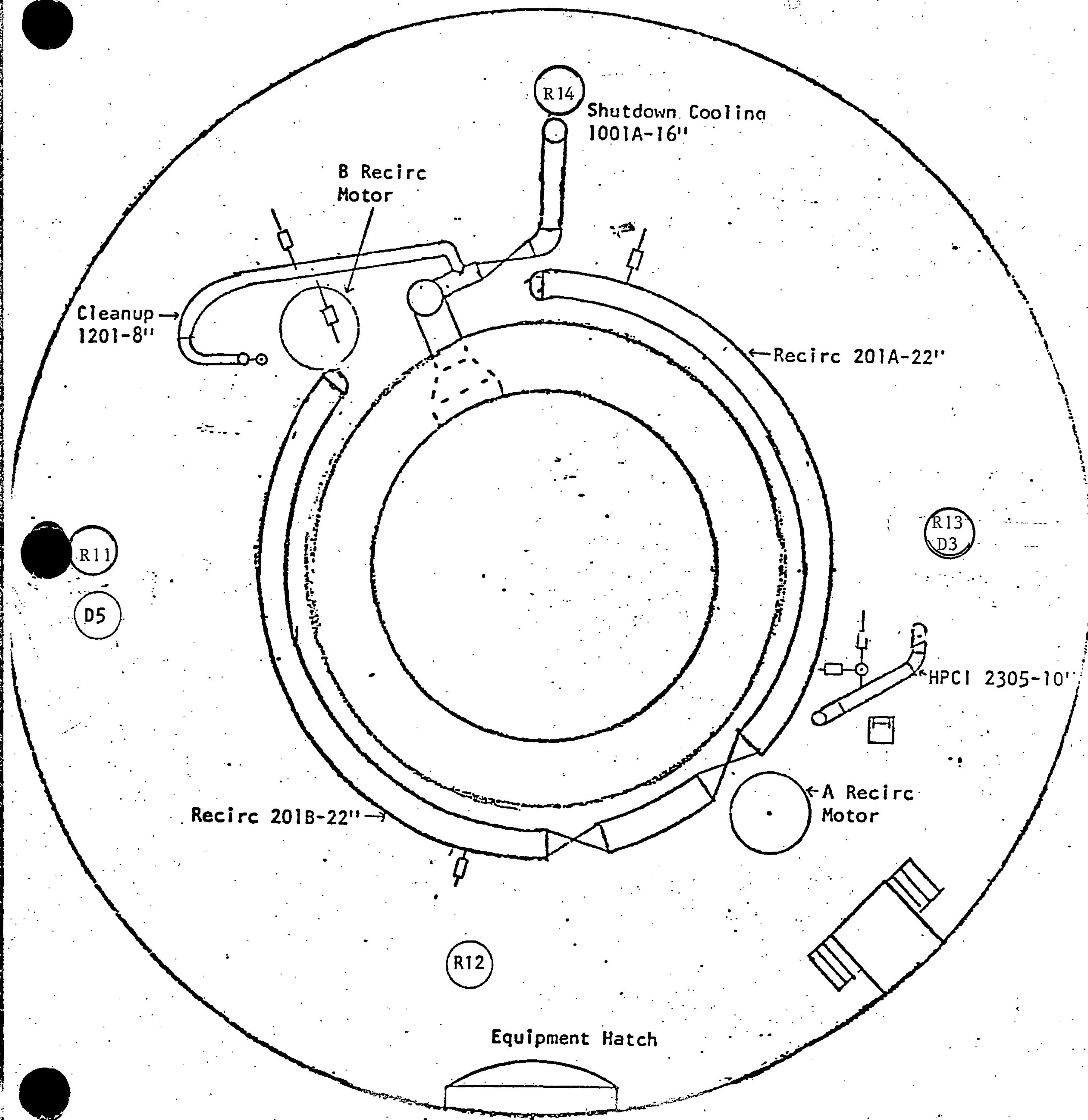
FIGURE D.3.b



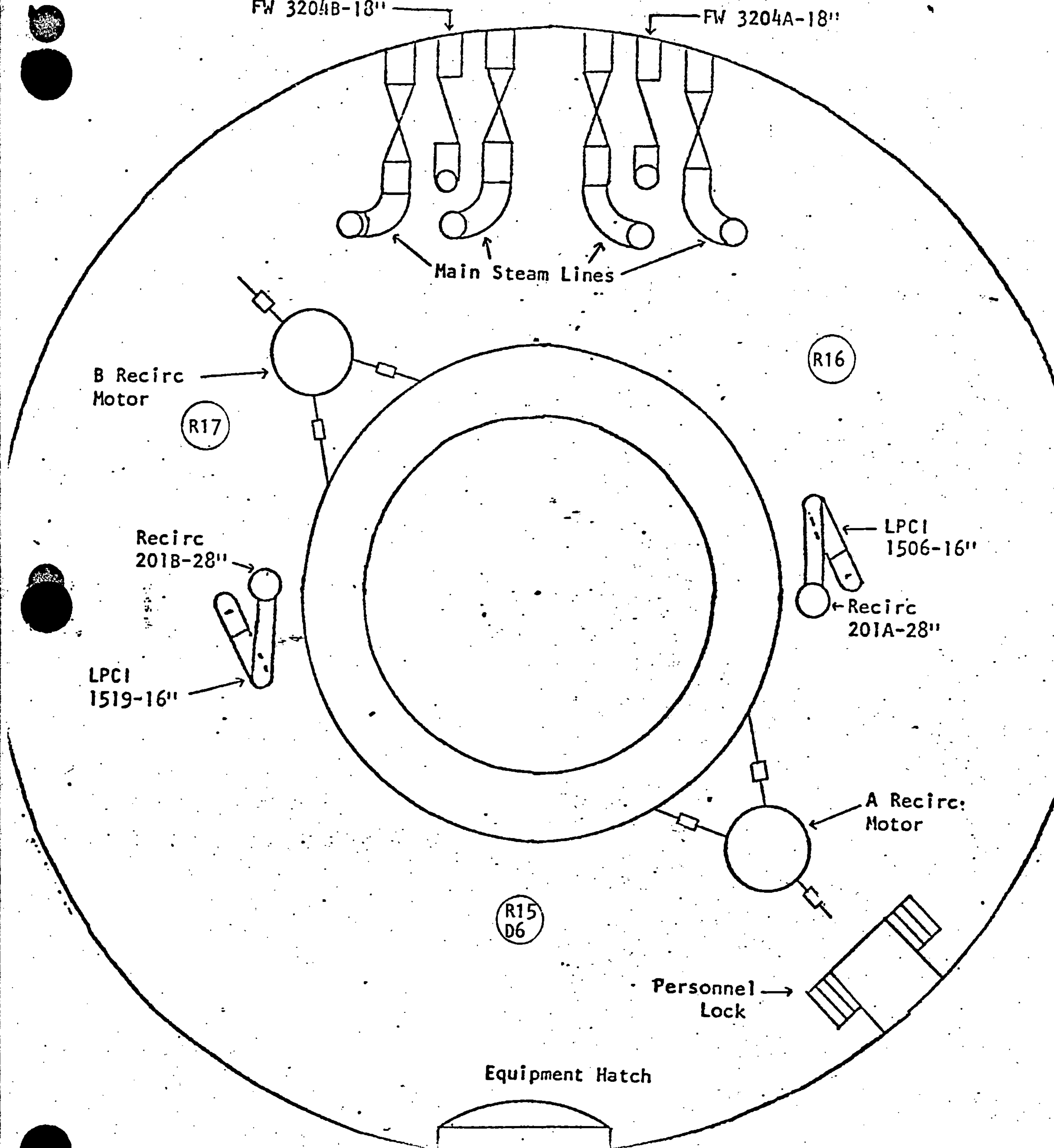
UNIT 2 DRYWELL

ELEVATION 545'

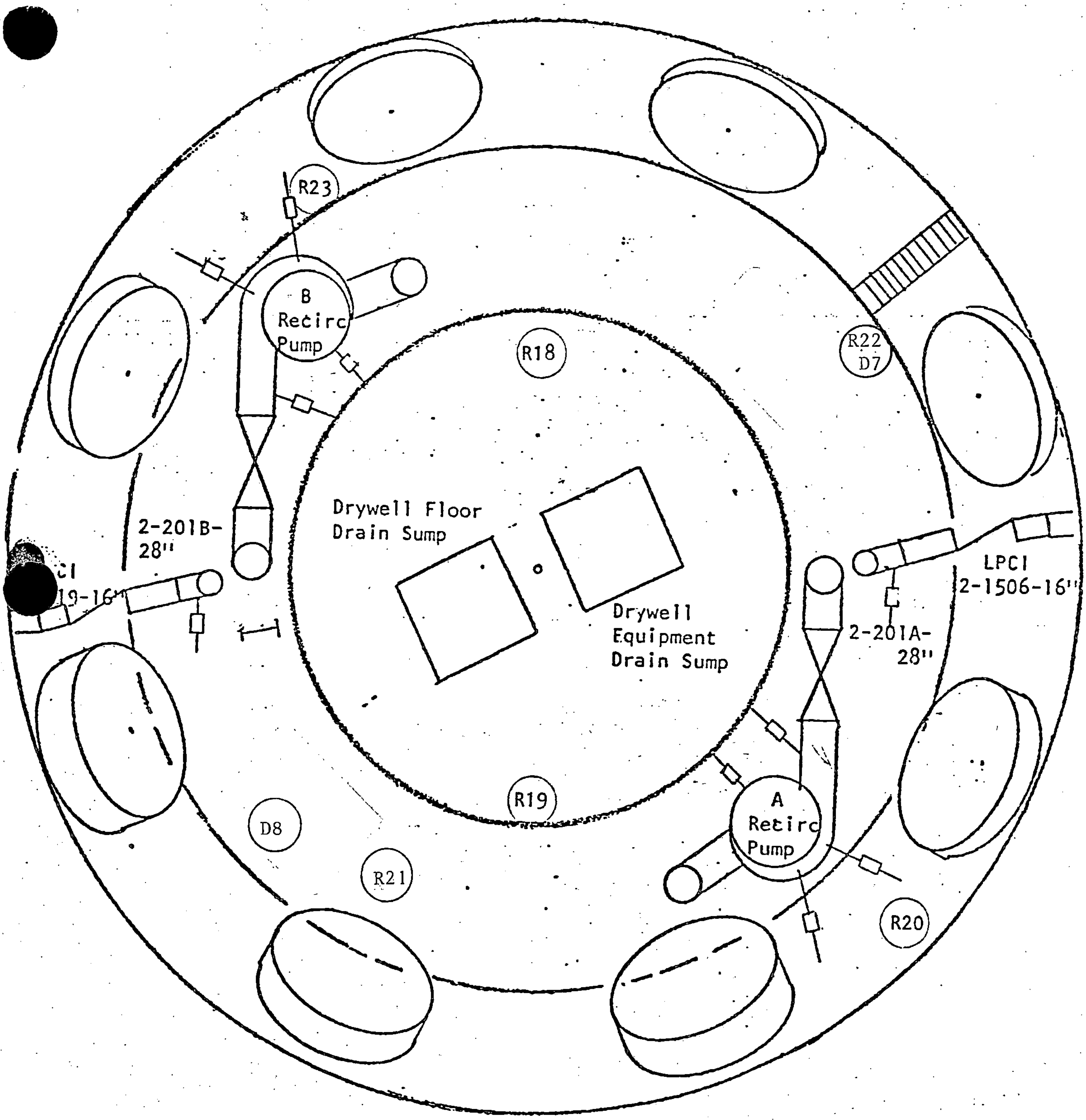
FIGURE D.3.c



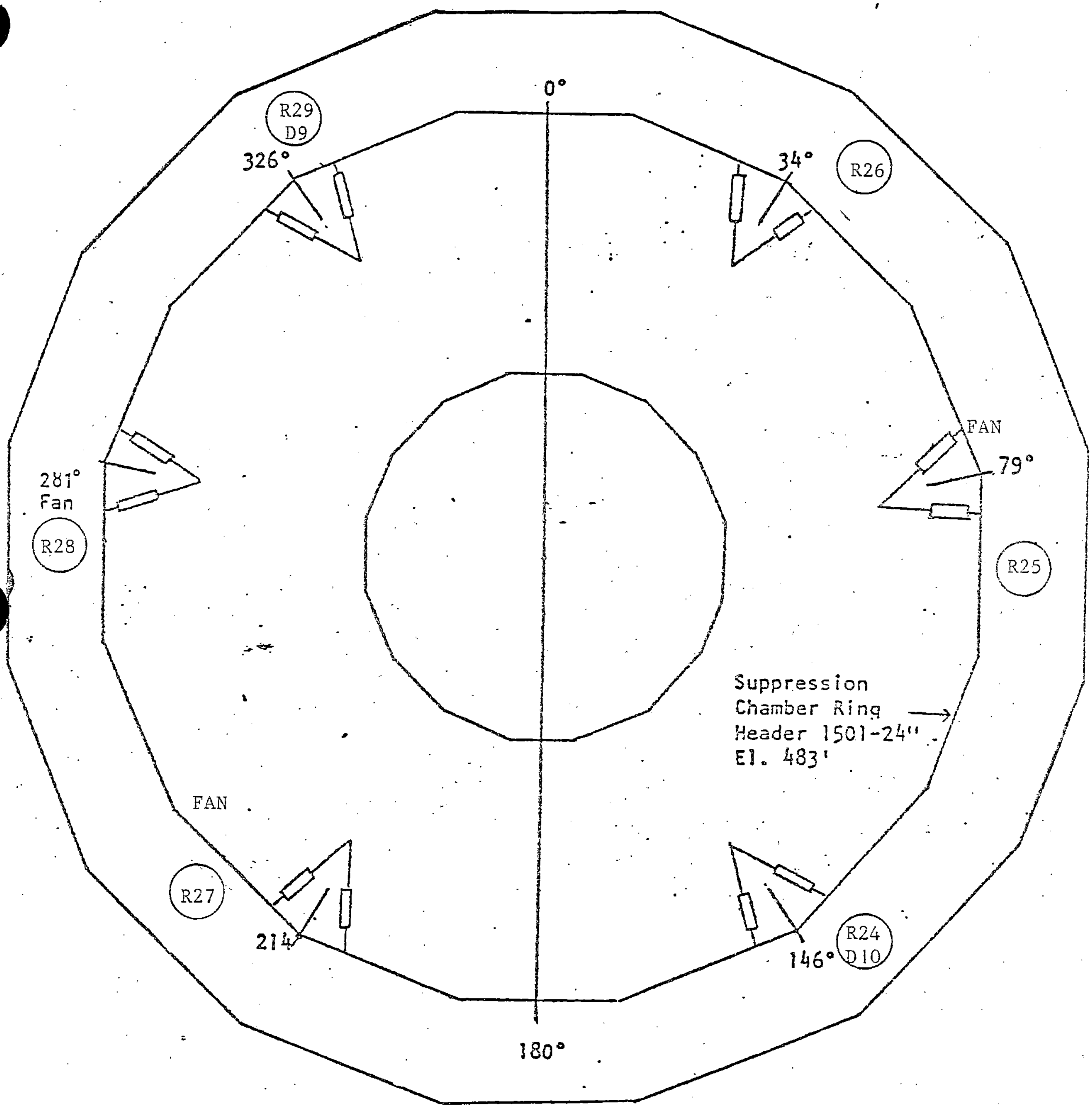
UNIT 2 DRYWELL
ELEVATION 531'
FIGURE D.3.d



UNIT 2 DRYWELL
ELEVATION 520'
FIGURE D.3.e

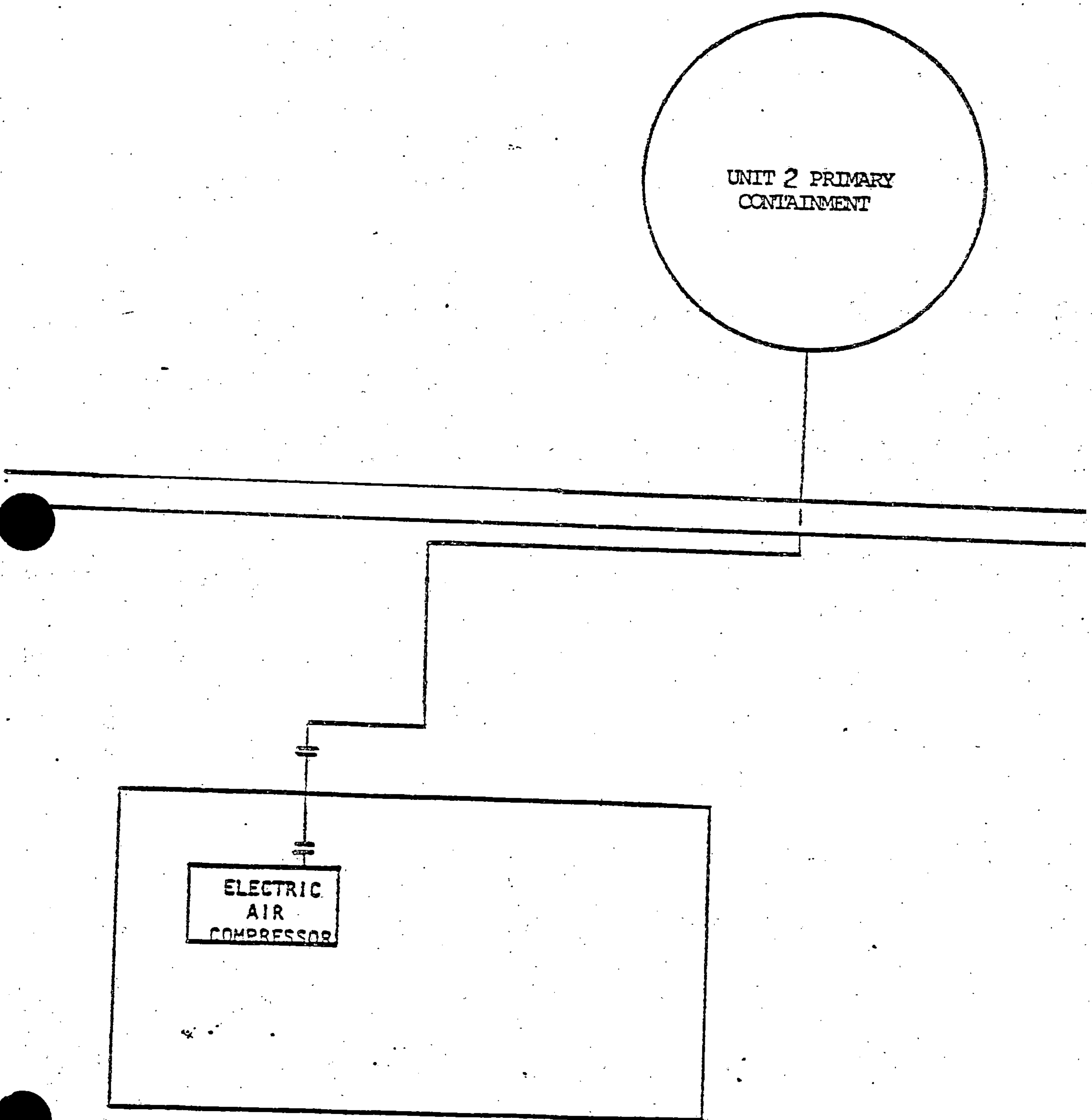


UNIT 2 DRYWELL
ELEVATION 509'
FIGURE D.3.f



UNIT 2 TORUS

FIGURE D.3.g



CONTAINMENT PRESSURIZATION SYSTEM

FIGURE D.4.a

The volumes of the larger pieces of equipment were taken into account when calculating the subvolumes. (See Figure D.2.a for a diagram of the idealized containment and zoning configuration used.) Table E.1.a lists the subvolume weighting factors associated with each zone.

E.2. Data Reduction

Before the ideal gas law could be applied for obtaining the contained dry air mass, the raw data had to be reduced to a single dry air pressure and temperature. The total containment absolute pressure was determined by arithmetically averaging the two precision gauges. The average containment temperature and dewpoint were obtained by utilizing the same application of the volume weighting factors. Like sensors within a subvolume were arithmetically averaged to determine the mean atmospheric conditions for the subvolume. Any subvolume void of a sensor type was assumed to have the same average value as the next subvolume in sequence. The sum of the products of the subvolume averages and respective weighting factors yielded the average containment temperature and dewpoint. The dewpoint was then converted to vapor pressure and subtracted from the average total containment pressure, yielding absolute dry air pressure. The following mathematical expressions summarize the data reduction process.

Average Subvolume Temperature and Dewpoint

$$Tj = \frac{\text{(All operable RTD's in jth subvolume)}}{\text{Number of operable RTD's in the jth subvolume}} \quad {}^0F$$

$$D.P.j = \frac{\text{(All operable dewcells in the jth subvolume}}{\text{Number of operable dewcells in jth subvolume}} \quad {}^0F$$

where Tj = average temperature of the jth subvolume
D.P.j = average dewpoint of the jth subvolume

Primary Containment Temperature and Dry Air Pressure

$$T = \sum_{j=1}^{NVOL} (VFj)\ (Tj) \quad {}^0F$$

if Tj = undefined, then
Tj = T(j + 1) for $1 \leq j \leq$ (NVOL-2)
Tj = T(j - 1) for j = NVOL - 1
Tj = estimate for j = NVOL

$$D.P. = \sum_{j=1}^{NVOL} (VFj)\ (D.P.j) \quad {}^0F$$

if D.P.j = undefined, then
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

$$D.P.({}^0K) = 273.16 + \frac{D.P.({}^0F) - 32}{1.8}$$

X = 647.27 - D.P. (K)
A = 3.2437814
Z = 5.86826 x 10^{-3}
C = 1.1702379 x 10^{-8}
D = 2.1878462 x 10^{-3}

$$EXPON = \frac{X(A + ZX + CX^3)}{(D.P.(^0K)\ \ (1 + DX)}$$

$$PV = \frac{(218.167)\ \ (14.696)}{(EXPON\ in\ 10)}\ PSI$$

$$Pt = \frac{P_1 + P_2}{2}\ PSIA$$

$$P = Pt - Pv\ PSIA$$

$$W = \frac{(28.97)\ \ (144)\ \ (P)\ \ ((total\ volume - (level - 50)\ \ (28.635))}{1545.33\ (T + 459.69)}\ Lbs.$$

where: NVOL = number of primary containment subvolumes
NFj = volume weighting factor of the j^{th} subvolume
T = volume weighted containment temperature
D.P. = volume weighted containment dewpoint
X, A, Z, C, D, EXPON = dewpoint to vapor pressure conversion constants and coefficients
Pv = volume weighted containment vapor pressure
Pt = total absolute containment pressure
P = contained dry air absolute pressure
W = contained dry air mass
Level = reactor water level

NOTE: The subvolume numbering sequence is from the top to the bottom of the containment.

E.3 Measured Leak Rate (Total Time)

From BN-TOP-1 Rev. 1, Section 4.5 the following equation is given for the measured leak rate using the total time procedure:

$$M_i = \frac{2400}{H} \left(1 - \frac{T_o \overline{P}_i}{T_i \overline{P}_o} \right) \ (\%\ per\ day)$$

where M_i = measured leak rate in weight % per day for the i^{th} data point.

H = time interval, in hours, between measurements.

T_o, T_i = mean absolute temperature, ^0R, of the containment atmosphere at the beginning and the end of test interval (H) respectively.

P_o, P_i = mean total absolute pressure, psia, of the containment atmosphere at the beginning and end of the test interval (H), respectively.

Using the following relationship derived in ANSI N45.4 - 1972 Appendix B given below:

$$\frac{W_o - W_i}{W_o} = 1 - \frac{T_o \bar{P}_i}{T_i \bar{P}_o}$$

where W_o, W_i = dry air mass of the containment at the beginning of the test and data point i, respectively.

And substituting in the calculation of the containment dry air mass that corrects for a change in Reactor Water level gives the following expression for the measured leakage:

$$M_i = \frac{2400}{H} \left(1 - \frac{T_o \bar{P}_i \text{ (volume} - (\text{LEVEL}_i - 50)\ (28.635))}{T_i \bar{P}_o \text{ (volume} - (\text{LEVEL}_o - 50)\ (28.635))} \right)$$

where LEVEL_o, LEVEL_i = reactor water level in inches at beginning of the test and the data point i, respectively.

E.4 Calculated Leak Rate (Least Squares Fit)

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 contained 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:

$$L_i = A + B \times t_i$$

where t_i = time in hours since the beginning of the test to the i^{th} data set point.

The values of the constants A and B such that the regression line is best fitting to the ILRT data are

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

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

In order to reduce the round-off error in the above calculations, the equations are rearranged such that:

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

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

E.5 95% Confidence Limits

To determine the value of the confidence limits the following statistical information is required; the variance, standard deviation, and students' T-distribution.

$$S^2 = \frac{SSQ}{n-2}$$

where $SSQ = (M_i - L_i)^2$

S^2 = variance

S = standard deviation based (n-2) degrees of freedom.

The standard deviation has more practical significance since computing the standard deviation returns the measure of variability to the original units of measurement. Additionally, it can be shown that given a normal distribution of measurements, approximately 95% of the measurements will fall within two standard deviations of the mean.

The number of standard deviations either side of the regression line which establish a 95% confidence interval are more accurately determined using a statistical table called a "Table of Percentage Points of the T-Distribution" and provide increased confidence in outcomes for small and large sample sizes.

The Table of T-Distributions has been formulized for use by the computer program as follows:

$$TD = 1.95996 + \frac{2.37226}{(n-2)} + \frac{2.8225}{(n-2)^2}$$

where TD = value of T-Distribution for the 95% confidence limit and (n-2) degrees of freedom.

n = number of data points including the i^{th} data point.

The application of the additional factor to the variance formula yields:

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

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

where t_p = time after start of test

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

$$UCL = L_i + TD \times \sigma$$

E.6 Computer Program

In order to expedite the data reduction and statistical computations, the Station Prime computer system was used. A telephone connection to the Prime system at the Corporate Offices was also available had the Station computers become unavailable at any time during the test. Data was recorded and analyzed at 10 minute intervals.

The raw test data was printed by the Volumetrics Console, located just outside the drywell. Each data set was also automatically transferred over cables from the console to the Computer Room, where it was checked on a display terminal against the console tapes before being released for disk storage, calculations, and printing. Key test parameters were plotted on a color-graphics display screen as the test progressed. Hard copies of these graphs were also plotted by the computer system.

The computer program was written by off-site Commonwealth Edison Computer Systems personnel. Its logic was protected by codes intended to prevent unauthorized access. The program was reviewed and approved at the Station by the same process used for all test procedures and surveillances prior to their use.

E.7 Leak Rate Compensation for Non-Vented Penetrations

The actual result of the Type "A" ILRT as performed was 0.1890 weight %/day. The test was performed with the following penetrations not drained and vented. Included with each penetration listed is the leakage as determined by Type C local leak rate testing.

SYSTEM DESCRIPTION	VALVE NUMBERS	LEAK RATE SCFH	LEAK RATE WT. %/DAY
"A" Rx Feedwater	220-57A & 220-58A	3.456	0.00673
	220-57A & 220-62A	--	--
"B" Rx Feedwater	220-57B & 220-58B	3.807	0.00741
	220-57B & 220-62B	--	--

SYSTEM DESCRIPTION	VALVE NUMBERS	LEAK RATE SCFH	LEAK RATE WT. %/DAY
CRD Cooling H_2O Return	301-95 & 301-99	1.154	0.00225
	301-98 & 301-99	--	--
Shutdown Cooling	1001-1A,1B,2A,2B, & 2C	14.153	0.02756
Standby Liquid Control	1101-1 & 1101-15	1.064	0.00207
	1101-1 & 1101-16	--	--
Rx H_2O Cleanup	1201-1,2, & 3	6.260	0.01219
Isolation Condenser	1301-3 & 1301-4	-0-	-0-
"A" Core Spray Injection	1402-4A,8A,25A, & 36A	0.523	0.00102
	1402-24A & 25A	1.050	0.00204
"B" Core Spray Injection	1402-4B,8B,25B, & 36B	0.934	0.00182
	1402-24B & 25B	0.260	0.00051
"A" LPCI	1501-18A & 19A	5.317	0.01035
"B" LPCI	1501-18B & 19B	2.386	0.00464
"A" LPCI	1501-20A & 1501-38A	-0-	-0-
"B" LPCI	1501-20B & 1501-38B	0.751	0.00146
"A" LPCI	1501-22A,26A, & 1001-5A	0.243	0.00047
	1501-25A & 1501-26A	--	--
"B" LPCI	1501-22B, 26B & 1001-5B	1.427	0.00278
	1501-25B & 1501-26B	--	--
"A" LPCI (Containment Spray)	1501-27A & 1501-28A	0.155	0.00031
"B" LPCI (Containment Spray)	1501-27B & 1501-28B	0.272	0.00053
HPCI Condensate Return	2301-45 & 2301-74	-0-	-0-
Primary Sample	220-44 & 45	-0-	-0-
Drywell Cam	9707A & 9207B*	0.83	0.00161
	9208A & 9208B*	1.646	0.00321
	Total	45.688	0.08896

*LLRT results for these lines are included because these lines were used during the ILRT for test instrumentation.

The total containment leak rate, including local leak rate test results for unvented systems as shown in the preceding list, is 0.278 weight %/day. The associated 95% upper confidence limit is 0.577 weight %/day.

F. CONTAINMENT PRESSURIZATION

F.1 Preparation

The following major events were completed prior to containment pressurization as required by 10 CFR Part 50, Appendix J, and ANSI/ANS 56.8-1981.

1. Satisfactory completion of all Type B and C Leak Rate tests.
2. Primary containment temperature and humidity survey.
3. Calibration of all instrumentation.
4. Instrumentation error analysis calculation.
5. Visual containment inspection.
6. Venting of the reactor vessel to the primary containment atmosphere.

Table E.1.a

Temperature and Humidity Weighting Factors

SUB VOLUME	VOLUME (FT)	WEIGHTING FACTOR
1	11373	0.03936
2	3081	0.01066
3	20281	0.07018
4	23043	0.07974
5	30819	0.10665
6	26363	0.09123
7	7226	0.02501
8	41828	0.14475
9	118529	0.41018
10	6423	0.02223

Two fans were installed in the torus to provide air recirculation. Two were also placed in the drywell; however, they proved unnecessary.

Training was provided to all technical personnel involved in the ILRT. The 4 hours of training was designed to familiarize personnel with the test instrumentation, computer program, and necessary scheduling for the successful completion of the 1982 ILRT.

A 2500 scfm electric compressor was brought on site to supply clean dry air to the primary containment through a four-inch pipe tied into the LPCI system. These compressors not only served as a source of oil free air but enabled Dresden personnel to realize 48 psig containment pressure in a minimal amount of time.

F.2 Containment Instrumentation

ILRT sensors were placed within the containment shortly before the test. All sensors were kept at a distance of three feet or farther from any pump, motor, or piece of piping. This was done so local temperature variations would not overly influence the real average subvolume temperature recorded by the sensor in that subvolume.

In preparation for the test, special care was taken to keep all sensors out of any airflow which might be caused by the compressor during pressurization or the ventilation fans placed in the torus.

F.3 ILRT Log Entries

At 0400 hours on April 17, 1983, pressurization of the containment was begun. The following is a list of significant events taken from the ILRT Log.

DATE	TIME	ILRT LOG
04/17/83	0317	Completed pre-test systems checklists. Restricted access to Reactor Building.
	0400	Started pressurization.
	0423	Started vacuum breaker test. This is a differential-pressure decrease test done per Technical Specification 4.7.A.4.b.(4).
	0433	Completed vacuum breaker test. Acceptable.
	0500	Equalized pressure of drywell and torus. Secured open 2 sets vacuum breakers per procedure. Restarted pressurizing.
	0510	Reached 4 psig containment pressure. Checking of boundaries with soap solution has been in progress since 2 psig.
	0525	Reached 6 psig containment pressure.
	0612	Containment pressure approximately 12 psig. Reactor level 48 inches.

DATE	TIME	ILRT LOG
04/17/83	0615	Checking of boundary valves, etc. is complete - no significant leaks found. Containment pressure 12.8 psig. Shutdown cooling "B" loop temperature is 136°F.
	0624	Have reached 14 psig. Secured pressurization to review leak rate.
	0636	Containment pressure is 13.9 psig, SDC "B" loop 136.06°F.
	0640	"B" SDC loop is 136.08, containment pressure is 13.9 psig; reactor level: 49.58 inches.
	0644	Restarted pressurization since containment is solid. Torus level has been -3 inches steady.
	0710	Drywell pressure: 17.6 psig. Rx H_2O ("B" SDC loop) temp: 136.17 F, Rx H_2O level: 49.4 inches.
	0810	Small leakage found on fittings outside containment where ILRT instrumentation was connected. (Tightened these @ 0845.) Drywell pressure: 41.6 psia, Rx H_2O level: 49.2 inches, Rx H_2O temp: 136.42 F.
	0845	Drywell pressure: 44.7 psia
	0925	Drywell pressure: 49.4 psia
	0925	Drywell pressure 49.4 psia, Rx H_2O level: 49.2 inches, Rx H_2O temp: 136.6°F.
	1114	Reached 48 psig.
	1134	Watching stabilization data.
	1230	Containment pressure falls approximately 0.08 psi over the course of 30 minutes.
	1305	Leakage appears significant.
	1330	Decide to repressurize the containment to 65 psia.
	1348	Repressurization started. (Pressure had fallen to approximately 63.17 psia).
	1408	Reached 65 psia.
	1430	Following torus-to-drywell - vacuum breaker arms are leaking at the shaft packing: 2-1601-32B (left shaft end packing only), 2-1601-33A, 33C, 33D, 33E, & 33F (both ends). Failure has been progressive. (Failed one-by-one.)

DATE	TIME	ILRT LOG
	1600	Decision is made to terminate ILRT. We will LLRT all the leaking shafts to quantify leakage.
	1615	Rechecking all other boundary valves, etc. with soap solution in order to ensure no other leaks
	1740	Start to blow down containment.
04/18/83	1900	LLRT's of failed vacuum breaker arm shaft seals is complete; total leakage is 1778.28 scfh (3.462 weight %/day). This exceeds Technical Specification Operational Limit 3.7.A.2.b.(1).(a). of 1.2 weight %/day. Initiated LER. (See attached.)
		Special Changes Regarding Instrumentation
		1) RTD 1 removed from scan because of internal multiplexer ground. Approved by Temporary Procedure Change 83-4-124, 4/16/83.
		2) Dewcell 7 removed from scan because of failure. Approved by Temporary Change 83-4-126, 4/17/83.
04/20/83	2013	Pre-test checklists completed.
	2030	Pressurization started.
	2044	Reached 1.6 psig for the vacuum breaker test. Acceptable.
	2112	Secured open 1 set vacuum breakers.
	2125	Secured open 2nd set vacuum breakers.
	2129	Restarted pressurization.
	2158	Approximately 5 psig containment pressure.
	2248	Pressurization stopped due to leakage observed on vacuum breaker 1601-33C top lid double gasketed seal @ 7 o'clock position. Leakage approximately 5 scfh. Tightened lid.
04/21/83	0000	LLRT of 1601-33C lid now shows no through leakage. Inner seal apparently is broken.
	0005	Restarted pressurization. No observable leakage at containment boundaries. While holding pressure at 26.23 psia, pressure drop only 0.01 psi.
	0100	Rx water level: 49.6 inches, Rx water temperature: 133.96 F, torus level: -3 inches.
	0200	Rx water temperature: 133.23 F. Made minor adjustment to shutdown cooling heat exchanger controller to bring temperature towards 135 ^{o}F.

LICENSEE EVENT REPORT

CONTROL BLOCK: | | | | | | | (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

0 1	I L D R S 2 (2)	0 0 - 0 0 0 0 0 - 0 0 (3)	4 1 1 1 1 (4)	(5)		
	LICENSEE CODE	LICENSE NUMBER	LICENSE TYPE	CAT		
CON'T 0 1	REPORT SOURCE L (6)	0 5 0 0 0 2 3 7 (7)	0 4 1 8 8 3 (8)	0 4 2 9 8 3 (9)		
		DOCKET NUMBER	EVENT DATE	REPORT DATE		

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2 During the refueling outage, a primary containment integrated leak rate test

0 3 was being performed. Air leaks were found at the actuating arms for 6 torus-

0 4 to-drywell vacuum breakers. These leaks were later quantified at 1778.28 scfh,

0 5 which exceeds the Tech. Spec. 3.7.A.2.b.(1).(a). operational limit of 1.2

0 6 weight percent per day. Safety significance was considered minimal since

0 7 off-site dose calculations were less than 10 CFR Part 100 limits. There are

0 8 no previous integrated leak rate test failures at Dresden Unit 2 or 3.

	SYSTEM CODE	CAUSE CODE	CAUSE SUBCODE	COMPONENT CODE	COMP. SUBCODE	VALVE SUBCODE
0 9	S A (11)	B (12)	A (13)	V A L V E X (14)	C (15)	C (16)

(17) LER/RO REPORT NUMBER	EVENT YEAR		SEQUENTIAL REPORT NO.		OCCURRENCE CODE	REPORT TYPE		REVISION NO.
	8 3	—	0 2 9	/	0 1	T	—	0

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
F (18)	Z (19)	C (20)	Z (21)	0 0 0 0	Y (23)	N (24)	N (25)	A 5 8 5 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

1 0 The leaks were caused by failure of the vacuum breaker actuating arm seals.

1 1 The integrated leak rate test was aborted, and the leaks quantified per

1 2 10 CFR 50, app. J. All torus-to-drywell vacuum breaker arm seals were

1 3 replaced with an improved design and no further leakage problems observed.

1 4

	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
1 5	H (28)	0 0 0 (29)	N/A	B (31)	Integrated Leak Rate Test

	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
1 6	Z (33)	Z (34)	N/A	N/A

PERSONNEL EXPOSURES

	NUMBER	TYPE	DESCRIPTION (39)
1 7	0 0 0 (37)	Z (38)	N/A

PERSONNEL INJURIES

	NUMBER	DESCRIPTION (41)
1 8	0 0 0 (40)	N/A

LOSS OF OR DAMAGE TO FACILITY (43)

	TYPE	DESCRIPTION
1 9	Z (42)	N/A

PUBLICITY

	ISSUED	DESCRIPTION (45)	NRC USE ONLY
2 0	N (44)	N/A	

NAME OF PREPARER Robert J. Whalen PHONE: (815) 942-2920 x523

FOR INFORMATION ONLY

GPO 917-236

ATTACHMENT TO LICENSEE EVENT REPORT #83-29/01T-0
COMMONWEALTH EDISON COMPANY (CWE)
DRESDEN UNIT 2
DOCKET # 50-237

Event Description

During the refueling outage, a primary containment integrated leak rate test was being performed. At 0400 hours 4/17/83, pressurizing of the containment was begun. In accordance with Station Prodecure DTS 1600-7, the containment isolation boundaries were checked with soap solution as pressure rose from 2 to 15 psig. This was completed by 0615 hours; no leakage was identified. At 0624, pressurizing was stopped and containment pressure held steady. At 1112 hours, 48 psig containment pressure was reached. At 1230 hours, containment pressure was observed to fall approximately 0.08 psi over the course of 30 minutes. At 1330, it was decided to repressurize the containment because it was unclear whether the pressure drop was due to stabilization effects or leakage. At 1430, the following torus-to-drywell vacuum breaker actuating arm shafts were observed to be leaking: 32B, 33A, 33C, 33D, 33E, and 33F. The 32B was leaking at the packing on the left end of the shaft; the others were leaking at both shaft ends. At 1615 hours, checking of all the containment boundaries was restarted. This was finished at 1740; no other significant leakage was found. The containment was blown down and local leak rate testing was begun of the items in question. Total through leakage of all the failed items was quantified at 1778.28 scfh at 1900 hours 4/18/83. This is in excess of the Technical Specification 3.7.A.2.b.(1).(a). operational limit of 1.2 weight percent per day, or 616.392 scfh. There have been no previous failures of the integrated leak rate test at Dresden units 2 and 3. However, there have been isolated cases of torus-to-drywell vacuum breaker arm shaft packing local leak rate test failures. These include the following: R.O. 75-23, 82-01 on Docket 50-249 and R.O. 76-14 on Docket 50-237.

Cause Description and Consequences

The leakage was caused by failure of the actuating arm shaft packing (Atwood and Morrill Co., Inc.) to provide a sufficient seal. This material was apparently designed for a higher pressure application, which would have required a pressure higher than the test value in order to sufficiently expand the chevron seals. Additionally, there had been a manufacturing change in the seals wherein only one internal chevron was provided in

(cont.)

Cause Description and Consequences (cont.)

the assembly whereas previously two had been supplied. The one-chevron assemblies were apparently installed on the "32" series vacuum breakers during the 1981 refueling outage. All of the vacuum breakers were successfully local leak rate tested at the beginning of the 1983 refueling outage. (This is done by pressurizing the small area between the two seal assemblies that are used on each end of the shaft). However, when the entire containment was pressurized for a period of time, the seals were found to progressively fail. In the unlikely event that a LOCA had occurred during the time the vacuum breaker sleeves were leaking, the safety significance was considered minimal since off-site dose calculations for a flow rate of 32.03 scfm (48 psig continuous containment pressure) and assuming no dilution in the secondary containment was less than 10 CFR Part 100 limits. Various redundant ECCS systems were continuously available to prevent such conditions from developing. Additionally, secondary containment and the standby gas treatment systems were available.

Corrective Actions and Conclusion

A new type of seal (John Crane Co.) was installed on all the torus-to drywell vacuum breakers. It uses one chevron per assembly, but is designed for the appropriate pressure (design-basis accident conditions). The vacuum breakers were again local leak rate tested with no failures. The integrated leak rate test was restarted and the containment leakage was found to be well within Technical Specification limits. The vacuum breaker arms were carefully checked with soap solution periodically during the ILRT and no leakage was found. Although Dresden Unit 3 successfully passed an ILRT during its 1982 refueling outage, 25 percent of its torus-to-drywell vacuum breaker arms will be disassembled and checked during the next shutdown of sufficient duration. Action Item Record 12-83-32 has been issued to track the completion of the Unit 3 inspection.

DATE	TIME	ILRT LOG
	0300	Rx water temperature: 132.56°F, Rx water level: 49.2 inches, torus level: -3 inches.
	0400	Rx water temperature: 133.95°F, Rx water level: 49.84 inches, torus level: -3 inches.
04/21/83	0452	Completed pressurization. 65 psia.
	0500	Rx water level: 49.2 inches, Rx water temperature: 132.74°F.
	0600	Rx water temperature: 133.17°F, Rx water level: 49.6 inches, torus level: -3 inches.
	0714..17	Data set 63 appears odd. Total containment pressure steady, but dewcells, RTD's fluctuating. All data returns to normal after this one data set.
	0804	Returned LPCI piping to normal approximately 10 minutes ago (broke pressurization line).
	1055	Decided to begin 12-hour phase @ 10.04. Removed data set 63.
	1304	Sharp rise in leak rate seen due to dewcell, RTD fluctuations. Total pressure appears solid. Appears to be electrical problem (same as occurred 0714).
	1432	Operating adjusts reactor water level.
	1452	Technical Staff is checking all boundaries again with soap solution.
	1602	No leaks of significance found.
	2033	Turned off containment fans at MCC 28-1. Purpose was to investigate possibility of circuit interference with multiplexer causing earlier instrumentation problems.
	2210	Lost Reactor Building HVAC.
04/22/83	0005	Noted that measured leakage rose slightly @ 1644 due to small makeup to reactor level.
	0100	Discussed progress of test with NRC. Agreed to run 12-hour test from 13 44 - 0144.
	0130	Called technician to prepare for air sample.
	0144	Finished 12-hour test.
	0149	Started containment air sample.

DATE	TIME	ILRT LOG
	0228	Stopped sample.
	0310	Sample results: I_{131}: 3.9 x 10^{-11}, $\beta\gamma$: 3.5 x 10^{-11}.
	1054	Started containment blowdown.

Special Changes Regarding Instrumentation

1) RTD 1 is still deleted.

F.4 Final Calculated Leak Rate

The final calculated leak rate was found to be 0.1890 weight %/day. The upper 95% confidence limit was 0.4871 weight %/day. Including compensation for non-vented systems, these results are 0.278 weight %/day and 0.577 weight %/day respectively. (Refer to Section E.7.) Since these values are well within the Technical Specification Limit of 1.2 weight %/day for reactor startup, the Unit 2 primary containment integrity remains intact.

G. SUPPLEMENTAL VERIFICATION TEST (INDUCED PHASE)

The purpose of the induced portion of the ILRT is to verify that the results of the 12-hour measured phase are valid. The supplemental test portion of the ILRT procedure involves inducing a leak from the primary containment through a separate calibrated flowmeter. Concurrently, readings from the computerized ILRT data acquisition system are analyzed to determine the magnitude of the total containment leakage. If the criteria established by the following equation is satisfied, the ILRT calculated leakage is considered acceptable and the test is terminated.

$$\left| L \begin{pmatrix}\text{Induced Phase} \\ \text{Total Containment} \\ \text{Calculated Leak Rate}\end{pmatrix} - \left\{ L \begin{pmatrix}\text{12-hour phase} \\ \text{calculated} \\ \text{leak rate}\end{pmatrix} + L \begin{pmatrix}\text{Superimposed} \\ \text{Leak rate}\end{pmatrix} \right\} \right| \leq 0.25 L_a$$

G.2 Magnitude of Induced Leakage

The induced portion of the ILRT began at 0315 hours on 4/22/83. A flow of 14 scfm was induced to the secondary containment. This was converted to weight %/day as follows:

$$14.0 \text{ scfm} \; \frac{1440 \text{ Min}}{\text{Day}} \; \frac{T + 459.69^0 R}{519.69^0 R} \; \frac{14.696 \text{ psia}}{P} \; \frac{100\%}{\text{Vol}} = \underline{1.718 \text{ Weight \%/Day}}$$

Where, T = Induced phase average containment temperature, 98.086°F

P = Induced phase average containment pressure, 64.053 psia. (Includes dry air and vapor)

VOL = Free volume of the containment, 288966 Ft^3.

The induced phase calculated leak rate, as shown by the computerized data acquisition system, was 1.9073 weight %/day. The resulting difference, following the equation of Section G.1, is:

$$\left| 1.9073 - (0.1890 + 1.718) \right| \leq 0.25\ L_a$$

Since L_a, the maximum allowable containment leak rate is 1.6 weight %/day,

$$\left| 1.9073 - (0.1890 + 1.718) \right| \leq 0.4$$

$$0.0003 \leq 0.4$$

Since the difference, as shown above, was well below the 0.4 weight %/day accuracy requirement the ILRT values are considered valid.

H. TEST EVALUATION

Both the statistical leak rate and the upper confidence limit, corrected for process lines not vented or drained, were well within all Technical Specification limits.

Reactor vessel temperature transients were minimized by leaving the shutdown cooling system (B heat exchanger) in steady-state operation throughout the test. Reactor water temperature was controlled by varying the reactor building closed cooling water (RBCCW) supply flow rate to the heat exchanger. Remote throttling of the RBCCW discharge valve provided this method for stabilizing reactor water temperature.

APPENDIX A

TYPE A TEST INSTRUMENT ACCURACY ERROR ANALYSIS

APPENDIX A

INSTRUMENT ACCURACY ERROR ANALYSIS

A.1 Development of Equations

Per Topical Report BN-TOP-1 the measured total time leak rate (M) in weight percent per day is computed using the Absolute Method by the formula

$$M = (100)\,\frac{24}{H}\left[1 - \frac{T_1\,\bar{P}_n}{T_n\,\bar{P}_1}\right] \qquad (1)$$

where:

$\bar{P}_1 = P_1 - PV_1$ = total containment atmosphere absolute pressure, in psia, at the start of test, corrected for water vapor pressure.

$\bar{P}_n = P_n - PV_2$ = Total containment atmosphere absolute pressure, in psia, at data point n after start of the test, corrected for water vapor pressure.

T_1, T_n = containment mean atmospheric temperature in or at the start and at data point n, respectively.

H = test interval in hours between time 1 and time n.

R = gas constant.

The change or uncertainty interval in M due to uncertainties in the measured variables is given by:

$$M = \frac{2400}{H}\left[\left(\frac{dM}{dP_2}\cdot\delta_{P_2}\right)^2 + \left(\frac{dM}{dP_1}\cdot\delta_{P_1}\right)^2 + \left(\frac{dM}{dT_1}\cdot\delta_{T_1}\right)^2 + \left(\frac{dM}{dT_2}\cdot\delta_{T_2}\right)^2\right]^{\frac{1}{2}} \qquad (2)$$

where δ is the standard error for each variable. This formula assumes that all errors are systematic rather than random in character. Even though the formula is deterministic it does, however, allow assessment of figure of merit for various equipment to be used in the measuring system without the need for assembling and calibrating the system as an entity.

The error in M after differentiating is:

$$e_M = \frac{2400}{H} \left[\left(-\frac{T_1}{\bar{P}_1 T_2} \cdot e_{\bar{P}_2} \right)^2 + \left(\frac{\bar{P}_2 T_1}{\bar{P}_1^{\,2} T_2} \cdot e_{\bar{P}_1} \right)^2 \right. \quad (3)$$

$$\left. + \left(-\frac{\bar{P}_2}{\bar{P}_1 T_2} \; e_T \right)^2 + \left(\frac{\bar{P}_2 T_1}{\bar{P}_1 T_2^{\,2}} \; e_T \right)^2 \right]^{\frac{1}{2}}$$

where:

$$e_{\bar{P}_1} = \delta_{P_1}$$

$$e_{\bar{P}_2} = \delta_{P_2}$$

$$e_T = e_{T_1} = e_{T_2}$$

For the purpose of developing a finite number for e_M using equation (3), it is necessary to assume certain containment conditions made.

1. For purposes of comparison to other tests H = 24 hours.

2. Containment leak rate is essentially zero, that is:

$T_1 = T_2 = \bar{T}$ where $\bar{T}$ is the average volume weighted primary containment air temperature (R) during the test;

$P_1 = P_2$ where P is the total containment atmospheric pressure (psia);

$PV_1 = PV_2$ where PV is the partial pressure of water vapor in the primary containment;

Equation (3) becomes:

$$e_M = \frac{2400}{H} \left[2 \left(\frac{e_P}{\bar{P}} \right)^2 + 2 \left(\frac{e_T}{\bar{T}} \right)^2 \right]$$

where:

e_P = the error in pressure which accounts for the error in the total pressure measurement system; both total absolute pressure and water vapor pressure.

$$e_P = \left[(e_{P_T})^2 + (e_{P_V})^2 \right]^{\frac{1}{2}}$$

e_{P_T} = inst. accuracy error/ $\sqrt{\text{no. inst.}}$ = error in total absolute pressure in psia.

e_{P_V} = inst. accuracy error/ $\sqrt{\text{no. inst.}}$ = error in water vapor pressure (dewpoint) indicator in psia at 70^0F.

e_T = inst. accuracy error/ $\sqrt{\text{no. inst.}}$ = error in temperature, ^{0}R.

A.2 Calculations

Instrument	RTD (^{0}F)	PPG (PSIA)	DEWCELL (^{0}F)	FLOWMETER (SCFM)
Range	50-200	0-100	-50 - 140	2-20
Accuracy	$\pm$ 0.54	0.015	$\pm$ 2.5^{0}F	1% (Full Scale)
Repeatability	$\pm$ 0.01	0.001	$\pm$ 0.03^{0}F	0.02

BN-TOP

Computation of Instrument Accuracy Uncertainty.

1. e_T "Error in temperature"

$$e_T = \pm \frac{0.54}{\sqrt{30}} = 0.09859 \ ^0F$$

2. "Error in total absolute pressure in psia"

$$e_{PT} = \pm (0.015\%)\ (100)\ /\sqrt{2}$$

$$= 0.0106 \text{ psia}$$

3. Computing "e_p"

Error in water vapor pressure (dewpoint) indicator in psia at a dewpoint of 80 ^{0}F (assumed), an accuracy of 2.5^{0}F corresponds to 0.044 psia

$$e_{pv} = \pm \left(0.97777 \times \frac{0.044}{\sqrt{8}} + 0.02223 \times \frac{0.3335}{\sqrt{1}}\right)$$

$$= 0.01521 + 0.00074$$

$$= 0.01595 \text{ psia.}$$

4. Computing "e_p"

$$e_p = \pm \{(e_{pT})^2 + (e_{pv})^2\}^{\frac{1}{2}}$$

$$= \pm \{(0.0106) + (0.0152)^2\}^{\frac{1}{2}}$$

$= 0.01845$ psia

5. Computing total instrument accuracy uncertainty "em".

$$em = \pm \frac{2400}{12} \{2 \times (\frac{ep}{63.0})^2 + 2 \times (\frac{e_T}{550})^2\}^{\frac{1}{2}}$$

$$= \pm 200 \{2 \times (\frac{0.01854}{63.0}) + 2 \times (\frac{0.09128}{550})^2\}^{\frac{1}{2}}$$

$= \pm 0.0956\%$/day.

Computing Instrument Repeatability.

1. "e_T"

$$e_T = \pm \frac{0.01}{\sqrt{30}}$$

$= 0.00182\ ^0R$

2. "e_{PT}"

$$e_{PT} = \frac{0.001}{\sqrt{2}}$$

$= \pm 0.0007$ psia.

3. "e_{pv}"

$$e_{pv} = \pm (0.97777 \times \frac{0.044}{\sqrt{8}} \pm 0.02223 \times \frac{0.03335}{\sqrt{1}})$$

$= \pm 0.015951$ psia

4. "e_p"

$$e_p = \pm \{(0.0007)^2 + (0.015951)^2\}^{\frac{1}{2}}$$

$= 0.015967$ psia

5. "e_m"

$$e_m = \pm \frac{2400}{12} \{ 2 \times \frac{(0.015967)^2}{63} + 2\frac{(0.00182)^2}{550}\}^{\frac{1}{2}}$$

$= \pm 0.071672$ %/day

APPENDIX B

TYPE A TEST DATA

DRESDEN UNIT 2 07:39:38 THU, 28 APR 1983

12-HOUR PHASE DATA SUMMARY

DRESDEN UNIT 2 07:39:38 THU, 28 APR 1983

**** BECTHEL CALCULATIONS FOR DATA SETS 100 THRU 172 ****

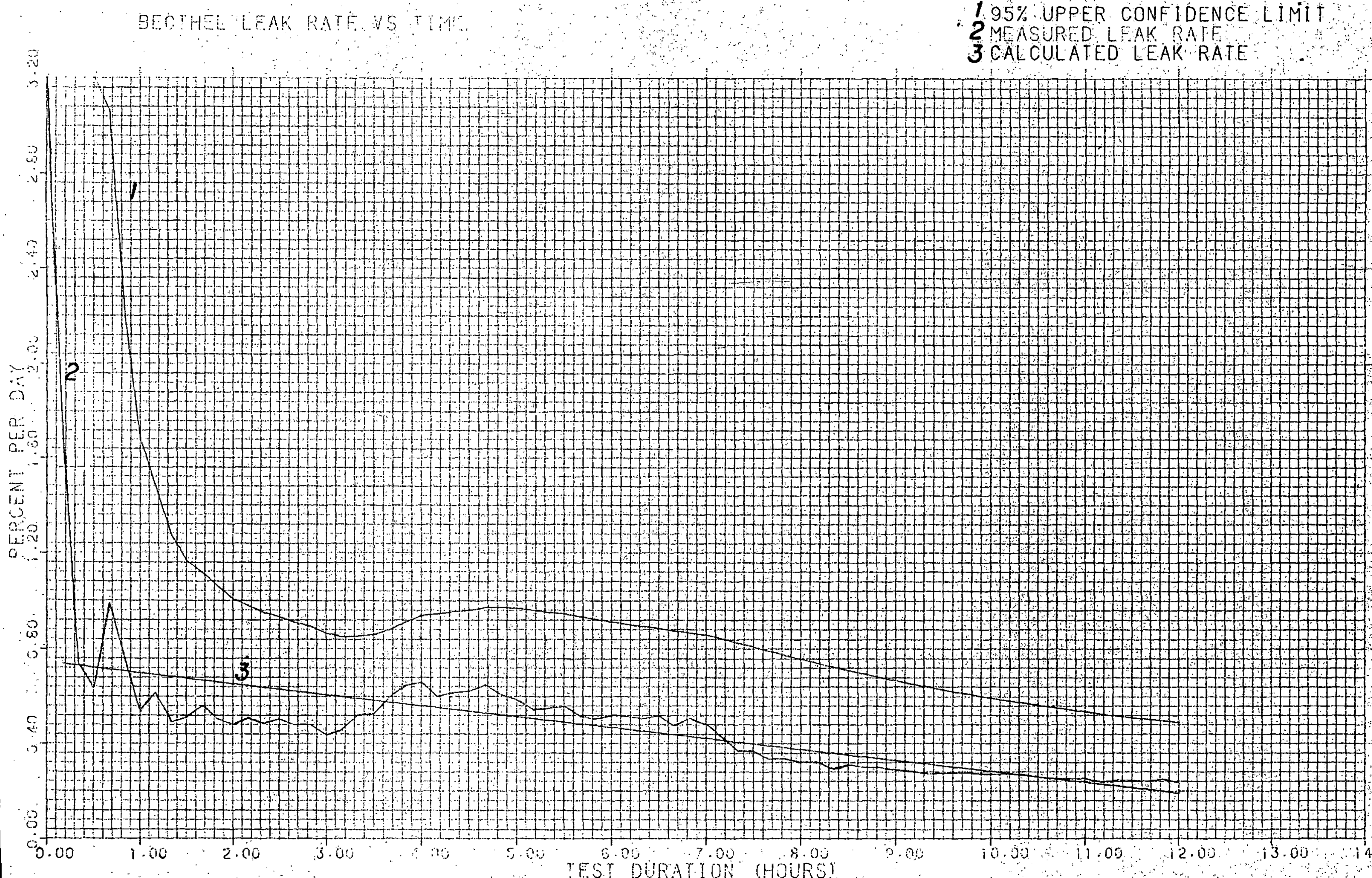
DATA SET	TEST DURATION (HRS)	TEMP. (R)	DRY AIR PRESSURE (PSIA)	WATER LEVEL (IN)	MEAS LEAK RATE % / DAY	CALC LEAK RATE % / DAY	95% UPPER CONFIDENCE LIMIT
100	0.000	557.800	63.844	48.570	0.0000	0.0000	0.0000
101	0.167	557.807	63.837	48.600	1.7141	0.7370	0.0000
102	0.333	557.818	63.839	48.530	0.7406	0.7293	0.0000
103	0.500	557.821	63.837	48.510	0.6334	0.7215	3.9149
104	0.667	557.824	63.828	48.410	0.9908	0.7138	3.0629
105	0.833	557.839	63.831	48.520	0.7491	0.7061	2.1907
106	1.000	557.848	63.834	48.370	0.5342	0.6984	1.6778
107	1.167	557.854	63.830	48.410	0.6145	0.6907	1.4710
108	1.333	557.852	63.831	48.410	0.4901	0.6829	1.2732
109	1.500	557.867	63.830	48.430	0.5117	0.6752	1.1634
110	1.667	557.873	63.826	48.380	0.5584	0.6675	1.1176
111	1.833	557.881	63.827	48.350	0.5051	0.6598	1.0575
112	2.000	557.894	63.827	48.300	0.4817	0.6521	1.0042
113	2.167	557.905	63.822	47.930	0.5069	0.6444	0.9766
114	2.333	557.910	63.822	48.000	0.4867	0.6366	0.9466
115	2.500	557.919	63.820	47.930	0.5033	0.6289	0.9294
116	2.667	557.932	63.820	47.860	0.4796	0.6212	0.9074
117	2.833	557.941	63.819	47.820	0.4811	0.6135	0.8901
118	3.000	557.948	63.822	47.990	0.4373	0.6058	0.8633
119	3.167	557.960	63.819	47.820	0.4587	0.5981	0.8472
120	3.333	557.969	63.814	48.100	0.5225	0.5903	0.8519
121	3.500	557.977	63.818	49.060	0.5279	0.5826	0.8563
122	3.667	557.988	63.816	50.130	0.5999	0.5749	0.8790
123	3.833	557.989	63.814	50.880	0.6479	0.5672	0.9094
124	4.000	557.998	63.811	50.930	0.6605	0.5595	0.9362
125	4.167	558.005	63.814	50.620	0.5987	0.5518	0.9426
126	4.333	558.015	63.811	50.720	0.6147	0.5440	0.9507
127	4.500	558.026	63.811	51.100	0.6208	0.5363	0.9580
128	4.667	558.035	63.804	50.840	0.6466	0.5286	0.9685
129	4.833	558.043	63.808	50.990	0.6081	0.5209	0.9698
130	5.000	558.053	63.809	50.900	0.5855	0.5132	0.9665
131	5.167	558.062	63.813	50.540	0.5457	0.5054	0.9571
132	5.333	558.070	63.811	50.880	0.5524	0.4977	0.9493
133	5.500	558.077	63.807	50.650	0.5570	0.4900	0.9427
134	5.667	558.083	63.811	50.660	0.5171	0.4823	0.9313
135	5.833	558.100	63.812	50.540	0.5050	0.4746	0.9193
136	6.000	558.106	63.810	50.750	0.5147	0.4669	0.9094
137	6.167	558.119	63.808	50.570	0.5141	0.4591	0.9001
138	6.333	558.128	63.808	50.480	0.5049	0.4514	0.8904
139	6.500	558.140	63.805	50.490	0.5164	0.4437	0.8827
140	6.667	558.150	63.811	50.380	0.4732	0.4360	0.8712
141	6.833	558.158	63.804	50.380	0.5069	0.4283	0.8637
142	7.000	558.162	63.806	50.270	0.4813	0.4206	0.8541
143	7.167	558.048	63.802	50.290	0.4223	0.4120	0.8398
144	7.333	557.997	63.804	50.240	0.3710	0.4051	0.8225

12-HOUR PHASE DATA (CONT'D)

145	7.500	557.962	63.799	50.170	0.3681	0.3974	0.8059
146	7.667	557.941	63.801	50.110	0.3336	0.3897	0.7880
147	7.833	557.930	63.798	50.130	0.3374	0.3820	0.7713
148	8.000	557.915	63.798	50.140	0.3233	0.3743	0.7546
149	8.167	557.915	63.796	50.050	0.3231	0.3665	0.7388
150	8.333	557.913	63.799	49.900	0.2951	0.3588	0.7221
151	8.500	557.911	63.794	49.930	0.3120	0.3511	0.7073
152	8.667	557.909	63.795	49.890	0.3002	0.3434	0.6926
153	8.833	557.915	63.794	49.830	0.2994	0.3357	0.6787
154	9.000	557.907	63.793	49.600	0.2895	0.3280	0.6649
155	9.167	557.911	63.794	49.620	0.2831	0.3202	0.6514
156	9.333	557.914	63.796	49.640	0.2713	0.3125	0.6379
157	9.500	557.919	63.794	49.520	0.2726	0.3048	0.6253
158	9.667	557.918	63.791	49.320	0.2757	0.2971	0.6135
159	9.833	557.919	63.791	49.310	0.2725	0.2894	0.6021
160	10.000	557.931	63.790	49.100	0.2685	0.2816	0.5911
161	10.167	557.928	63.788	49.130	0.2717	0.2739	0.5810
162	10.333	557.916	63.787	49.040	0.2656	0.2662	0.5710
163	10.500	557.904	63.786	49.100	0.2591	0.2585	0.5611
164	10.667	557.891	63.785	48.930	0.2507	0.2508	0.5512
165	10.833	557.895	63.783	48.890	0.2534	0.2431	0.5421
166	11.000	557.881	63.780	48.760	0.2530	0.2353	0.5334
167	11.167	557.885	63.784	48.700	0.2374	0.2276	0.5241
168	11.333	557.875	63.779	48.790	0.2466	0.2199	0.5160
169	11.500	557.869	63.776	48.620	0.2470	0.2122	0.5083
170	11.667	557.866	63.777	48.620	0.2415	0.2045	0.5007
171	11.833	557.861	63.772	48.590	0.2503	0.1968	0.4941
172	12.000	557.856	63.773	48.380	0.2383	0.1890	0.4871

2-HOUR PHASE

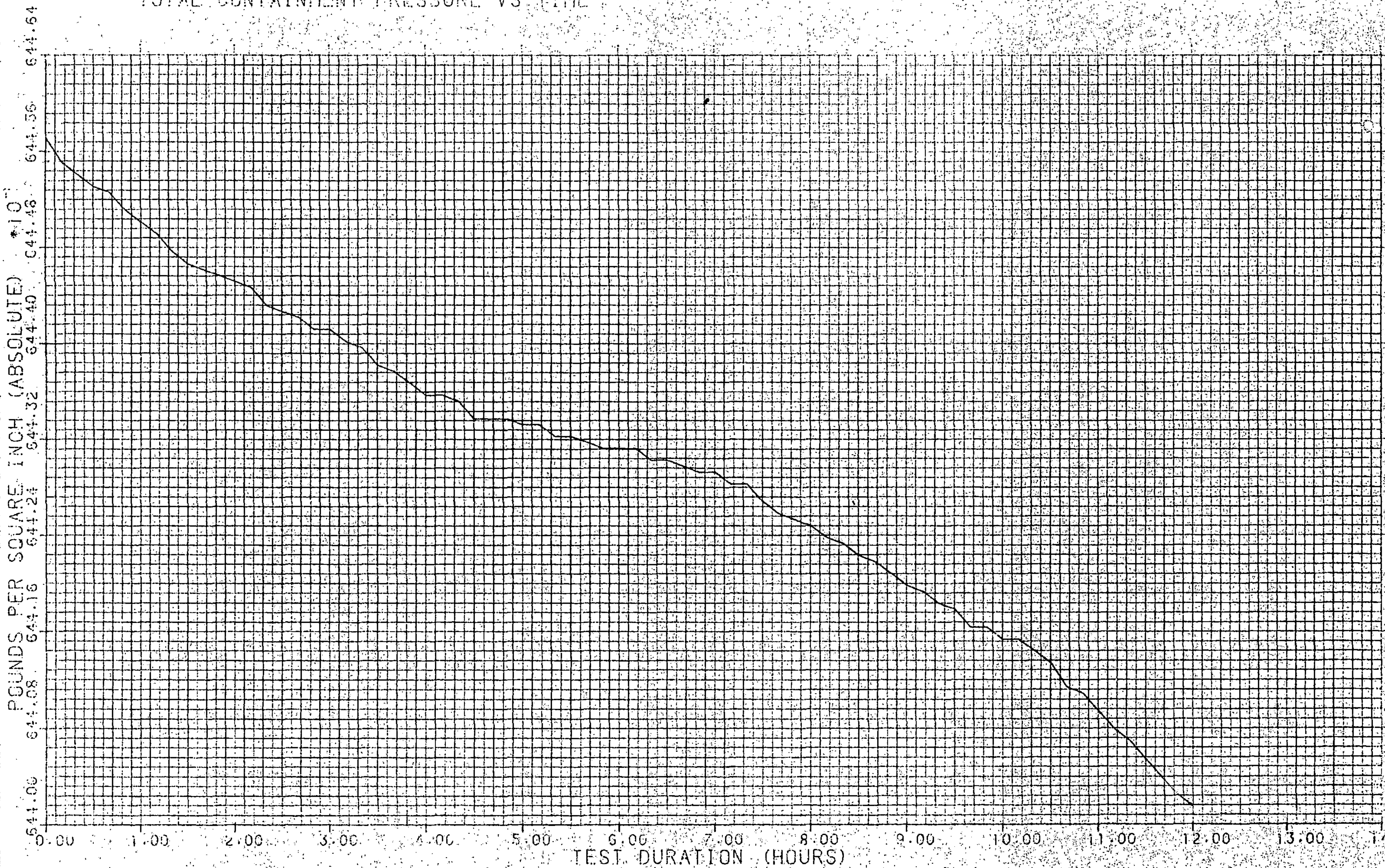
DRESDEN UNIT 2



I[illegible] HOUR PHASE

DRESDEN UNIT 2

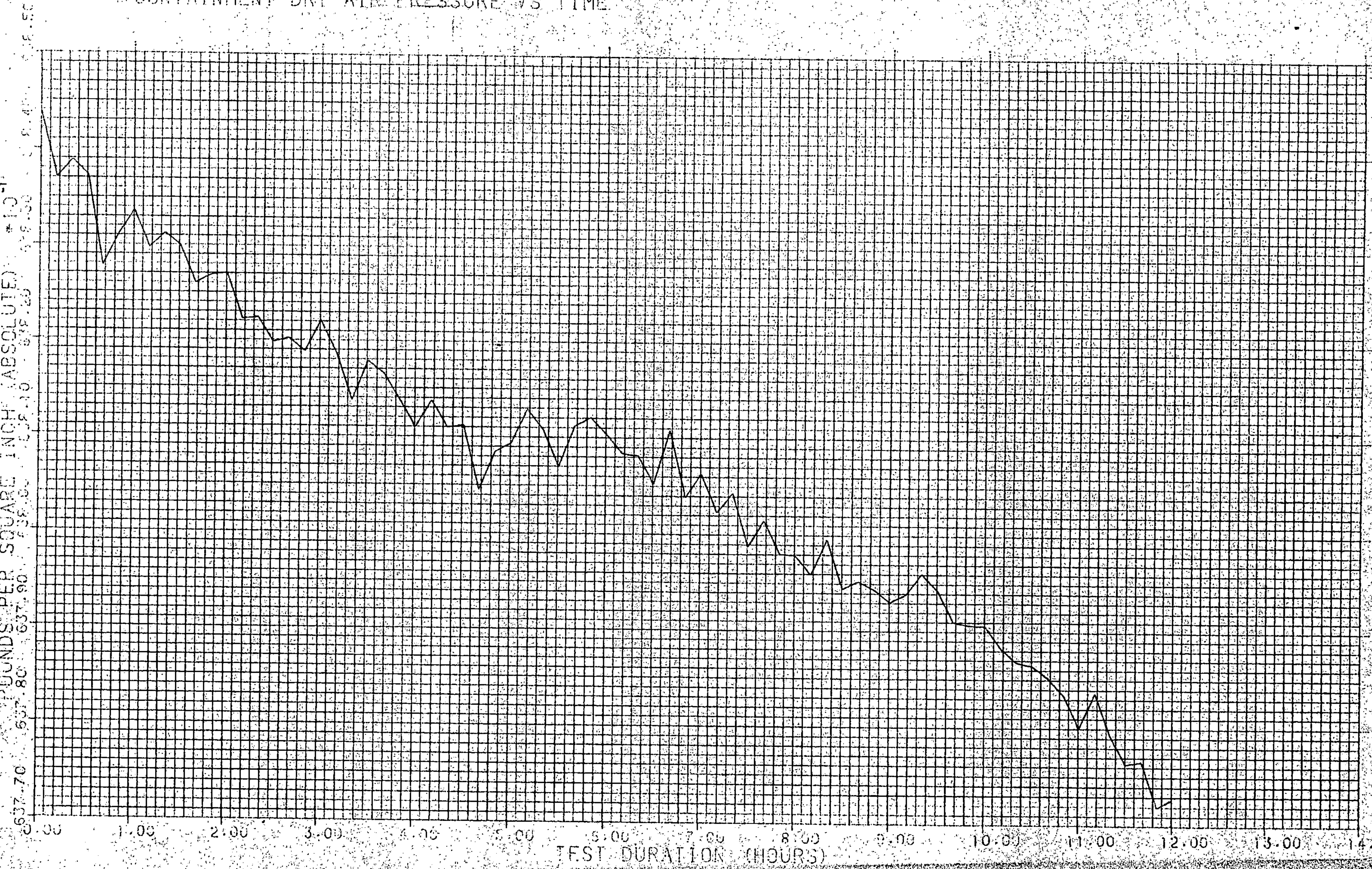
TOTAL CONTAINMENT PRESSURE VS TIME



I HOUR PHASE

DRESDEN UNIT 2

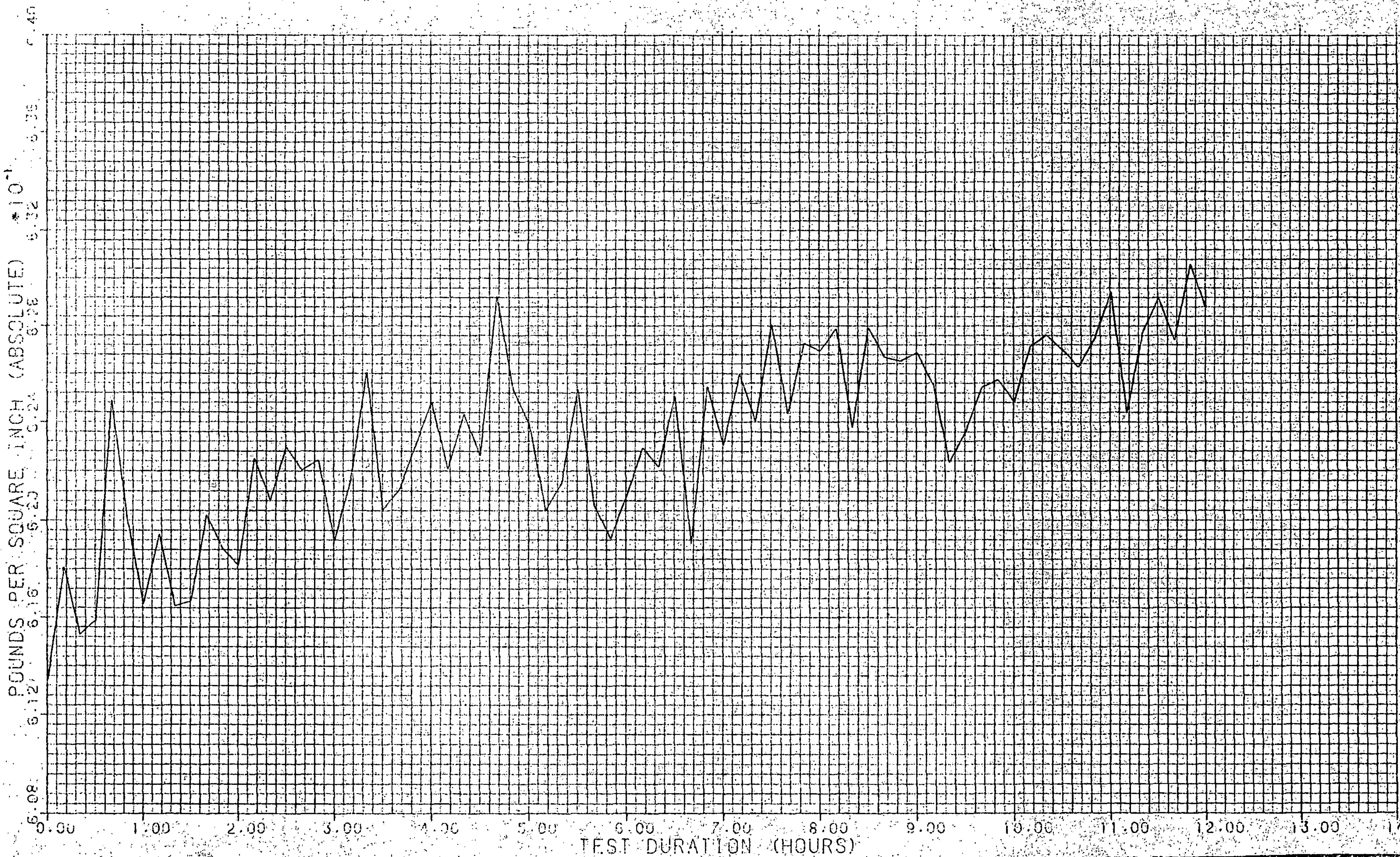
CONTAINMENT DRY AIR PRESSURE VS TIME



12 HOUR PHASE

DRESDEN UNIT 2

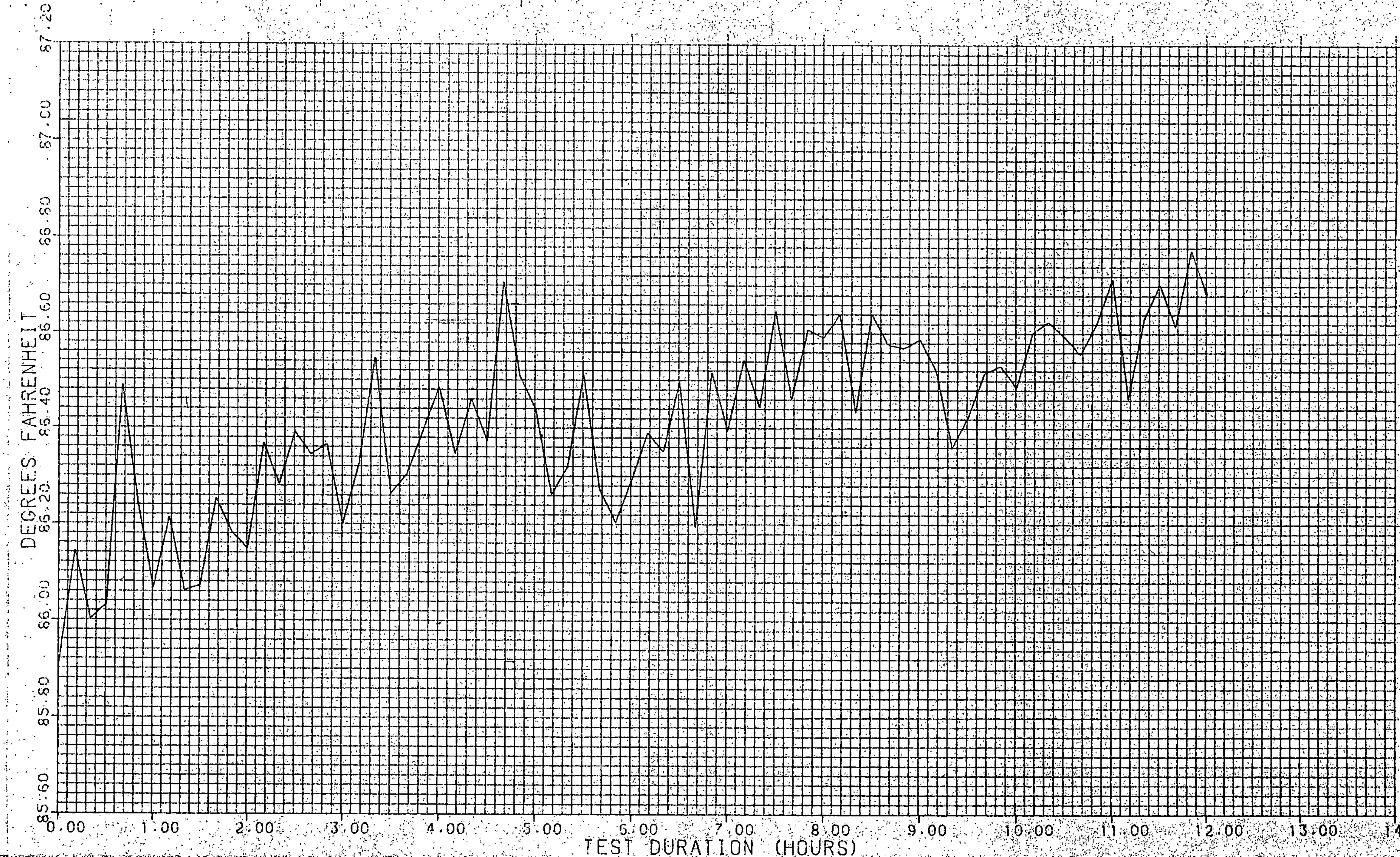
CONTAINMENT VAPOR PRESSURE VS TIME



2-HOUR PHASE

DRESDEN UNIT 2

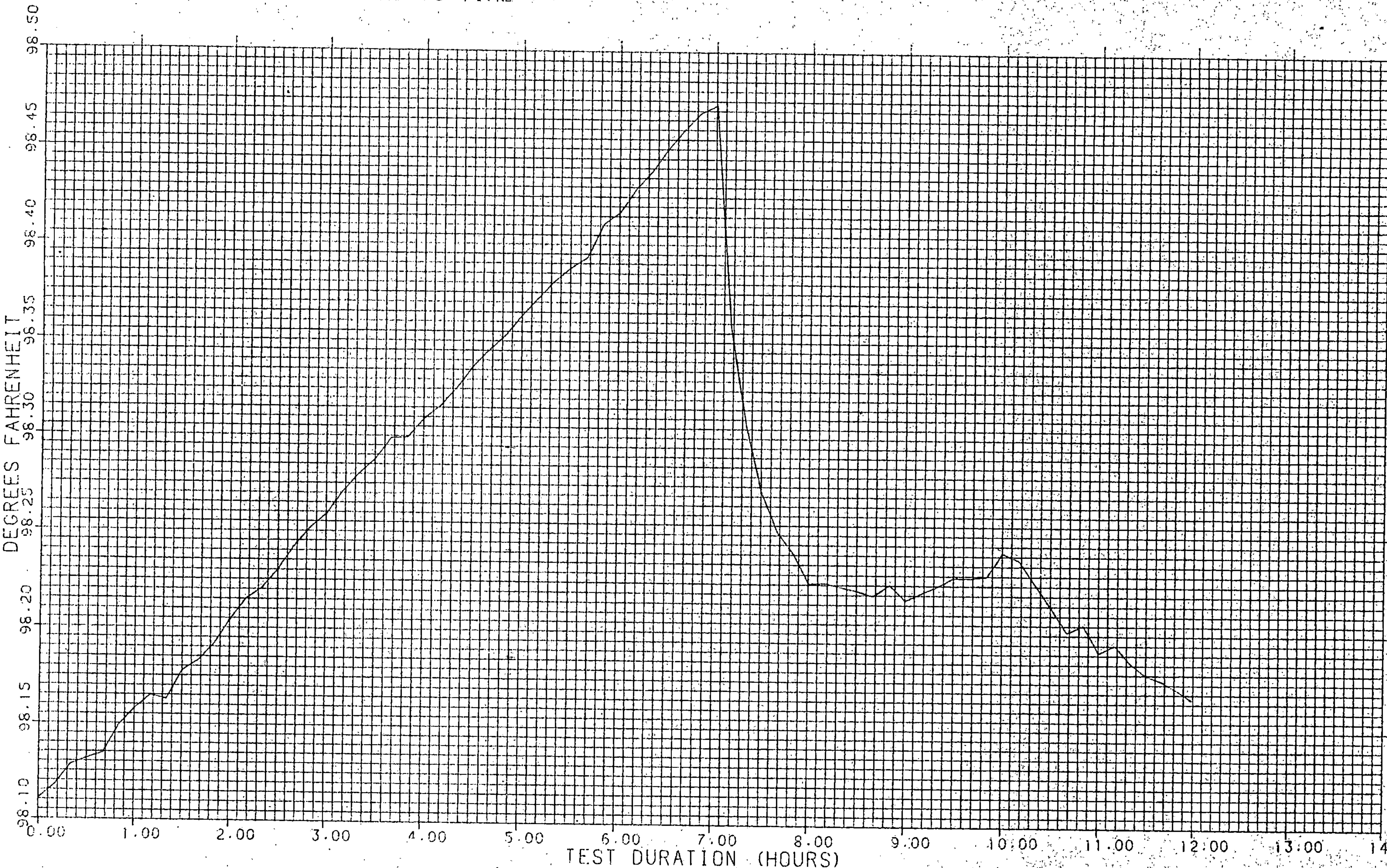
DEW POINT TEMPERATURE VS TIME



12-HOUR PHASE

DRESDEN UNIT 2

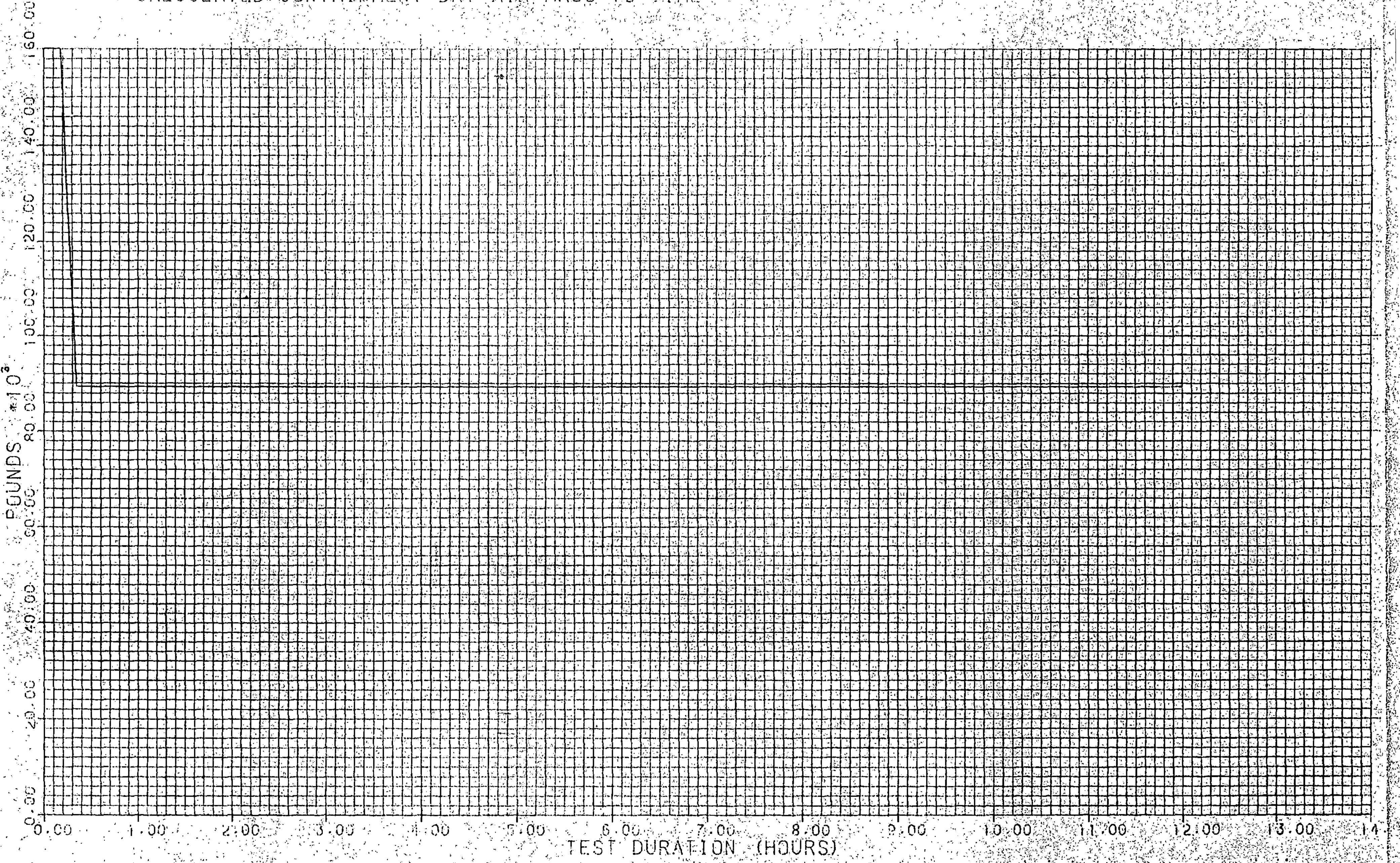
DRY-BULB TEMPERATURE VS TIME



1[illegible] HOUR PHASE

DRESDEN UNIT 2

CALCULATED CONTAINMENT DRY AIR MASS VS TIME



DRESDEN UNIT 2 07:40:29 THU, 28 APR 1983

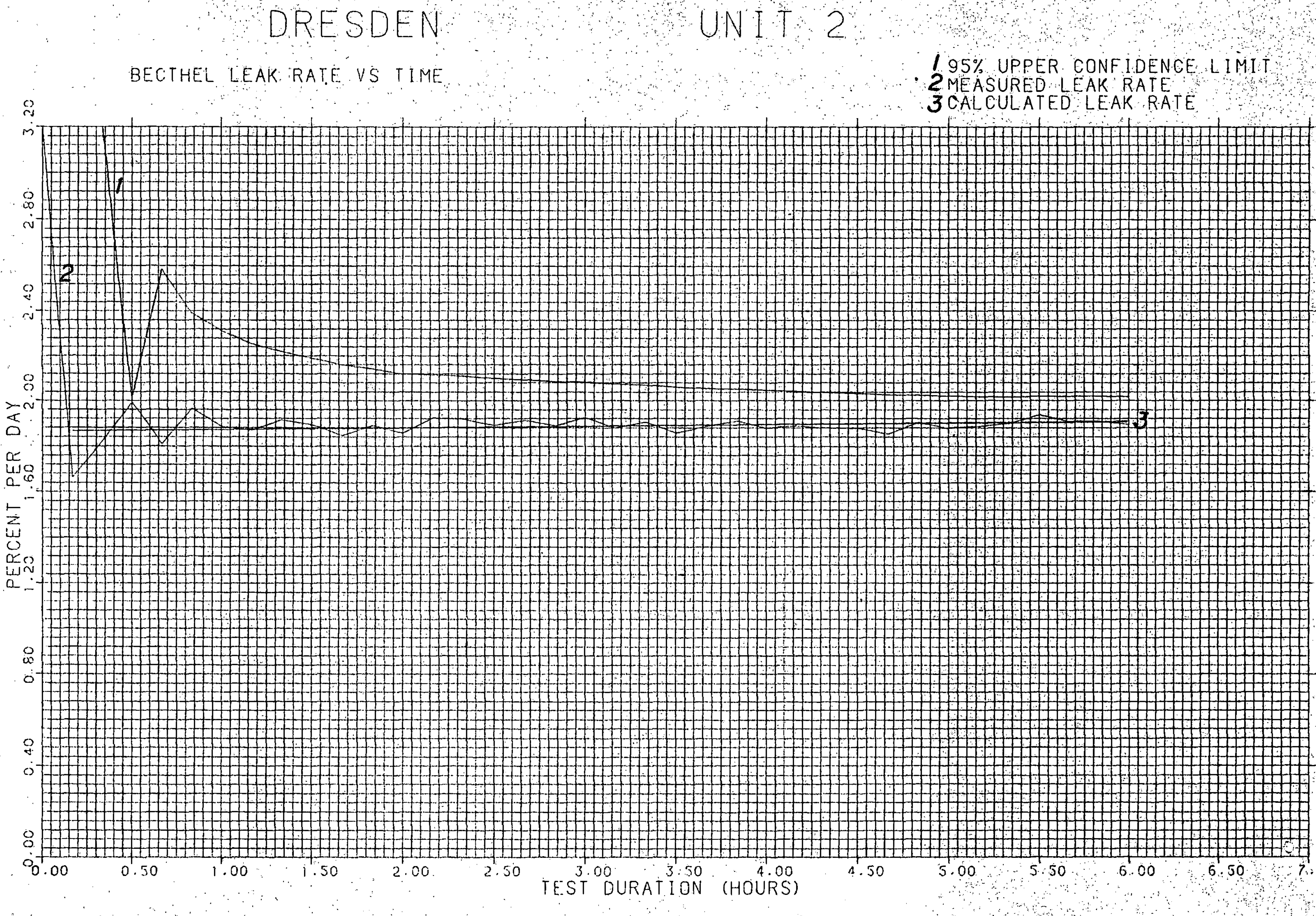
INDUCED PHASE DATA SUMMARY

DRESDEN UNIT 2 07:40:29 THU, 28 APR 1983

**** BECTHEL CALCULATIONS FOR DATA SETS 184 THRU 220 ****

DATA SET	TEST DURATION (HRS)	TEMP (R)	DRY AIR PRESSURE (PSIA)	WATER LEVEL (IN)	MEAS LEAK RATE % / DAY	CALC LEAK RATE % / DAY	95% UPPER CONFIDENCE LIMIT
184	0.000	557.807	63.744	48.010	0.0000	0.0000	0.0000
185	0.167	557.817	63.736	47.800	1.6609	1.8640	0.0000
186	0.333	557.803	63.726	47.870	1.8228	1.8653	0.0000
187	0.500	557.804	63.716	47.840	1.9901	1.8665	2.0104
188	0.667	557.797	63.709	47.730	1.8099	1.8677	2.5822
189	0.833	557.796	63.697	47.730	1.9641	1.8690	2.3901
190	1.000	557.785	63.689	47.700	1.8860	1.8702	2.3111
191	1.167	557.785	63.681	47.630	1.8690	1.8714	2.2533
192	1.333	557.786	63.671	47.560	1.9140	1.8727	2.2177
193	1.500	557.779	63.662	47.510	1.8936	1.8739	2.1879
194	1.667	557.777	63.655	47.470	1.8456	1.8751	2.1579
195	1.833	557.775	63.645	47.460	1.8882	1.8764	2.1382
196	2.000	557.775	63.639	47.380	1.8557	1.8776	2.1161
197	2.167	557.769	63.625	47.370	1.9240	1.8789	2.1128
198	2.333	557.765	63.617	47.450	1.9173	1.8801	2.1073
199	2.500	557.761	63.609	47.300	1.8899	1.8813	2.0967
200	2.667	557.757	63.598	47.340	1.9125	1.8826	2.0916
201	2.833	557.757	63.591	47.280	1.8882	1.8838	2.0827
202	3.000	557.757	63.581	47.350	1.9240	1.8850	2.0810
203	3.167	557.752	63.575	47.290	1.8786	1.8863	2.0724
204	3.333	557.751	63.564	47.280	1.9052	1.8875	2.0680
205	3.500	557.750	63.559	47.140	1.8568	1.8887	2.0586
206	3.667	557.750	63.548	47.100	1.8656	1.8900	2.0527
207	3.833	557.749	63.537	47.130	1.9095	1.8912	2.0507
208	4.000	557.747	63.531	46.990	1.8779	1.8925	2.0446
209	4.167	557.750	63.521	46.940	1.8882	1.8937	2.0402
210	4.333	557.744	63.514	47.030	1.8792	1.8949	2.0351
211	4.500	557.740	63.505	46.930	1.8784	1.8962	2.0303
212	4.667	557.738	63.499	46.930	1.8534	1.8974	2.0237
213	4.833	557.742	63.485	46.980	1.9038	1.8986	2.0227
214	5.000	557.745	63.480	46.880	1.8772	1.8999	2.0167
215	5.167	557.749	63.471	46.860	1.8853	1.9011	2.0157
216	5.333	557.737	63.462	46.840	1.8993	1.9024	2.0145
217	5.500	557.761	63.448	46.830	1.9367	1.9036	2.0184
218	5.667	557.764	63.444	46.730	1.9078	1.9048	2.0178
219	5.833	557.772	63.435	46.670	1.9097	1.9061	2.0174
220	6.000	557.775	63.430	46.700	1.8952	1.9073	2.0155

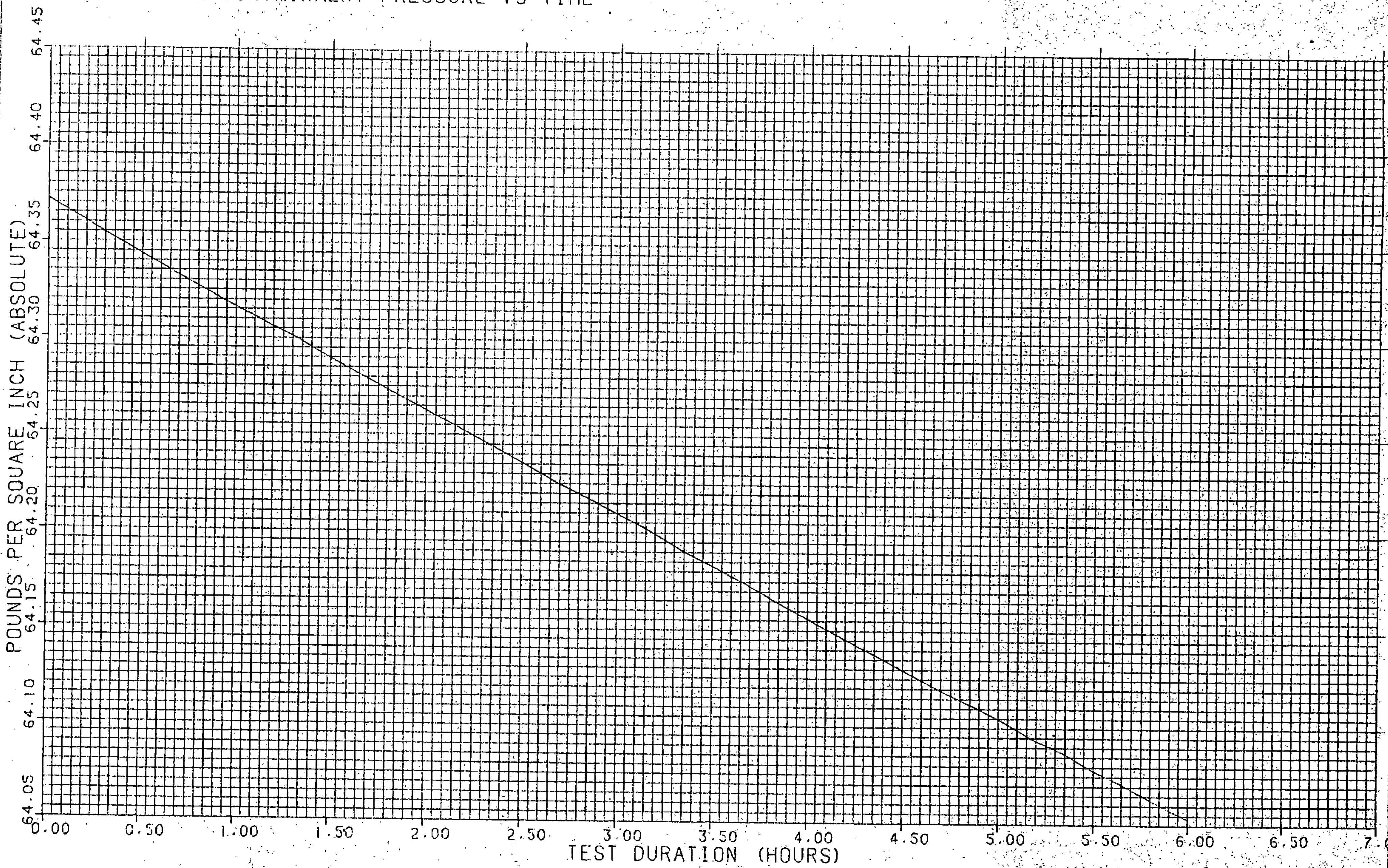
INDUCED PHASE



INDUCED PHASE

DRESDEN UNIT 2

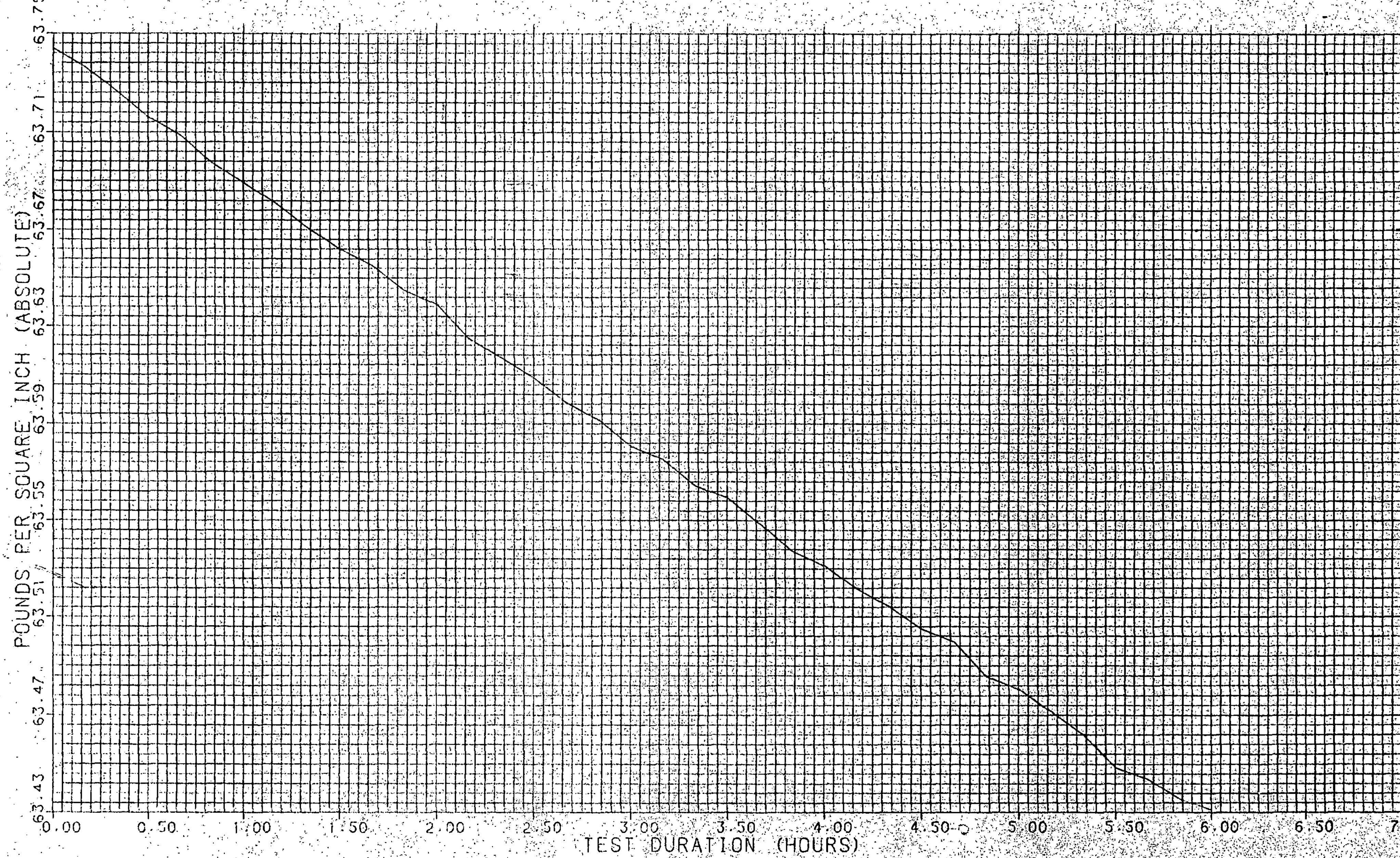
TOTAL CONTAINMENT PRESSURE VS TIME



DRESDEN UNIT 2

INDUCED PHASE

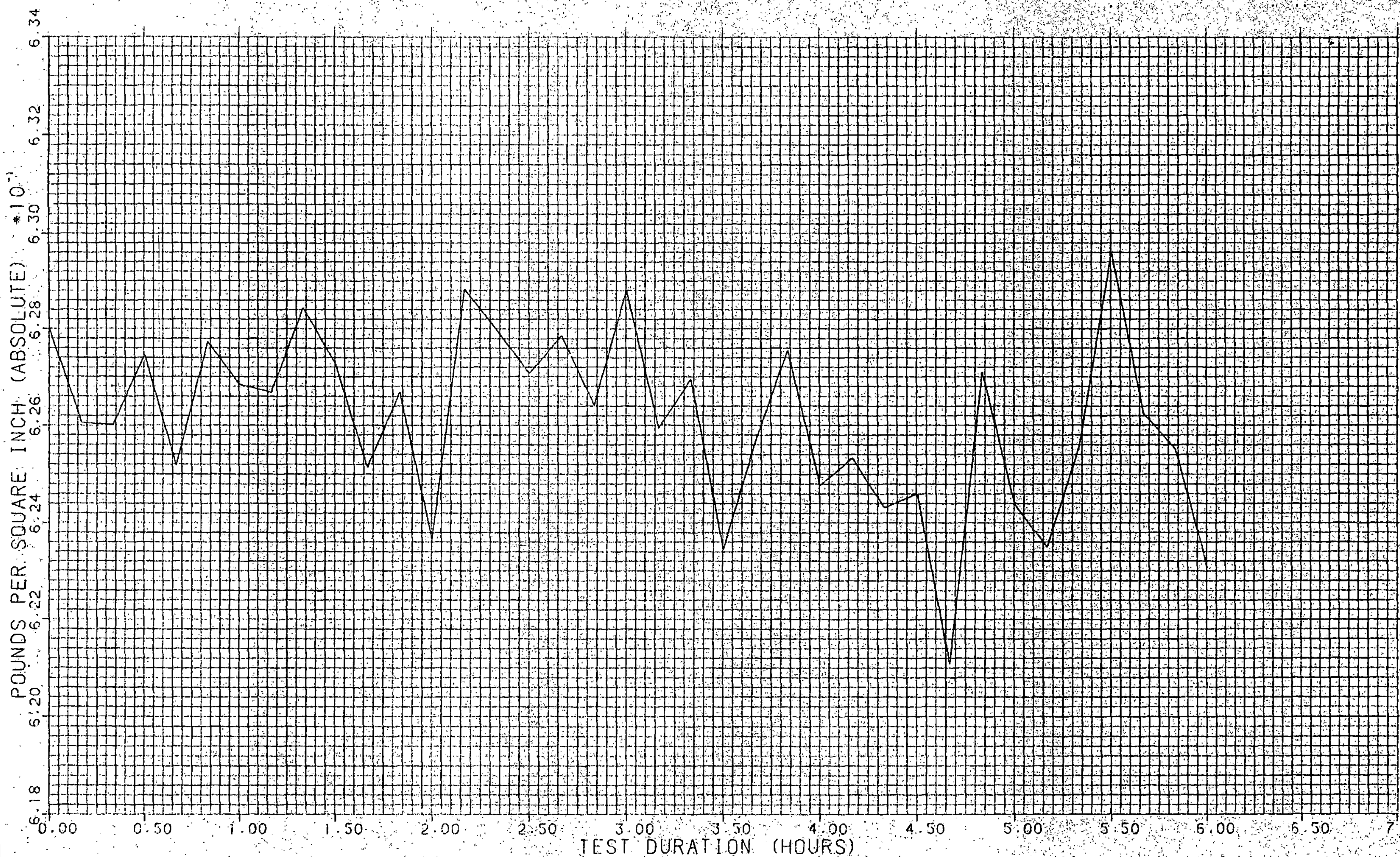
CONTAINMENT DRY AIR PRESSURE VS TIME



INDUCED PHASE

DRESDEN UNIT 2

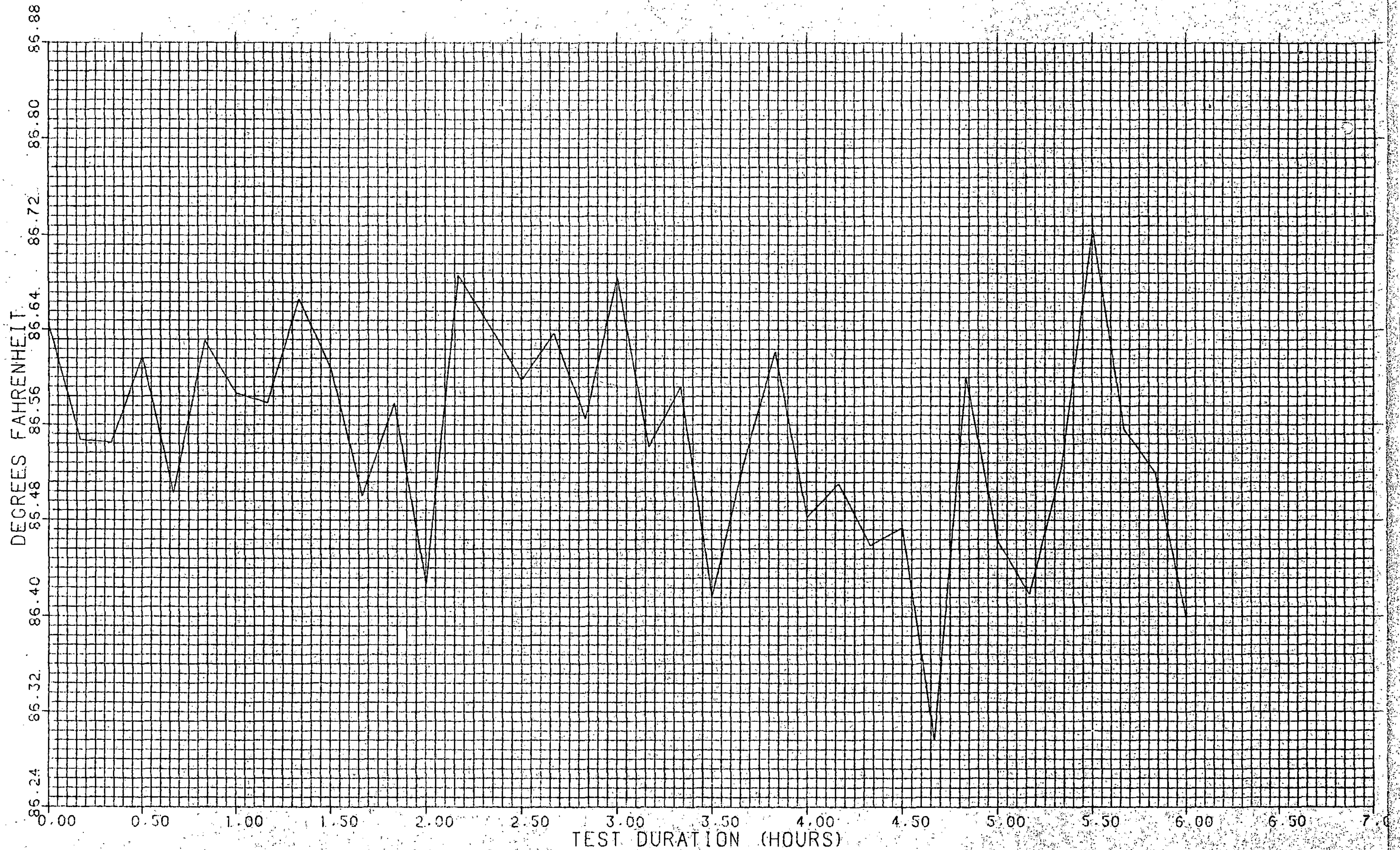
CONTAINMENT VAPOR PRESSURE VS TIME



INDUCED PHASE

DRESDEN - UNIT 2

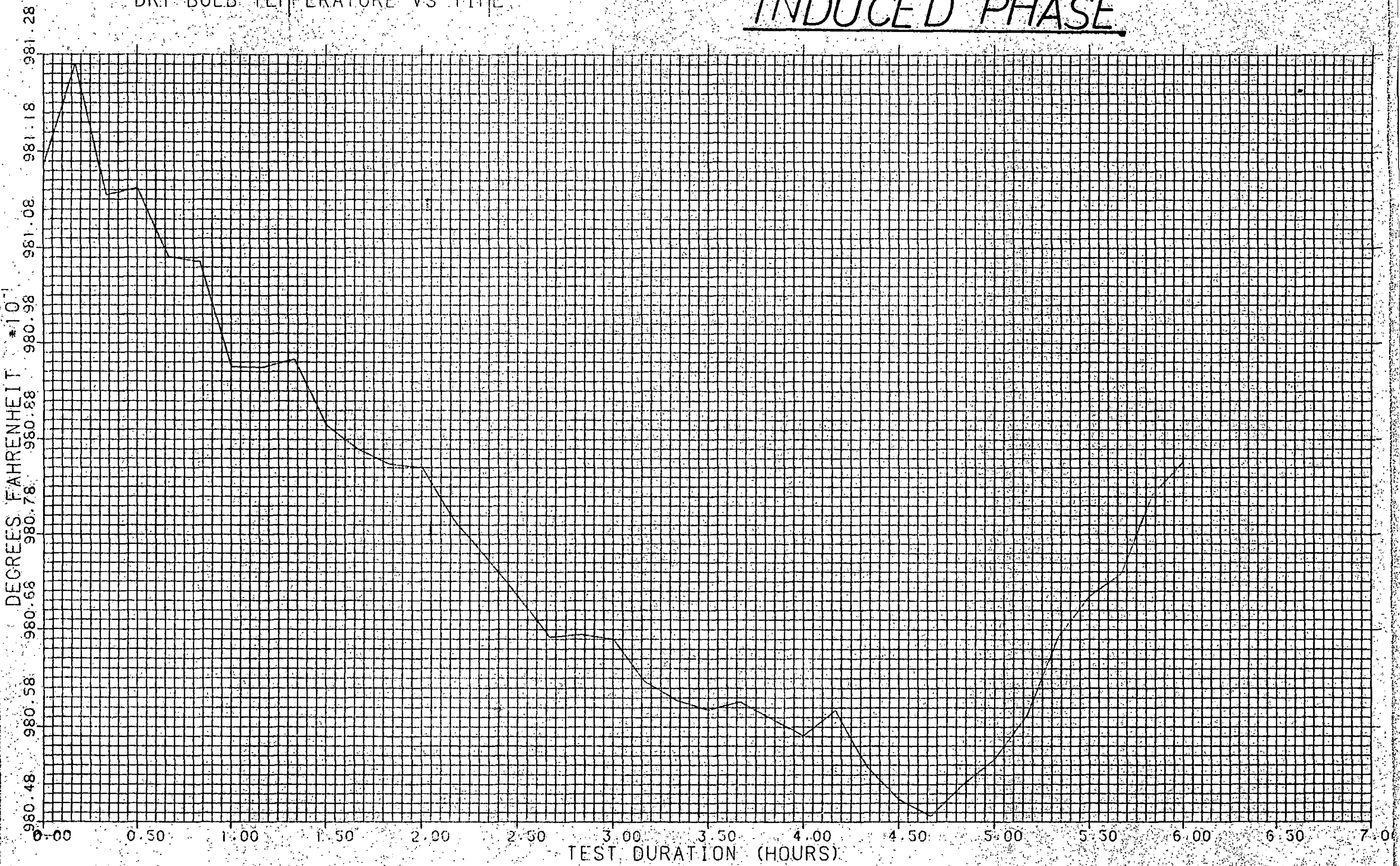
DEW POINT TEMPERATURE VS TIME



DRESDEN UNIT 2

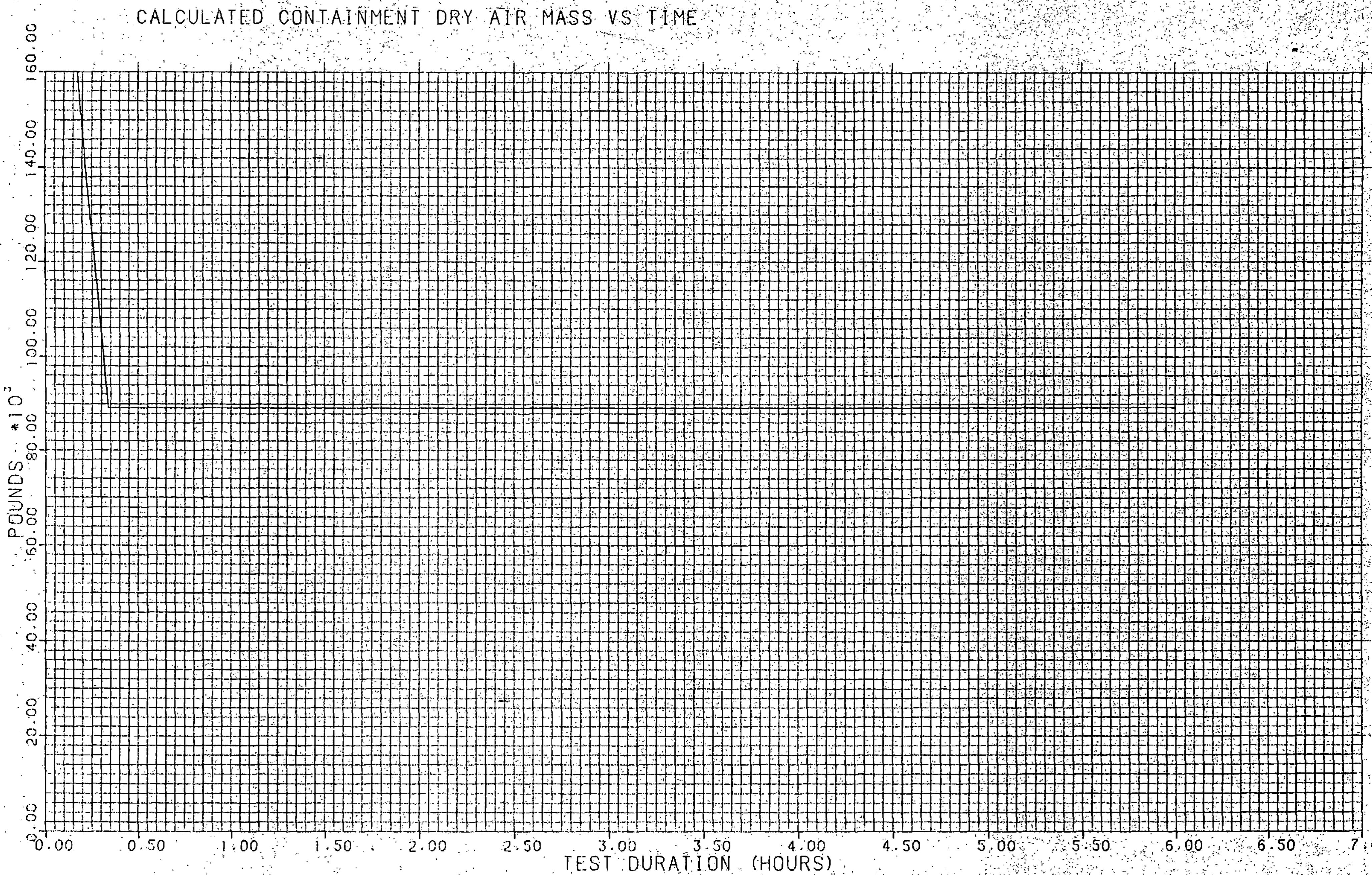
DRY-BULB TEMPERATURE VS TIME

INDUCED PHASE



INDUCED PHASE

DRESDEN UNIT 2



APPENDIX C

TYPE "B" AND "C" TEST RESULTS
UNIT 2 1983 REFUELING OUTAGE

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: MAIN STEAM ISOLATION VALVES
TESTED AT 25 PSIG

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
1	X-105A	203-1A* & 203-2A					
2	X-105A	203-1A & 203-2A	2.71	1.347	.674	2.763	1.382
3	X-105B	203-1B* & 203-2B					
4	X-105B	203-1B & 203-2B	.698	42.760	21.38	4.304	2.152
5	X-105C	203-1C* & 203-2C					
6	X-105C	203-1C & 203-2C	4.77	2.613	1.307	9.820	4.91
7	X-105D	203-1D* & 203-2D					
8	X-105D	203-1D & 203-2D	6.64	1.330	.665	8.315	4.158
		TOTAL THRU LEAKAGE FOR PAGE			24.026		12.602

*Indicates waterhead present on one side of valve.

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: ISOLATION VALVES

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
9	X-147	205-2-4 & Blind Flange	.721	52.891	45.485	1.493	3.897
10	X-147	205-2-7 & Blind Flange	0	38.078	--	4.808	--
11	X-106	220-1 & 220-2	0	.087	.044	.087	.044
12	X-122	220-44 & 220-45	.027	0	0	0	0
13	X-107A	220-57A* & 220-58A	--	129.747	64.874	6.911	3.456
14	X-107A	220-57A* & 220-62A	0	0	--	0	--
15	X-107B	220-57B* & 220-58B	0	**	**	1.604	3.005
16	X-107B	220-57B* & 220-62B	3.671	4.406	4.406	4.406	--
17	X-109B	301-95 & 301-99*	4.464	0	1.154	0	1.154
18	X-109B	301-98 & 301-99*	0	2.307	--	2.307	--
19	X-111A, 111B	1001-A*, 1B*, 2A, 2B & 2C*	5.658	28.305	14.153	28.305	14.153
20	X-138	1101-1* & 1101-15	--	.804	1.064	.804	1.064
21	X-138	1101-1* & 1101-16	1.395	1.323	--	1.323	--
22	X-113	1201-1, 2 & 3	2.449	7.271	3.636	12.519	6.260
23	X-108A	1301-1 & 1301-2	0	0	0	0	0
24	X-109A	1301-3 & 1301-4*	0	0	0	0	0
25	X-108A, 109A	1301-17 & 1301-20	1.994	0	0	0	0
26	X-310A	1402-4A, 8A*, 25A & 36A*	0	2.049	1.025	1.046	.523
27	X-149A	1402-24A & 1402-25A	0	2.100	1.05	2.100	1.05
28	X-310B	1402-4B, 8B*, 25B & 36B*	0	1.867	.934	1.867	.934
29	X-149B	1402-24B & 1402-25B	.27	.519	.260	.519	.260
		TOTAL THRU LEAKAGE FOR PAGE			138.047		35.800

* Indicates waterhead present on one side of valve.

** Indicates volume could not be pressurized.

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: ISOLATION VALVES

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
30	X-311A	1501-18A & 1501-19A	.490	10.633	5.317	10.633	5.317
31	X-311B	1501-18B & 1501-19B	.047	4.772	2.386	4.772	2.386
32	X-310A	1501-20A & 1501-38A	0	0	0	0	0
33	X-310B	1501-20B & 1501-38B	.769	1.502	.751	1.502	.751
34	X-116A	1501-22A, 26A* & 1001-5A	0	0	.243	0	.243
35	X-116A	1501-25A & 1501-26A*	0	.486	--	.486	--
36	X-116B	1501-22B, 26B* & 1101-5B	0	2.854	1.427	2.854	1.427
37	X-116B	1501-25B & 1501-26B*	0	0	--	0	--
38	X-145	1501-27A & 1501-28A	0	.310	.155	.310	.155
39	X-150A	1501-27B & 1501-28B	0	.544	.272	.544	.272
40	X-304	1601-20B & 1601-31B	.458	14.535	7.268	14.535	7.268
41	X-304	1601-20A & 1601-31A	.254	1.587	.794	1.587	.794
42	X-126, 304	1601-21, 22, 55 & 56	7.337	4.806	2.403	4.806	2.403
43	X-125, 318	1601-23, 24, 60, 61, 62 & 63	5.864	9974.59	4987.295	2.849	1.425
44	X-126, 304	1601-57, 58 & 59	0	.240	.12	.240	.12
45	X-118	2001-5 & 2001-6	.712	7.480	3.740	11.704	5.852
46	X-117	2001-105 & 2001-106	.208	.219	.110	0	0
47	X-128	2301-4 & 2301-5	1.213	0	0	0	0
48	X-312	2301-34 & 2301-71	0	9.168	4.584	9.168	4.584
49	--	2301-35 & 230-36	0	3.939	1.970	3.939	1.970
50	X-317	2301-45 & 2301-74	10.185	0	0	0	0
		TOTAL THRU LEAKAGE FOR PAGE			5018.835		34.967

* Indicates waterhead present on one side of valve.

**Indicates volume coult not be pressurized.

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: ISOLATION VALVES

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
51	X-202V	2499-1A & 2499-2A	.235	.163	.082	.163	.082
52	X-204B	2499-1B & 2499-2B	2.273	.666	.333	.666	.333
53	X-316A	2499-3A & 2499-4A	0	0	0	0	0
54	X-316B	2499-3B & 2499-4B	0	0	0	0	0
55	X-202V	2599-2A & 2599-23A	.01	1.236	.618	1.236	.618
56	X-204B	2599-2B & 2599-23B	4.809	1.366	.683	1.366	.683
57	X-316A	2599-3A & 2599-24A	0	0	0	0	0
58	X-316B	2599-3B & 2599-24B	0	.345	.173	.345	.173
59	X-125, 318	2599-4A & 2599-5A	0	1.749	.875	1.749	.875
60	X-125, 318	2599-4B & 2599-5B	0	.539	.270	.539	.270
61	X-139D	4720 & 4721	.018	0	0	0	0
62	X-121	4722 & Check Valve	0	0	0	0	0
63	X-309A	8501-1A & End of Line	--	.081	11.403	.081	11.403
64	X-309A	8501-1B & End of Line	0	22.725	--	22.725	--
65	X-204	8501-3A & 8501-3B	.206	2.692	1.346	2.692	1.346
66	X-143	8501-5A & End of Line	--	0	.065	0	.065
67	X-143	8501-5B & End of Line	0	.130	--	.130	--
68	X-143	9205A & End of Line	--	0	0	0	0
69	X-143	9205B & End of Line	0	0	--	0	--
70	X-143	9206A & End of Line	0	.912	.931	.912	.931
71	X-143	9206B & End of Line	0	.949	--	.949	--
		TOTAL THRU LEAKAGE FOR PAGE			16.779		16.779

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: ISOLATION VALVES

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
72	X-101	9207A & End of Line	--	1.160	.830	1.160	.830
73	X-101	9207B & End of Line	.452	.500	--	.500	--
74	X-101	9208A & End of Line	2.103	1.584	1.646	1.584	1.646
75	X-101	9208B & End of Line	--	1.708	--	1.708	--
76	X-136E	TIP Purge Check Valve	.133	.298	.149	.298	.149
77	X-136C	TIP Ball Valve A	3.008	2.83	1.415	2.83	1.415
78	X-136B	TIP Ball Valve B	.770	.894	.447	.894	.447
79	X-136D	TIP Ball Valve C	2.815	.478	.239	.905	.453
80	X-136F	TIP Ball Valve D	1.78	2.68	1.34	2.68	1.34
81	X-136E	TIP Ball Valve E	.529	2.57	1.285	2.57	1.285
82	X-313A	East Torus Drain Valves	0	0	0	0	0
83	X-313B	West Torus Drain Valves	0	37.952	18.976	.938	.469
84	X-101	Personnel Air Lock	0	0	0	0	0
		TOTAL THRU LEAKAGE FOR PAGE			26.327		8.034

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: ELECTRICAL

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
85	X-200A	CRD Indication	0	4.7	2.35	4.7	2.35
86	X-200B	LV Power & Control	1.951	0	0	0	0
87	X-202B	HV Power	.327	0	0	0	0
88	X-202BB	CRD Indicators	3.62	15.0	7.5	15.0	7.5
89	X-202D	HV Power	.50	0	0	0	0
90	X-202F	Thermocouples	.667	0	0	0	0
91	X-202J	Neutron Monitor	.333	0	0	0	0
92	X-202N	Neutron Monitor	.165	0	0	0	0
93	X-202O	LV Power & Control	.167	.7	.35	.7	.35
94	X-202S	CRD Indicators	1.834	3.9	1.95	3.9	1.95
95	X-202W	CRD Indicators	7.635	22.0	11.0	22.0	11.0
96	X-202X	Core Vibration Measurement	.01	0	0	0	0
97	X-203A	CRD Indicators	5.122	5.0	2.5	5.0	2.5
98	X-203B	LV Power & Control	.67	0	0	0	0
99	X-204E	Neutron Monitor	.168	4.6	2.3	4.6	2.3
100	X-204H	Neutron Monitor	.499	.5	.25	.5	.25
101	X-204P	HV Power	0	0	0	0	0
102	X-204Q	HV Power	0	.5	.25	.5	.25
103	X-204S	LV Power & Control	0	1.0	.50	1.0	.50
104	X-204T	CRD Indicators	.337	1.1	.55	1.1	.55
105	X-205E	LV Power & Control	.834	0	0	0	0
106	X-316A	ACAD/CAM	--	.75	.375	.75	.375
107	X-316B	ACAD/CAM	--	0	0	0	0
		TOTAL THRU LEAKAGE FOR PAGE			29.875		29.875

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: DRYWELL BELLOWS SEALS

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
108	X-109B	Iso. Cond. Condensate Return	--	.346	.173	.346	.173
109	X-149A	Core Spray	--	3.974	1.987	3.974	1.987
110	X-149B	Core Spray	2.23	.389	.195	.389	.195
111	X-144	CRD Return	--	.475	.238	.475	.238
112	X-105A	Main Steam Line	--	.354	.177	.354	.177
113	X-105B	Main Steam Line	--	--	--	--	--
114	X-105C	Main Steam Line	--	--	--	--	--
115	X-105D	Main Steam Line	--	--	--	--	--
116	X-106	Main Steam Drain	--	--	--	--	--
117	X-107A	Feedwater	--	--	--	--	--
118	X-107B	Feedwater	--	--	--	--	--
119	X-111A	Shutdown Cooling	1.62	--	--	--	--
120	X-111B	Shutdown Cooling	--	--	--	--	--
121	X-115A	HPCI Steam Line	--	--	--	--	--
122	X-116A	LPCI Injection	--	--	--	--	--
123	X-116B	LPCI Injection	--	--	--	--	--
124	X-123	RBCCW Inlet	--	--	--	--	--
125	X-124	RBCCW Outlet	--	--	--	--	--
126	X-126	Vent to Drywell	--	0	0	0	0
		TOTAL THRU LEAKAGE FOR PAGE			2.77		2.77

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: DRYWELL BELLOWS SEALS

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
127	X-108A	Iso. Cond. Steam Line	--	.173	.087	.173	.087
128	X-113	Cleanup	--	0	0	0	0
129	X-125	Vent from Drywell	0	--	--	--	--
130	X-130	Standby Liquid Control	--	0	0	0	0
131	X-147	Reactor Head Spray	--	0	0	0	0
		TOTAL THRU LEAKAGE FOR PAGE			.087		.087

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: DOUBLE GASKETED SEALS

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
132	X-100	Drywell Equipment Hatch	0	0	0	0	0
133	X-102	CRD Hatch	0	0	0	0	0
134	X-135E	Spare	0	.085	.043	.085	.043
135	X-136A	TIP Monitor Flange (Spare)	0	0	0	0	0
136	X-136B	TIP Monitor Flange	0	0	0	0	0
137	X-136C	TIP Monitor Flange	0	0	0	0	0
138	X-136D	TIP Monitor Flange	0	0	0	0	0
139	X-136E	TIP Monitor Flange	0	0	0	0	0
140	X-136F	TIP Monitor Flange	0	0	0	0	0
141	X-136G	TIP Monitor Flange	0	0	0	0	0
142	X-136H	TIP Monitor Flange	0	0	0	0	0
143	X-136J	TIP Monitor Flange	0	0	0	0	0
144	X-137	Drywell Head Manhole	0	0	0	0	0
145	N/A	Drywell Head Flange	0	0	0	0	0
146	X-301A	Torus Vacuum Breaker 1601-32A	.156	.070	.035	.036	.018
147	X-301A	Torus Vacuum Breaker 1601-32B	.046	3.584	1.792	.131	.066
148	X-301B	Torus Vacuum Breaker 1601-32C	.100	.036	.018	0	0
149	X-301B	Torus Vacuum Breaker 1601-32D	.055	0	0	0	0
150	X-301C	Torus Vacuum Breaker 1601-32E	.064	.071	.036	.108	.054
151	X-301C	Torus Vacuum Breaker 1601-32F	.056	.645	.323	1.172	.586
		TOTAL THRU LEAKAGE FOR PAGE			2.247		.767

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: DOUBLE GASKETED SEALS

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	1981 FINAL THRU LEAKAGE SCFH	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
152	X-301F	Torus Vacuum Breaker 1601-33A	.045	5.380	2.690	.036	.018
153	X-301F	Torus Vacuum Breaker 1601-33B	.073	.142	.071	.086	.043
154	X-301E	Torus Vacuum Breaker 1601-33C	.074	3.637	1.819	0	0
155	X-301E	Torus Vacuum Breaker 1601-33D	.063	3.650	1.825	0	0
156	X-301D	Torus Vacuum Breaker 1601-33E	.064	.089	.045	.017	.009
157	X-301D	Torus Vacuum Breaker 1601-33F	.054	1.817	.909	0	0
158	X-306A	East Torus Access Hatch	0	0	0	0	0
159	X-306B	West Torus Access Hatch	0	1.663	.832	0	0
160	X-313A	East Torus Drain	0	0	0	.097	.049
161	X-313B	West Torus Drain	0	0	0	0	0
162		Shear Lug Hatch	0	.222	.111	.222	.111
163		Shear Lug Hatch	0	1.454	.727	1.454	.727
164		Shear Lug Hatch	0	.017	.009	.017	.009
165		Shear Lug Hatch	0	.017	.019	.017	.019
166		Shear Lug Hatch	0	.034	.017	.034	.017
167		Shear Lug Hatch	0	0	0	0	0
168		Shear Lug Hatch	0	.017	.019	.017	.019
169		Shear Lug Hatch	0	.035	.018	.035	.018
		TOTAL THRU LEAKAGE FOR PAGE			9.111		1.039

LOCAL LEAK RATE TESTS PERFORMED DURING THE UNIT 2 REFUELING OUTAGE OF 1983

TYPE OF PENETRATION: MISCELLANEOUS TEST & AUGMENTED TESTS

TEST NUMBER	PENETRATION NUMBER	VOLUME BEING TESTED	INITIAL LEAK RATE SCFH	INITIAL THRU LEAKAGE SCFH	FINAL LEAK RATE SCFH	FINAL THRU LEAKAGE SCFH
		CCSW Vault Door	.023 gal/hr	--	--	--
		CCSW3-1510-16"D	Passed	--	--	--
		CCSW-3-1514-16"D	Passed	--	--	--
	CCSW	CCSW3-1510A-10"D	Passed	--	--	--
	Wall	CCSW3-1505B-12"D	Passed	--	--	--
	Penetrations	CCSW3-1512C-12"D	Passed	--	--	--
		Power Supply to CCSW Pump "B:	Passed	--	--	--
		Power Supply to Unit 2 CCSW Pump "C"	Passed	--	--	--
		Hypochlorite 3-4505-3"AS	Passed	--	--	--
		Hypochlorite 3-4506-3"AS	Passed			
		Service Water to Hypochlorite 3-3935-2"	Passed	--	--	--
		Target-Rock Pneumatic System	1.2 psig/hr		--	--