D.C. COOK PLANT
UNIT NO. 2
REACTOR BUILDING CONTAINMENT INTEGRATED LEAK RATE TEST
APRIL 30 - MAY 4, 1981

INDIANA & MICHIGAN ELECTRIC COMPANY

432

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TABLE OF CONTENTS

Section		Page
1.0	Introduction	1
2.0	ILRT Acceptance Criteria	1
3.0	ILRT Results	2
4.0	Conduct of Test	5
	4.1 Organization of Test	5
	4.2 Log of Time and Events	8
5.0	Test Instrumentation and Equipment	10
	5.1 Table of Instruments	10
	5.2 Instrument Specifications	11
	5.3 Sensor Locations	12
	5.4 Instrument Error Analysis	12
	5.5 Pressurization Apparatus	14
6.0	Containment Model and Leak Rate Calculations	14
	6.1 Volume Weighing Factors	15
	6.2 Containment Pressure and Vapor Pressure	17
	6.3 Containment Temperatures	17
	6.4 Statistical Determination of the Leak Rate	18
	6.5 Upper Confidence Limit	19
	6.6 Leak Rate Computer Program, 'ILRTEST'	22
7.0	'ILRT' Program Printout	24

Table of Contents Continued . . .

Section		Page
8.0	Data Analysis and Summaries	32
	8.1 Graphical Analysis	32
	8.2 Program Summaries	35
9.0	Local Leak Test Program	44
	9.1 Past Test Results Summary	44
	9.2 May 1981 Local Leak Test Results	53
10.0	References	59

1.0 Introduction

The first periodic Integrated Leak Rate Test (ILRT) for the Donald C. Cook Nuclear Plant - Unit 2 reactor containment was successfully completed on May 4, 1981 by personnel of Indiana & Michigan Electric Company (I&M).

The ILRT was performed as specified in surveillance test procedure 12 THP 4030 STP.202, Rev. 3 and in compliance with American National Standard - ANSI N45.4 - 1972, 'Leakage Rate Testing of Containment Structures for Nuclear Reactors' and Code of Federal Regulations 10 CFR 50 Appendix J - 'Primary Reactor Containment Leakage Testing for Water Cooled Power Reactors'. The absolute test method was used on the 3 compartment containment model developed for both the Unit 1 and Unit 2 Preoperational Integrated Leak Rate Tests.

Data was collected at half hour intervals over a 24 hour test period. This data was used to calculate the normalized weight of the initial dry air mass remaining in the containment at each half hour interval. The measured Type A leakage rate, Lam, is the slope of a straight line determined for a linear least-squares fit of the calculated normalized weight vs. time.

2.0 ILRT Acceptance Criteria

The Unit 2 Technical Specifications and Section 5 of the Final Safety Analysis Report (FSAR) define the containment allowable leakage, La, as 0.25 percent by weight of the containment air per 24 hours at a pressure, Pa, of 12.0 psig. The measured leakage rate, Lam, must be demonstrated to be less than 0.75 La, (0.1875% wt/day) as required by 10 CFR 50 Appendix J. In addition, the accuracy of the leakage measurement must be verified by performing a supplemental test, the results of which are acceptable provided the difference between the supplemental test results and the Type A results is within 0.25 La (0.0625% wt/day).

As specified in Section 5.0 of D. C. Cook Plant Surveillance Test Procedure 12 THP 4030 STP.202 and in accordance with 10 CFR 50 Appendix J Section III-A, 'Leakage Test Requirements, Type A Tests', the test was considered acceptable when the following criteria had been met:

2.1 The leak rate, as determined by the 95% upper confidence limit of the least squares line, Lam/95% has converged to an acceptable level:

Lam/95% (0.75 La - Type C Leakage Penalty)

2.2 The duration of the ILRT has exceeded the minimum of 12 hours and the difference between the 95% upper confidence leakage limit and the leakage rate itself does not exceed 0.0625% wt/day in the most recent data set.

2.3 The upper confidence level leakage and the measured leakage do not show a negative trend over the last four data runs.

The Supplemental Test was considered acceptable when the following criteria were met:

2.4 The duration of the Supplemental Test meets or exceeds the minimum of 6 hours.

2.5 The sum of the imposed leak, L_o, and the leakage measured during the Type A test, L_{am}, is within $\pm$ 0.25 L_a of the composite leakage, L_c, measured in the supplemental test.

$$(L_o + L_{am} - 0.25\ L_a) < L_c < (L_o + L_{am} + 0.25\ L_a)$$

The criteria used for this Integrated Leak Rate Test is more stringent than that specified in 10 CFR 50 Appendix J. These criteria incorporate additional test commitments made by D. C. Cook to the Nuclear Regulatory Commission. These additional commitments are embodied in a response to Question 22.14 of Appendix Q of the D. C. Cook Nuclear Plant Unit 2 FSAR.

3.0 ILRT Results

3.1 Leakage Rate Summary:

Duration of Type A Test: 24 hours

Duration of Supplemental Test: 6 hours

	Measured Leakage* (% wt/24 hours)	Allowable Leakage* (% wt/24 hours
A. ILRT 'Type A' Leak Rate, L_{am}	-0.05287	-0.1875**
B. ILRT 'Type A' 95% Upper Confidence Limit Leak Rate, $L_{am}/95\%$	-0.05748	0.75 L_a - Type C Leakage Penalty ++ = -0.1875 - (-0.015975) = -0.17153
C. Type C Leakage Penalty	-0.015975	N/A
D. Imposed Leak Rate, L_o	-0.2006	$0.5\ L_a < L_o < L_a$ + $-0.125 < L_o < -0.25$
E. Supplemental Test Composite Leakage, L_c	-0.24631	N/A
F. Supplemental Test Correlation	$L_{am} - (L_c - L_o)$ 0.00716	$L_{am} - (L_c - L_o) < .25\ L_a$ ** $L_{am} - (L_c - L_o) < .0625$

[illegible]

* The slope of the linear regression line computed for weight remaining in the containment as a function of time is negative since weight remaining in the containment decreases as a function of time. Hence leakage <u>out</u> of the containment is shown as negative in the table.

** 10 CFR 50 Appendix J criterion

++ Test criterion specified by plant procedure 12 THP 4030 STP.202

\+ Guideline proposed by ANS 274 Draft No. 1.

<u>Item A</u>, L_{am}, is the measured containment leakage after 24 hours of taking data in one-half hour intervals. It was calculated using the 'Absolute Method' on a 'total time' basis as described in American National Standard N45.4 - 1972.

<u>Item B</u>, L_{am}/95%, is the 95% upper confidence limit of the leak rate. It is calculated from the variance of the slope of the least-squares line and the value of the t-distribution for a 95% confidence that L_{am}/95% is the upper limit of the actual leak rate.

<u>Item C</u>, The type C penalty leakage is calculatd from the local leakage test program conducted per plant procedure 12 THP 4030 STP.203, 'Type B and C Leak Rate Test'. The Type C penalty leakage represents the leakage of systems penetrating the containment pressure boundary that is required to be drained and vented for the Type A test, that due to existing piping, configurations or plant conditions could not be drained or vented. The leakage of isolation valves associated with these systems appears in Table 3.2. The total on Table 3.2, expressed in weight percent per day, is subtracted from the allowable leakage specified for Item B in Section 3.1.

The use of the Type C penalty in lieu of draining the affected system was part of commitments made to the NRC and appears formally in Appendix Q, Question 22.14 of the Unit 2 FSAR.

<u>Item D</u>, L_o, is the imposed leak used in the supplemental test to verify the accuracy of the Type A test. In accordance with guidelines of ANS 274 Draft No. 1 and the Unit 2 Technical Specifications the rate of the air bleed, in weight %/day, was established at .2006 wt %/day.

Table 3.2

Type C Penalty Leakage For
Undrain Systems

Description	CPN#	Isolation Valves	Leakage (SCCM)
RCDT to RCDT pps	40	DCR-205 DCR-206	0
RC System accumulator fill lines	68	ICM-256	49.6
Refueling water line to Refueling Cavity	36	SF-151 SF-153	0 0
Cont. Sump Line to Waste Hold up Tanks	41	DCR-600 DCR-601	748.6
NESW to and from Containment	--	---	6061.4
RCP Seal Water Lines	11 12 13 14	CS-442-1 CS-442-2 CS-442-3 CS-442-4	76.2
CVCS Letdown and Excess Letdown Lines	34 37	QCR-300 QCM-250 & -350	50.0
Sample Lines from Accumulators	81	ICR-5 ICR-6	0
Sample Lines from Pressurizer	66	NCR-109 & 110 NCR-107 & 108	0
CVCS Charging Line	35	CS-321	60.6
Glycol Lines to and From Ice Condenser AHU's	86	VCR-10 & 11 VCR-201	0

Total Type C Leakage
Penalty (SCCM) = 7046.4
Expressed in % La = 6.39
Expressed in % wt/day = .015975

Item E, the composite leakage, L_c, is the slope of the least squares line determined from the data taken during the supplemental test. Ideally, L_c would be equal to the sum of L_{am} and L_o.

Item F, Supplemental Test Correlation. 10 CFR 50 Appendix J requires that the agreement between L_c and (L_{am} + L_o) is within .25 L_a. The table shows that the correlation between L_c and (L_{am} + L_o) is .00716 % wt/day or 0.03 L_a.

4.0 Conduct of Test

4.1 Organization of Test

The D. C. Cook Plant Performance Engineering Section was responsibile for the Integrated Leak Rate Test. Functions performed by persons involved in the test could be subdivided between pre-test and test activities. Figure 4.1.1 and 4.1.2 illustrate the organization of pre-test and test activities, respectively.

Pre-Test Responsibilities

Test Supervisor - Organized efforts required to ensure the readiness of Unit 2 Containment Systems and test instrumentation for the conduct of this test. This included arranging for instrument calibration, installation, and system channel verification, and completing test prerequisites.

Instrument Technicians - Performed installation and channel verification of test instrument system.

Containment Inspection Group - Organized and conducted an inspection of all accessible containment interior and exterior surfaces, penetrations and associated systems. Evaluated and reported inspection results and was responsible for initiating any corrective action required.

Local Leak Test Program Group - Performed Type B and C Leak Rate Test as per plant procedure 12 THP 4030 STP.203. Responsible for initiation corrective action as indicated by test results. Reported results to Test Supervisor.

Department Interfaces - Contacted as required to help safisfy test prerequisites.

Test Responsibilities

Test Supervisor - (1 per 12 hour shift) Responsible for maintenance of test documentation, data inspection, and the general conduct of the test.

Timekeeper/Data Coordinator - (1 per 12 hour shift) Maintained control over data collection intervals and transferred data to the computer input format.

Data Dispatcher - (1 per 12 hour shift) Checked the transfer of data from data acquisition system tapes and data takers' sheets to the computer input format. Shuttled coding forms from test area to computer terminal, loaded punched cards into card reader, and checked transfer of data from coding forms to computer printout.

Data Takers - (3 per 12 hour shift) Responsible for the recording of specific test instrument readings.

Keypunch Operator - (1 per 8 hour shift) Responsible for punching data onto cards from coding sheet. Assisted data dispatcher in checking transfer of data from coding forms to computer printout.

FIGURE 4.1.1 - PRE-TEST ORGANIZATION

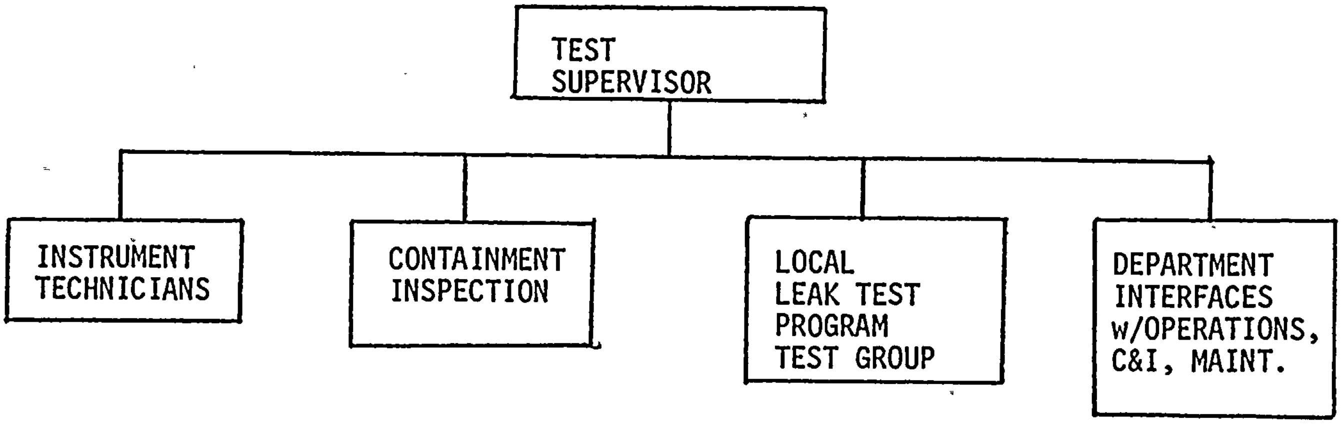
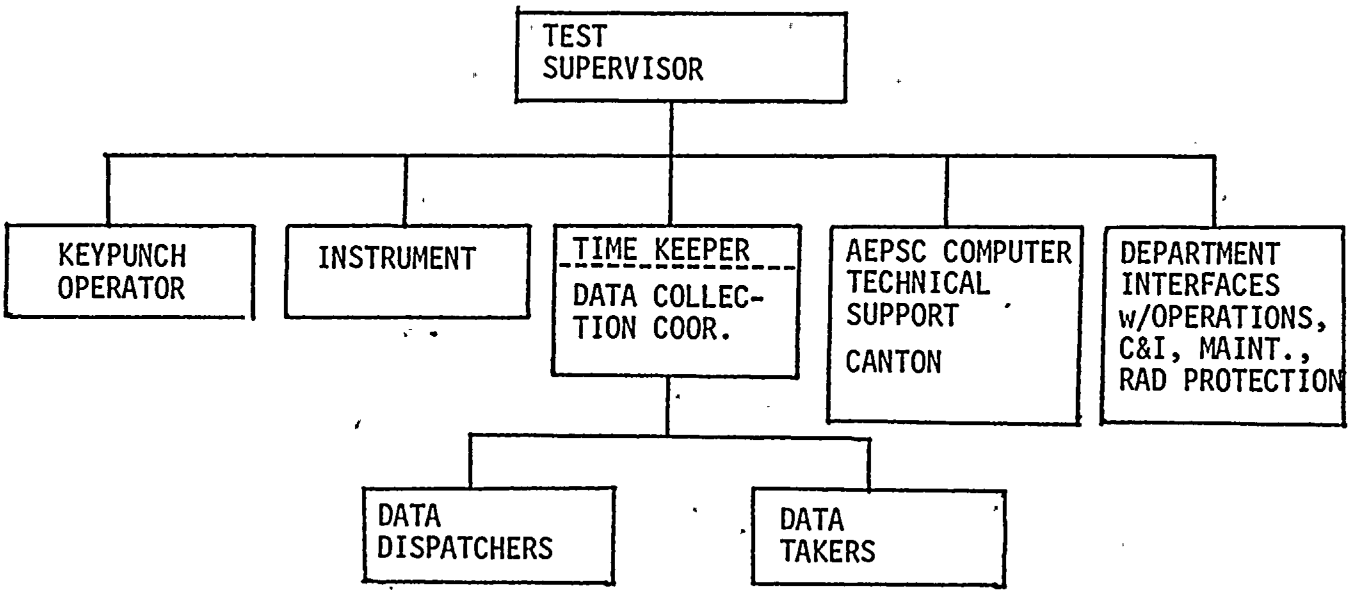


FIGURE 4.1.2 - TEST ORGANIZATION



AEPSC Computer Technical Support - Canton - On call in case of a failure of either the data analyais program or the computer system.

Instrument Technicians - (2 per 12 hour shift) Responsible for maintaining all test instrumentation in a proper operating condition.

Department Interfaces - Contacted as required to complete test requirements.

4.2 Log of Times and Events

Having satisfactorily completed the installation and checkout of all test instrumentation, a successful containment inspection, the valve line-up, initial conditions, and all other test pre-requisites, pressurization of the containment was initiated.

Pressurization of the Unit 2 reactor containment began at 0530 hours on May 1, 1981. Containment temperatures, pressures, and vapor pressures, and ambient temperature and barometric pressure were logged on an hourly basis. Each data set collected were assigned a 'Run Number' starting with Run #1 at 0600 hours.

At 0130 on May 2, 1981 pressurization was terminated at a pressure of 12.4932 PSIG (Run 25 P). During the pressurization period two separate entries were made into the containment instrument room to work on dew point hygrometers. Rewiring of the hygrometer readouts corrected the hygrometer problems on all hygrometers except VPL-2. It was decided just prior to the end of the pressurization period to run the test without this redundant hygrometer. Throughout the remainder of the test VPL-1 was used alone for lower volume dew point.

The stabilization period was initiated at 0200 on May 2. After the minimum period of 4 hours, containment temperatures were monitored closely to determine when the stabilization criteria had been met. Stabilization criteria defined by procedure 12 THP 4030 STP.202 are:

a. The duration of the stabilization period has exceeded the minimum 4 hours.

b. The containment has been maintained at a pressure of 12.0 (+ 0.5, - 0.0) psig for a minimum of 2 hours.

c. The weighed average temperature in the Upper, Lower, and Ice Condenser compartments has not varied more than 0.1 °F/hr over the last four (4) hour period.

d. No single Upper, Lower or Ice Condenser compartment temperature reading has changed more than 0.5°F during the last hour of the stabilization period.

At approximately 0300 it was discovered that a heater was energized on HV-CUV-2 which was running. This heater was secured and all ventilating units in the containment were started to try to circulate air to improve the temperature distribution. Most of the fans tripped off due to thermal overload after about one hour and were left off. All fans were secured at about 0530.

After 15 hours all of the stabilization criteria were met and the stabilization period was declared over at 1700 on May 2, 1981 (Run 31S).

The 'Type A' test was begun at 1730 on May 2, 1981 with a containment pressure of 12.3799 psig. Preliminary leakage calculations performed for the stabilization period had indicated that the 'Type A' test criterion had already been satisfied. It was now just a matter of continuing the half-hour data collection intervals until the minimum 24 hour time requirement and other self imposed criteria had been met. After 24 hours of data collection the 'Type A' test was declared successfully complete. (Run 49T).

After Radiation Protection drew a sample of the containment air for analysis, air was bled from the containment through a calibrated rotameter. This leak rate was established at 3.1 scfm (.2006 wt %/day) which is in accordance with the Unit 2 Technical Specifications (quantity greater than 25% of total measured leakage at Pa) and the guidelines of ANS 274 Draft 1 ($.5\ L_a < L_o < L_a$). At the completion of the minimum 6 hours of data collection the supplemental test and the ILRT was declared successfully complete. The supplemental test showed a correlation between the measured leak and the imposed leak of $.03\ L_a$, well within the requirement of less than $.25\ L_a$. The containment was subsequently depressurized and systems were restored to normal as required by plant operations.

5.0 Test Instrumentation & Equipment

Table 5.1 Test Instrumentation

Item	Manufacturer	Type	Model	Range	Accuracy	Test ID
Pressure Measurement	Mensor	Quartz	QM10100-001	0-100 psig 0-75 psia*	± 0.015 reading .0001 psi resolution	PU-1, PL-1, PL-2 PI-1, PI-2 PU-2*
	Texas Instr.	Manometer	145	0-50 psia	±.03% reading .0001 psi resolution	Patm
Temperature Sensors/ Bridge	Hycal Engineering	100Ω Platinum RTD's/Matched Modular Linearizing Bridges	RTS-4233-B ESD-9050-A	Upper Cont., Ice Cond. (0-100°F) Lower Cont. (0-120°F)	±0.06°F	ETR-101 thru ETR-146, Ambient
Dew Point Temperature	EG&G	Mirror Surface	992 (B) 660 (4)	0-100°F -50 to +100°C	±0.5°F ±0.3°C	VPL-1, VPL-2 VPI-1, VPI-2, VPU-1, VPU-2
Temperature Recorder	Fluke	Data Logger	2240B	0 - 40 mV 0 - 4 v	±0.01% reading ±0.005% span	ETR's Dew Points
Supplemental Test Flowmeter	Brooks	Rotameter	1110-08	0.2 to 5.6 SCFM	± 1% FS	N/A
Supplemental Test Pressure Gage	Heise	Bourdon Tube	CCM	0 - 3 psig	0.1% FS	N/A

* 0 - 75 psia Quartz manometer used at test connection PU-2.

5.2 Instrument Specifications

The instrumentation used during the ILRT is shown in Table 5.1. Each of the instruments shown here was supplied with calibration performed within 6 months of the test and traceable to the National Bureau of Standards. Calibration conversion formulas and corrections were preprogrammed into the ILRT computer program to allow direct input of all pressure, temperature and dew point instrument readings.

Two precision Mensor Quartz manometers were used for redundant measurement of the pressure in each of the upper, lower, and ice condenser compartments of the containment. A seventh was used to monitor atmospheric pressure during the test.

The three containment compartments were instrumented with a total of forty-six (46) 100 platinum RTD sensors. The upper, lower, and ice condenser compartments contained 16, 23 and 7 sensors respectively. Each sensor is located to represent the temperature of a unique sub-volume within its compartment. The sub-volumes collectively represent the total volume of their respective compartment. Each RTD reading is converted in the leak rate computer program to temperature in degrees Fahrenheit. Each temperature is weighed by the fraction of the total compartment volume contained in the sub-volume the RTD represents. The sum of the weighed temperatures in each compartment is the weighed average temperature of that compartment.

Six Cambridge Dew Point Hygrometers were used for monitoring compartment dew point temperatures for the determination of vapor pressure in the leak rate computer program. They provided redundant measurement of dew point in each of the lower containment, upper containment and ice condenser.

The Unit 1 and Unit 2 preoperational tests used only 4 hygrometers, 2 in the lower volume and one in both the upper and ice condenser volumes. For this test, two hygrometers were added for the upper and ice condenser volumes. The original 4 hygrometers are the Model #992 dew point hygrometers used in the Unit 1 and Unit 2 preoperational tests. The new Model #660 hygrometers are improved and more compact than the Model #992. They all operate on the same principle. The air sample is drawn through instrument lines across a mirrored surface of which the temperature is controlled by an optical feedback circuit to precisely the point at which a dew (or frost) appears. The mirror temperature is measured by a platinum RTD imbedded in the body of the mirror. The sensor and control units were located inside the lower containment volume so that the samples would be maintained at the containment pressure. The error associated with each individual dew point measurement is $\pm$ 0.5 F. The addition of redundant measurements did not significantly affect the error of the overall dew point temperature measurement system.

A Brooks rotameter was used in the supplemental test to measure and maintain a constant flow rate for the imposed leak. It was calibrated in the range of 0.6 to 6 scfm at 14.7 psia and 70 F with an accuracy of ± 1.0% of Full Scale. The actual inlet temperature and pressure for the supplemental test were 63.7 and 18.8 psia. The temperature was measured using ETR-133 which is in close proximity to the end of the rotameter inlet line inside the lower containment. Pressure was measured at the inlet to the rotameter itself using a 0-30 psia Heise gage. The temperature and pressure readings were used to correct the indicated rotameter readings to standard conditions using the following relationship:

$$W_{corr} = W_{ind} \times \sqrt{\frac{530}{460 + T_{ETR-133}}} \times \sqrt{\frac{P_{Gage} + P_{atm}}{14.7}}$$

Wcorr	=	Corrected rotameter flow in path
Wind	=	Indicated rotameter flow in cfm
$T_{ETR-133}$	=	Rotameter inlet temperature, °F
P_{atm}	=	Atmospheric pressure, psia

5.3 Sensor Locations

The locations of the sensors used for this test were identical to the locations originally specified for the Unit 1 and Unit 2 preoperational ILRT's, Figure 5.2.1 (MSK-78C) shows the location in section views of the containment.

5.4 Error Analysis

The inaccuracies associated with the use of the test instrumentation package used in the Unit 2 Preoperational ILRT in measurement of the containment leakage rate was determined to be ± 0.076 L_a. A copy of the analysis calculation is contained in the Unit 2 Preoperational Integrated Leak Rate Test Report. In terms of the impact on this error analysis only insignificant differences exist between the instrumentation package used in the Unit 2 Preoperational-ILRT and the package used in this test. The error analysis and the ± 0.076 L_a result obtained for the Unit 2 Preoperational ILRT is considered to be also representative of the modified instrumentation package used in this test.

5.5 Containment Pressurization Apparatus

As in the Unit 1 and Unit 2 Preoperational tests, the plant air system, in conjunction with test pressurization filters and driers, were used for pressurizing the containment. The air enters the containment at approximately ambient temperature and a dew point of approximately -20°F. The air enters the containment through a spare penetration in the upper volume. A valve is provided at the penetration outside the containment, where the air line can be isolated and closed with a blank flange.

6.0 Containment Model and Leak Rate Calculation

The containment leak are performed by the 'absolute' method on a 'total time' as described in ANS-N45.4-1972. The containment design pressure is 12.0 psig and allowable leakage (0.75 La) is 0.1875% wt/day. The containment model and leakage calculations used to perform this test are essentially the same as the ones used in the Unit 1 and Unit 2 preoperational tests.

A 3-compartment model is employed for the calculation of the containment leak rate. It was developed to accommodate the distinct and widely varied environmental conditions existing in each of the Upper, Lower and Ice Condenser Volumes. The normalized fraction of the initial containment dry air mass, W_n, is calculated on a compartmental basis by ratioing the sum of the product of each compartment's dry air density and compartment volume fractions as determined from data collected at time t_n, to the same value determined from the initial data collected at time t_o.

Expressed in equation form:

$$Wn = \frac{\frac{1}{R}\left[VWF_u\left(\frac{P_{un} - VP_{Un}}{T_{un}}\right) + VWF_L\left(\frac{P_{Ln} - VP_{Ln}}{T_{Ln}}\right) + VWF_I\left(\frac{P_{In} - VP_{In}}{T_{In}}\right)\right]}{\frac{1}{R}\left[VWF_U\left(\frac{P_{Uo} - VP_{Uo}}{T_{Uo}}\right) + VWF_L\left(\frac{P_{Lo} - VP_{Lo}}{T_{Lo}}\right) + VWF_I\left(\frac{P_{Io} - VP_{Io}}{T_{Io}}\right)\right]} \quad (6\text{-}1)$$

Where: W_n = normalized weight remaining in containment at time t_n (dimensionless)

R = gas constant for dry air = 53.34 $\frac{ft\text{-}lbs}{lbm\text{-}^\circ R}$ (The terms cancel)

VWF = Volume Weighing Factor (Each compartment volume is ratioed to the Lower Compartment Volume) (dimensionless)

P = Compartment Total Pressure (psia)

VP = Compartment Vapor Pressure (psi)

T = Compartment Weighed Average Temperature (degrees Rankine)

Subscripts:

U = Upper Compartment
L = Lower Compartment
I = Ice Condenser
o = Initial Time
n = time at nth data collection

6.1 Volume Weighing Factors

Table 6.1.1 shows the compartment free volume distribution for normal operation:

Table 6.1.1*

Containment Free Volume

Compartment	Free Volume (ft^3)
Upper	687,819
Lower	365,614
Ice Condenser	210,723
Total	1,264,156

The volume distribution existing at the time of the test may differ from the values indicated in Table 6.1.1 in two ways:

* Ref. AEPSC I&C Calculation 12-PI-05 'Volume Weighing Factors'

1. The total volume of the ice condenser in Table 6.1.1 does not include the volume of ice resident in the ice basket.

2. The location of the moveable sections of the reactor missile shield do not necessarily have to be in place during the test.

The ice condenser volume was adjusted for the presense of the volume of ice in the ice condenser as determined by the Ice Basket Weighing Program, performed per plant procedure 12 THP 4030 STP.211 between March 16 and April 8, 1981. The total ice weight was 2.637×10^6 pounds. The standard density of ice, 56 lbs/ft^3, is assumed to calculate the volume displaced, 47,095 ft^3. This reduces the net free volume in the Ice Condenser to 163,628 ft^3.

The location of the movable sections of the reactor missile shield affects the volume distribution between the upper and lower volumes. When the shield is removed from its normal operating position it provides open access to the control rod drives, and reactor head from the upper volume. The 16,147 ft^3 of free volume above the head normally isolated from the upper volume by the shields, is then in direct communications with the upper volume. When the shields are in place, the volume is vented only to the lower containment and is therefore considered part of the lower volume. Table 6.1 shows the volume distribution of the containment with a missile shield removed, which is the position the shields were in for the performance of this test. Had the shields been in place, 16,147 ft^3 would have been subtracted from the upper volume total and added to the lower volume.

The containment volumes used in the calculations of the leak rate in this test are shown in Table 6.1.2.

Table 6.1.2

Containment Volume Adjusted For Conditions Existing During Unit 2 ILRT

Compartment	Free Volume (ft^3)
Upper	703,966
Lower	349,467
Ice Condenser	163,628
Total	1,217,061

Volume weighing factors were determined from the values in Table 6.1.2. The volume weighing factors express compartment volumes in per-unit using the lower volume as 'base'. Table 6.1.3 shows the volume weighing factors used for the calculation of the leak rate in this test.

Table 6.1.3

Containment Volume Weighing Factors (derived from Table 6.1.2)

Compartment		Volume Weighing Factor
Upper	$\frac{V_u}{V_L}$	2.0144
Lower	$\frac{V_L}{V_L}$	1.0000
Ice Condenser	$\frac{V_I}{V_L}$	0.4682

6.2 Containment Pressure and Vapor Pressure

Equation 6-1 shows that the compartment pressures are compensated for vapor pressure in the calculation of weight remaining in the containment volume. The evaporation of water from the exposed surfaces of water volumes in the containment would result in an increase in containment vapor pressure as well as total pressure. The condensation of water vapor onto containment surfaces cooler than the dew point of the vapor would cause a decrease in both the vapor pressure and total pressure. If the total pressure were not compensated for vapor pressure, vapor pressure increases due to evaporation would reflect an apparent increase of the containment air mass, which when superimposed over a mass loss due to containment leakage would result in a measured leak rate of a less magnitude than the actual leak rate. Condensation would result in a measured leakage greater than the actual leak rate if the corresponding vapor pressure change were not accounted for.

The sensitivity of the leak rate calculations to vapor pressure changes is especially great in an Ice Condenser Containment since the energy absorbing ice bed reduces the design accident pressure from 50-60 psig, typical of conventional containments, to 12 psig. The vapor pressure therefore represents a large fraction of the total pressure in the ice condenser containment.

6.3 Containment Temperatures

Containment temperatures are used to compensate the weight remaining calculation for total pressure changes caused by the thermal expansion or contraction of the containment atmosphere. It is recognized that temperature gradients exist in the containment and temperature changes will not necessarily be uniform throughout the containment. Therefore the containment

is instrumented with 46 temperature probes, located such that each monitors a fraction of the total containment volume. In the establishment of temperature sub-volume boundaries and temperature probe location, consideration was given to the location of physical thermal barriers and heat sources and sinks. The sub-volumes are generally different in size as well as shape, thus, in determining average containment temperature, temperature readings are weighed as a function of the volume fraction they represent. The weighing of temperature readings occurs on a compartmental basis. The weighted average temperature in a compartment is given by the following expression.

$$T_{avg_{cn}} = \sum_{i=1}^{Nc} T_{K_{cni}} K_{ci} \qquad (6.3.1)$$

$T_{avg_{cn}}$ = Weighed average compartment temperature (°F) for compartment c at time t_n

$T_{K_{cn}}$ = Temperature at sensor i in compartment c at time t_n

K_{ci} = Temperature weighing factor associated with sensor i in compartment c.

N_c = Total number of sensors in compartment c.

Temperature weighing factors, like the volume weighing factors discussed in Section 6.1 vary as a function of both ice condenser load and reactor missile shield placement.

6.4 The Statistical Determination of the Leak Rate

There is inevitably a certian amount of random error associated with the leak rate measurements and the containment leakage itself that cause a variance in the calculated remaining weight, Wn, and the leak rate, Lam. In order to determine the leak rate from Wn after a test period of t_n, a first order (linear) least-squares fit of W_n vs t_n is performed.

This method selects a function, W(t)=bt+a, in which slope, b, and intercept, a, are determined by minimizing the variance σ^2, of W_n with respect to W(t). The variance of W_n relative to W(t) is:

$$\sigma^2 = \sum_{i=1}^{n} (W_i - W(t_i))^2 = \sum_{i=1}^{n} (W_i - (bt_i + a))^2 \qquad (6.4\text{-}1)$$

The values of a and b that establish the minimum variance σ^2 are given by the homogeneous simultaneous solution of the partial derivatives of σ^2 with respect to a and b:

$$\frac{\partial\sigma^2}{\partial a} = 0 \text{ and } \frac{\partial\sigma^2}{\partial b} = 0 \qquad (6.4\text{-}2)$$

The solution of the above yield:

$$b = \frac{n \sum_{i=1}^{n} W_i t_i - \sum_{i=1}^{n} W_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i - (\sum_{i=1}^{n} t_i)^2} \qquad (6.4\text{-}3)$$

$$a = \frac{\sum_{i=1}^{n} t_i^2 \sum_{i=1}^{n} W_i - \sum_{i=1}^{n} t_i \sum_{i=1}^{n} W_i t_i}{n \sum_{i=1}^{n} t_i^2 - (\sum_{i=1}^{n} t_i)^2} \qquad (6.4\text{-}4$$

The slope of w(t), b, is the leak rate expressed as the change in normalized containment weight per unit time. The unit of time used is hours, and thus, L_{am} is given by

$$L_{am} = \frac{2400}{t_n} (b) \qquad (\%wt/day)$$

6.5 The Upper Confidence Limit

The 95% Upper Confidence Limit of the leak rate is determined from the variance of the slope of the least-squares line, W(t), and the value of the t-distribution for n-2 degrees of freedom based on a one-sided 95% confidence interval. The use of the one-sided interval in this test has replaced the two-sided interval used in the Unit 1 and Unit 2 Preoperational tests. The two-sided limit placed upper and lower bounds about the measured leak rate within which there was a 95% certainty of the 'actual' leak rate existing. Since the interval determined by this method is symmetrical, the 95% two-sided interval was actually imposing a 97.5% confidence on the upper bound of the leak rate. The imposition of a 95% confidence on the upper limit of the leak rate is equivalent to taking the upper bound of a 90% two-sided interval.

The t-distribution is used to estimate the interval about the mean value of a finite set of ν (nu) independent normally distributed measurements within which the mean of the population of infinite measurements from which the finite set was taken, exists to a stated level of confidence.

Referring to Table 6.5.1, the value K of the t-distribution, as determined from the point at which the cumulative distribution of the t-distribution has the normalized value $\alpha/2$, defines a two sided interval about the mean of ν (nu) independent measurements the entire population of measurements exist to a confidence of 1α. The t-distribution is normalized such that its mean is zero and the standard deviation is one. This allows $K(\nu,\alpha)$ to be applied directly to the mean, x, and standard deviation s, of any sample υ independent measurements representing a normally distributed population. The confidence limits are expressed as $x \pm K(\nu,\alpha)\ S$.

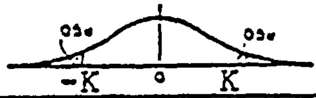
In the application of this statistical method to the leak rate test, the slope of the least-squares line, b, is the 'mean' value of the leak rate and the variance of the 'mean', S_b^2, is given by:

$$S_b^2 = \frac{\sum_{i=1}^{n} (W_i - (bt_i + a))^2}{(n-2) \sum_{i=1}^{n} (t_i - t)^2}$$

where, $\overline{t} = \sum_{i=1}^{n} t_i$

TABLE 6.5.1

DISTRIBUTION OF K



Degrees of freedom ν	Probability α 0.10	0.05	0.01	0.001
1	6.314	12.706	63.657	636.619
2	2.920	4.303	9.925	31.598
3	2.353	3.182	5.841	12.941
4	2.132	2.776	4.604	8.610
5	2.015	2.571	4.032	6.859
6	1.943	2.447	3.707	5.959
7	1.895	2.365	3.499	5.405
8	1.860	2.306	3.355	5.041
9	1.833	2.262	3.250	4.781
10	1.812	2.228	3.169	4.587
11	1.796	2.201	3.106	4.437
12	1.782	2.179	3.055	4.318
13	1.771	2.160	3.012	4.221
14	1.761	2.145	2.977	4.140
15	1.753	2.131	2.947	4.073
16	1.746	2.120	2.921	4.015
17	1.740	2.110	2.898	3.965
18	1.734	2.101	2.878	3.922
19	1.729	2.093	2.861	3.883
20	1.725	2.086	2.845	3.850
21	1.721	2.080	2.831	3.819
22	1.717	2.074	2.819	3.792
23	1.714	2.069	2.807	3.767
24	1.711	2.064	2.797	3.745
25	1.708	2.060	2.787	3.725
26	1.706	2.056	2.779	3.707
27	1.703	2.052	2.771	3.690
28	1.701	2.048	2.763	3.674
29	1.699	2.045	2.756	3.659
30	1.697	2.042	2.750	3.646
40	1.684	2.021	2.704	3.551
60	1.671	2.000	2.660	3.460
120	1.658	1.980	2.617	3.373
∞	1.645	1.960	2.576	3.291

This table gives the values of t corresponding to various values of the probability α (level of significance) of a random variable falling inside the shaded areas in the figure, for a given number of degrees of freedom ν available for the estimation of error. For a one-sided test the confidence limits are obtained for $\alpha/2$.

This table is taken from Table III of Fisher & Yates: *Statistical Tables for Biological, Agricultural, and Medical Research* published by Oliver & Boyd Ltd., Edinburgh, by permission of the authors and publishers.

The above table is used to determine the appropriate value of 'K' based on prevailing degrees of freedom. This table has been extracted from <u>Basic Statistical Methods For Engineers and Scientists</u>.

Of the total of n measurements ($W_i t_i$) only n-2 are independent since a and b, the slope and intercept of the least-squares line, having been derived from n ($W_i t_i$), can predict any two ($W_i t_i$) with the other n-2 measurements. Hence, ν=n-2.

The value of α used is that which corresponds to a 90% two-sided confidence interval which is equivalent to a 1 - α/2 or 95% one-sided interval. The value of α is therefore 0.1. Now, the upper confidence limit of the leak rate, b, is expressed as:

$$b-K(n-2, 0.1) = S_b$$

The negative sign defines the upper limit since the value of b is negative.

6.6 The Leak Rate Computer Program, 'ILRTEST'

The leak rate computer program, 'ILRTEST', has replaced earlier versions of the two programs used in the Unit 1 and Unit 2 preoperational test, know as 'CCVDREP' and 'CCVREPT'. 'ILRTEST' incorporates the revised statistical analysis discussed in Section 6.5 and an added degree of flexibility that its predecessors lacked.

'ILRTEST' accommodates the operator input of certain 'fixed-data': the calibration conversion and correction coefficients of the present instrumentation system, and the volume and temperature weighing factors. The fixed data represents that which is fixed for the duration of one ILRT, but will vary from one ILRT to the next.

'ILRTEST' receives test data from a card reader. The raw test data collected for each test interval is coded onto input data coding sheets and punched on to computer cards. The data includes the data run number, the elapsed decimal time from run #1 in hours, the 46 containment temperatures in millivolts, seven pressures (6 containment, 1 barometric) in psia, and dew point temperatures in millivolts. The data cards are accumulated in a deck in the order of the run numbers.

The program establishes a file for the raw data and computes values expressed in the proper engineering units. The program computes the average compartment and containment pressures, the containment pressure relative to atmospheric, the weighed average compartment temperatures, and the average compartment dew point temperatures. From the average dew point, the vapor pressure is calculated using the Goff-Gratch formulas for saturation vapor pressure over water or over ice.

For each run of the computer program, the raw input data and the above computed values are summarized for the most recent data run. This is a valuable aid to input data error checking and analysis. Also, at the option of the program operator this summary may be printed for an operator-specified range of runs ending with the last data run.

A separate summary of average compartment pressures, temperatures and vapor pressures is also printed for either all the runs entered into the program, or for all the runs in a range specified by the operator. The elapsed time printed for both the individual run summaries and the overall summary is controlled by the starting point of the range.

After three data runs have been made or three runs are available in the user specified range, (a minimum of three runs is required to perform the least-squares and statistical analysis) the program calculates the leak rate and 95% upper confidence limit of the leak rate. In addition, the program calculates the remaining weight of the containment, and of each compartment. The remaining weights in a compartment 'c', is given by the following:

$$W_{cn} = \frac{\dfrac{P_{cn} - PV_{cn}}{T_{cn}}}{\dfrac{P_{co} \quad PV_{co}}{T_{co}}}$$

The individual compartment remaining weights are used only as an aid to data interpretation.

A copy of 'ILRTEST' appears as Section 7.0 of this report. The program outputs for this test can be found in Section 8.0 of this report.

7.0 D. C. COOK NUCLEAR PLANT CONTAINMENT INTEGRATED LEAK RATE TEST PROGRAM

'ILRTEST'

```
*      IMPLICIT REAL*8(A-H,P-Z)                                              ** 01/27/78
*      REAL*8 K,LVP                                                          ** 02/02/78
*      DIMENSION TEMPUC(16),TEMPLC(24),TEMPIC(7)                             ** 01/27/78
*      DIMENSION  TEMPU(16), TEMPL(24), TEMPI(7)                             ** 01/27/78
*      DATA LUC,LLC,LIC/16,24,7/                                             ** 01/27/78
*      DIMENSION RTDL1(16),RTDL2(24),RTDL3(07)                               ** 01/27/78
*      DATA RTDL1/'ETR-101 ','ETR-102 ','ETR-103 ','ETR-104 ','ETR-105',    ** 01/27/78
*     -           'ETR-106 ','ETR-107 ','ETR-108 ','ETR-109 ','ETR-110',    ** 01/27/78
*     -'ETR-111 ','ETR-112 ','ETR-114 ','ETR-128 ','ETR-133 ','ETR-113 '/   ** 01/27/78
*      DATA RTDL2/'ETR-122 ','ETR-123 ','ETR-124 ','ETR-125 ','ETR-126 ',   ** 01/27/78
*     -           'ETR-127 ','ETR-129 ','ETR-130 ','ETR-131 ','ETR-132 ',   ** 01/27/78
*     -           'ETR-134 ','ETR-135 ','ETR-136 ','ETR-137 ','ETR-138 ',   ** 01/27/78
*     -           'ETR-139 ','ETR-140 ','ETR-141 ','ETR-142 ','ETR-143 ',   ** 01/27/78
*     -           'ETR-144 ','ETR-145 ','ETR-146 ','ETR-113 '/              ** 01/27/78
*      DATA RTDL3/'ETR-115 ','ETR-116 ','ETR-117 ','ETR-118 ','ETR-119 ',   ** 01/27/78
*     -           'ETR-120 ','ETR-121 '/                                    ** 01/27/78
*      DIMENSION WUC(99),WLC(99),WIC(99),W(99),TIME(99),NRA(99),            ** 01/27/78
*     - ATUC(99),APUC(99),AVPUC(99),ATLC(99),APLC(99),AVPLC(99),            ** 01/27/78
*     - ATIC(99),APIC(99),AVPIC(99)                                          ** 01/27/78
*      DIMENSION K(18),SR(70),DP(6),LVP(6),PRES(7),PRESC(7),VPR(6)           ** 01/27/78
*      DIMENSION WTUP(16),WTLOW(24),WTICE(7),TABLE(97)                      ** 05/23/78
*      DATA TABLE /6.314,2.920,2.353,2.132,2.015,1.943,1.895,1.860,1.833,    ** 05/23/78
*     -1.812,1.796,1.782,1.771,1.761,1.753,1.746,1.740,1.734,1.729,1.725,    ** 05/23/78
*     -1.721,1.717,1.714,1.711,1.708,1.706,1.703,1.701,1.699,1.697,1.695,    ** 05/23/78
*     -1.694,1.692,1.691,1.689,1.688,1.687,1.686,1.685,1.684,1.683,1.682,    ** 05/23/78
*     -1.681,1.680,1.679,1.679,1.678,1.677,1.676,1.676,1.675,1.675,1.674,    ** 05/23/78
*     -1.673,1.673,1.672,1.672,1.671,1.671,1.671,1.670,1.670,1.669,1.669,    ** 05/23/78
*     -1.669,3*1.668,3*1.667,3*1.666,4*1.665,4*1.664,5*1.663,5*1.662,        ** 05/23/78
*     -5*1.661/                                                              ** 05/23/78
*      DATA WDUP,WDLO,WDIC/'UPPER   ','LOWER   ','ICE     '/                ** 01/27/78
*C      START OF PROGRAM                                                     ** 01/27/78
*       I = 1                                                                ** 01/27/78
*       DLGIOO = DLOG10(1013.246D0)                                          ** 01/27/78
*       DLGO   = DLOG10(6.1071D0)                                            ** 01/27/78
*       WDEM = 0.0                                                           ** 02/22/78
*      READ (5,300,ERR=22,END=12) C1,C2,C3,C4,C5,C6,IXS,IXE,IPR              ** 01/27/78
*  300 FORMAT(6F6.3,4X,I3,7X,I3,7X,I3)                               02/22/78** 02/22/78
*       I = 2                                                                ** 01/27/78
*      READ (5,301,ERR=22,END=12) K                                          ** 01/27/78
*  301 FORMAT(6F11.6/6F11.6/6F11.6)                                          ** 01/27/78
*       I = 3                                                                ** 01/27/78
*      READ (5,302,ERR=22,END=12) SR                                         ** 01/27/78
*302   FORMAT(10F8.5/10F8.5/10F8.5/10F8.5/10F8.5/10F8.5/10F8.5)              ** 10/24/77
*       I = 4                                                                ** 01/27/78
*      READ (5,303,ERR=22,END=12) WTUP,WTLOW,WTICE                          ** 01/27/78
*303   FORMAT(10F6.5/6F6.5/11F6.5/13F6.5/7F6.5)                              ** 10/18/77
*       I = 5                                                                ** 01/27/78
*      READ (5,304,ERR=22,END=12) VWF1,VWF2,VWF3                             ** 02/02/78
*304   FORMAT(3F7.5)                                                         ** 10/18/77
*      WRITE (6,305) C1,C2,C3,C4,C5,C6,K(1),K(2),K(3),K(7),K(8),K(9),        ** 01/27/78
*     - K(13),K(14),K(15),K(4),K(5),K(6),K(10),K(11),K(12),                 ** 01/27/78
*     - K(16),K(17),K(18),SR                                                ** 01/27/78
*305   FORMAT(1H1,44X,'*** THIS IS A CHECK OF THE INPUT DATA ***'////1H ,    ** 10/18/77
*     *   'RTD MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS'/1H ,6X,     ** 10/18/77
*     *   'UPPER',12X,'LOWER',13X,'ICE'/1H ,F5.2,3X,F5.2,4X,F5.2,3X,         ** 10/18/77
```

```
*     *   F5.2,4X,F5.2,3X,F5.2////1H ,'HYGROMETER MILLI-VOLT TO ',              ** 10/18/77
*     -   'FAHRENHEIT CONVERSION COEFFICIENTS'/1H ,T15,'UPPER-1',T48,           ** 01/27/78
*     -   'LOWER-1',T82,'ICE-1'/1H ,9(F10.5,1X)//1H ,T15,'UPPER-2',T48,         ** 01/27/78
*     -   'LOWER-2',T82,'ICE-2'/1H ,9(F10.5,1X)////1H ,'MANOMETER PRESSUR      ** 01/27/78
*     -E CORRECTION COEFFICIENTS'/T40,'PU-1'/10(1X,F7.4)//1H ,38X,              ** 02/02/78
*     *   'PU-2'/1H ,9(F7.4,1X),F7.4//1H ,38X,'PL-1'/1H ,9(F7.4,1X),            ** 10/24/77
*     *   F7.4//1H ,38X,'PL-2'/1H ,9(F7.4,1X),F7.4//1H ,38X,'PI-1'/            ** 10/24/77
*     *   1H ,9(F7.4,1X),F7.4//1H ,38X,'PI-2'/1H ,9(F7.4,1X),F7.4//           ** 10/24/77
*     *   1H ,38X,'P-ATM'/1H ,9(F7.4,1X),F7.4)                                 ** 10/24/77
*       WRITE (6,306) WTUP,WTLOW,WTICE,VWF1,VWF2,VWF3                           ** 01/27/78
*   306 FORMAT(1H-,'RTD WEIGHTING FACTORS'/1H ,27X,'UPPER'/1H ,9(F5.4,1X),      ** 01/27/78
*     *   F5.4/1H ,5(F5.4,1X),F5.4//1H ,27X,'LOWER'/1H ,10(F5.4,1X),           ** 10/18/77
*     *   F5.4/1H ,12(F5.4,1X),F5.4//1H ,28X,'ICE'/1H ,6(F5.4,1X),F5.4//       ** 10/18/77
*     *   //1H ,'VOLUME WEIGHTING FACTORS'/1H ,1X,'UPPER',2X,'LOWER',3X,       ** 10/18/77
*     *   'ICE'/1H ,2(F6.4,1X),F6.4)                                            ** 10/18/77
*       IF (IXS.LE.0) IXS = 1                                                   ** 01/27/78
*        IF (IXE.LE.0) IXE = 999                                       02/22/78** 02/22/78
*       IF (WTUP(16).LE.0.0) GO TO 701                                          ** 01/27/78
*       LLC = 23                                                                ** 01/27/78
*       GO TO 702                                                               ** 01/27/78
*   701 LUC = 15                                                                ** 01/27/78
*   702 NR = 0                                                                  ** 02/02/78
*        LICP1 = LIC + 1                                                        ** 01/27/78
*        LUCP1 = LUC + 1                                                        ** 01/27/78
*C       NR IS STORAGE INDEX,PROGRAM DATA ACCESS LOOP STARTS HERE.              ** 01/27/78
*       DO 20 IR = 1,99                                                         ** 01/27/78
*        IBYP = 0                                                               ** 01/27/78
*       READ (5,100,ERR=42,END=32) NRD,TIMER                                    ** 01/27/78
*   100 FORMAT(I3,1X,F5.2)                                             02/22/78** 02/22/78
*C       INPUT SEQUENCE CHECK                                                   ** 01/27/78
*       IF (NR.EQ.0.OR.NRD.GT.NRO) GO TO 703                                    ** 02/09/78
*       WRITE (10,901) IR,NRD                                                   ** 01/27/78
*   901 FORMAT (1H0,2X,'ILR005I D INCORRECT DATA SEQUENCE',2X,I2,2X,I3)  02/24/78** 02/24/78
*       GO TO 23                                                                ** 01/27/78
*    32  IF (IPR.NE.0) GO TO 40                                                 ** 01/27/78
*        IPR = 99                                                               ** 01/27/78
*        GO TO 55                                                               ** 01/27/78
*   703 NRO = NRD                                                               ** 01/27/78
*       IF (NRO.GT.IXE) GO TO 32                                                ** 01/27/78
*       IF (NRO.GE.IXS) GO TO 705                                               ** 01/27/78
*        IBYP = 1                                                               ** 01/27/78
*       GO TO 707                                                               ** 01/27/78
*   705 IF (NRO.EQ.IXS) TIMEST = TIMER                                          ** 01/27/78
*        NR = NR + 1                                                            ** 02/02/78
*       TIME(NR) = TIMER - TIMEST                                               ** 01/27/78
*       NRA(NR) = NRD                                                           ** 01/27/78
*   200 FORMAT(1H1,'RUN NUMBER',4X,I3/1H ,'ELAPSED TIME',2X,F5.2///1H ,  02/22/78** 02/22/78
*     *   'CONTAINMENT TEMPERATURES DATA CHECK'//1H ,7X,'UPPER VOLUME',         ** 10/18/77
*     *   21X,'LOWER VOLUME',19X,'ICE CONDENSER'/1H ,3X,'RTD',2X,               ** 10/24/77
*     *   'MILLI-VOLTS',2X,'DEG. F.',7X,'RTD',2X,'MILLI-VOLTS',2X,              ** 10/18/77
*     *   'DEG. F.',7X,'RTD',2X,'MILLI-VOLTS',2X,'DEG. F.')                     ** 10/18/77
*   707 READ (5,101,ERR=42,END=62) TEMPUC                                       ** 01/27/78
*   101 FORMAT(10(F5.2,1X)/6(F5.2,1X))                                          ** 10/18/77
*       READ (5,102,ERR=42,END=62) TEMPLC                                       ** 01/27/78
*   102 FORMAT(11(F5.2,1X)/13(F5.2,1X))                                         ** 10/24/77
*       READ (5,103,ERR=42,END=62) TEMPIC                                       ** 01/27/78
*   103 FORMAT(7(F5.2,1X))                                                      ** 10/18/77
*       IF (IBYP.EQ.1) GO TO 45                                                 ** 01/27/78
```

```
*  505 FORMAT (1H ,32X,A8,2X,F6.2,5X,F6.2)                                      ** 01/27/78
*      WRITE (6,507) TMSMUC,TMSMLC,TMSMIC,TMSMUR,TMSMLR,TMSMIR                  ** 02/02/78
*  507 FORMAT (1H-,17X,'SUMMARY OF WEIGHTED AVERAGE TEMPERATURES'//1H ,         ** 02/02/78
*     -'UPPER VOLUME (DEG. F.)    ',F5.2,4X,'LOWER VOLUME (DEG. F.)   ',        ** 02/02/78
*     -   F6.2,4X,'ICE CONDENSER (DEG. F.)     ',F5.2/1H ,                      ** 02/02/78
*     -   'UPPER VOLUME (DEG. R.)   ',F6.2,4X,'LOWER VOLUME (DEG. R.)  ',       ** 02/02/78
*     -   F7.2,4X,'ICE CONDENSER (DEG. R.)   ',F7.2)                            ** 02/02/78
*       IF (IFR.EQ.99) GO TO 35                                                 ** 01/27/78
*   45 READ (5,509,ERR=42,END=62) VPR1,VPR2,VPR3,VPR4,VPR5,VPR6,PRES            ** 01/27/78
*  509 FORMAT (6F6.3/7F8.5)                                                     ** 01/27/78
*      IF (IBYP.EQ.1) GO TO 20                                                  ** 01/27/78
*      DP(1) = K(1)*VPR1*VPR1 +  K(2)*VPR1 +  K(3)                              ** 01/27/78
*      DP(2) = K(4)*VPR2*VPR2 +  K(5)*VPR2 +  K(6)                              ** 01/27/78
*      DP(3) = K(7)*VPR3*VPR3 +  K(8)*VPR3 +  K(9)                              ** 01/27/78
*      DP(4) =K(10)*VPR4*VPR4 + K(11)*VPR4 + K(12)                              ** 01/27/78
*      DP(5) =K(13)*VPR5*VPR5 + K(14)*VPR5 + K(15)                              ** 01/27/78
*      DP(6) =K(16)*VPR6*VPR6 + K(17)*VPR6 + K(18)                              ** 01/27/78
*      DO 403 J=1,4                                                             ** 01/27/78
*       IF (DP(J).LE.0.0) GO TO 403                                             ** 01/27/78
*      CIOOC = 373.16/((DP(J)-32.)/1.8 + 273.16)                                ** 01/27/78
*      LVP(J) = -7.90298*(CIOOC - 1.0) + 5.02808*DLOG10(CIOOC) +  DLGIOO        ** 01/27/78
*     -         -1.3816*(10**(-7.0))*(10**(11.344*(1.0-1.0/CIOOC)) - 1.)        ** 01/27/78
*     -         +8.1328*(10**(-3.0))*(10**(-3.49149*(CIOOC - 1.0)) - 1.)        ** 01/27/78
*  403 CONTINUE                                                                 ** 01/27/78
*      DO 50 J=5,6                                                              ** 01/27/78
*       IF (DP(J).LE.0.0) GO TO 50                                              ** 01/27/78
*      COC = 273.16/((DP(J)-32.0)/1.8 + 273.16)                                 ** 01/27/78
*      LVP(J) = -9.09718*(COC-1.0) - 3.56654*DLOG10(COC)                        ** 02/02/78
*     -         +0.876793*(1.0 - 1.0/COC) +  DLGO                               ** 01/27/78
*   50 CONTINUE                                                                 ** 01/27/78
*      DO 404 KAY =1,6                                                          ** 01/27/78
*      IF (DP(KAY).LE.0.0) GO TO 404                                            ** 01/27/78
*      VPR(KAY) = 0.0145038*10**LVP(KAY)                                        ** 01/27/78
*  404 CONTINUE                                                                 ** 01/27/78
*C      CHECK FOR MISSING VAPOR PRESSURE AND CALCULATE AVERAGE.                 ** 01/27/78
*      IF (DP(1).LE.0.0) GO TO 713                                              ** 01/27/78
*      IF (DP(2).GT.0.0) GO TO 715                                              ** 01/27/78
*      VPAUC = VPR(1)                                                           ** 01/27/78
*       VPR(2) = 0.0                                                            ** 01/27/78
*      GO TO 717                                                                ** 01/27/78
*  713 VPAUC = VPR(2)                                                           ** 01/27/78
*       VPR(1) = 0.0                                                            ** 01/27/78
*      GO TO 717                                                                ** 01/27/78
*  715 VPAUC = 0.5*(VPR(1) + VPR(2))                                            ** 01/27/78
*  717  IF (DP(3).LE.0.0) GO TO 719                                             ** 01/27/78
*       IF (DP(4).GT.0.0) GO TO 721                                             ** 01/27/78
*      VPALC = VPR(3)                                                           ** 01/27/78
*       VPR(4) = 0.0                                                            ** 01/27/78
*      GO TO 723                                                                ** 01/27/78
*  719 VPALC = VPR(4)                                                           ** 01/27/78
*       VPR(3) = 0.0                                                            ** 01/27/78
*      GO TO 723                                                                ** 01/27/78
*  721 VPALC = 0.5*(VPR(3) + VPR(4))                                            ** 01/27/78
*  723 IF (DP(5).LE.0.0) GO TO 725                                              ** 01/27/78
*      IF (DP(6).GT.0.0) GO TO 727                                              ** 01/27/78
*      VPAIC = VPR(5)                                                           ** 01/27/78
*       VPR(6) = 0.0                                                            ** 01/27/78
*      GO TO 729                                                                ** 01/27/78
```

```
 *  725 VPAIC = VPR(6)                                                                  ** 01/27/78
 *       VPR(5) = 0.0                                                                   ** 01/27/78
 *      GO TO 729                                                                       ** 01/27/78
 *  727 VPAIC = 0.5*(VPR(5) + VPR(6))                                                   ** 01/27/78
 *C       LINEAR INTERPOLATION FOR PRESSURES.                                            ** 01/27/78
 *  729 DO 405 M=1,70,10                                                                ** 01/27/78
 *      N1=M+1                                                                          ** 10/20/77
 *      N2=M+9                                                                          ** 10/20/77
 *      MY=((M-1)/10)+1                                                                 ** 10/20/77
 *       PRDG = PRES(MY)                                                                ** 01/27/78
 *      IF (PRDG.EQ.0.0) GO TO 408                                                      ** 02/09/78
 *      DO 406 N=N1,N2,2                                                                ** 10/20/77
 *      IF (PRDG.LT.SR(N)) GO TO 406                                                    ** 01/27/78
 *      IF (PRDG.EQ.SR(N)) GO TO 731                                                    ** 01/27/78
 *      IF (N.EQ.N1) GO TO 444                                                          ** 01/27/78
 *      PRESC(MY)=SR(N-1)+ (PRDG-SR(N))*(SR(N-3)-SR(N-1))/(SR(N-2)-SR(N))               ** 01/27/78
 *      GOTO 405                                                                        ** 10/20/77
 *406   CONTINUE                                                                        ** 10/20/77
 *  444 WRITE (10,407) NRD,MY,PRDG                                             02/22/78** 02/22/78
 *  407 FORMAT(T2,'***MANOMETER READING OFF CALIBRATION***',2X,I3,2X,           02/22/78** 02/22/78
 *     - I2,F9.4)                                                              02/22/78** 02/22/78
 *  408  PRESC(MY) = 0.0                                                                ** 02/09/78
 *      GO TO 405                                                                       ** 01/27/78
 *  731 PRESC(MY) = SR(N-1)                                                             ** 01/27/78
 *405   CONTINUE                                                                        ** 10/20/77
 *C       AVERAGING PRESSURES ALLOWING FOR ZERO ENTRY.                                   ** 01/27/78
 *      PRESCU = 0.5*(PRESC(1) + PRESC(2))                                              ** 01/27/78
 *      PRESCL = 0.5*(PRESC(3) + PRESC(4))                                              ** 01/27/78
 *      PRESCI = 0.5*(PRESC(5) + PRESC(6))                                              ** 01/27/78
 *       IF (PRESC(1).LE.0.0.OR.PRESC(2).LE.0.0) PRESCU = 2.0*PRESCU                     ** 01/27/78
 *       IF (PRESC(3).LE.0.0.OR.PRESC(4).LE.0.0) PRESCL = 2.0*PRESCL                     ** 01/27/78
 *       IF (PRESC(5).LE.0.0.OR.PRESC(6).LE.0.0) PRESCI = 2.0*PRESCI                     ** 01/27/78
 *      ACPA=(PRESCU+PRESCL+PRESCI)/3                                                   ** 10/20/77
 *      ACPG=ACPA-PRESC(7)                                                              ** 10/20/77
 *      IF (IPR.EQ.0.OR.IPR.GT.NBD) GO TO 747                                           ** 01/27/78
 *   35 WRITE (6,508) VPR1,DP(1),VPR(1),PRES(1),PRESC(1),                               ** 01/27/78
 *     -              VPR2,DP(2),VPR(2),PRES(2),PRESC(2),                               ** 01/27/78
 *     -              VPR3,DP(3),VPR(3),PRES(3),PRESC(3),                               ** 01/27/78
 *     -              VPR4,DP(4),VPR(4),PRES(4),PRESC(4),                               ** 01/27/78
 *     -              VPR5,DP(5),VPR(5),PRES(5),PRESC(5),                               ** 01/27/78
 *     -              VPR6,DP(6),VPR(6),PRES(6),PRESC(6),PRES(7),PRESC(7),              ** 01/27/78
 *     - VPAUC,VPALC,PRESCU,VPAIC,PRESCL,PRESCI,ACPA,ACPG                               ** 02/02/78
 *  508 FORMAT (1H-,11X,'CONTAINMENT VAPOR PRESSURE DATA CHECK',T83,                    ** 01/27/78
 *     *   'CONTAINMENT PRESSURES DATA CHECK'//1H ,19X,'MILLI-',8X,                     ** 10/21/77
 *     *   'DEW POINT',4X,'VAPOR PRESSURE',30X,'UNCORRECTED',7X,                        ** 10/21/77
 *     *   'CORRECTED'/1H ,2X,'HYGROMETER',8X,'VOLTS',8X,'(DEG. F.)',7X,                ** 10/21/77
 *     *   '(PSIA)',23X,'MANOMETER',2X,'READING (PSIA)',2X,'READING ',                  ** 10/21/77
 *     *   '(PSIA)'/1H ,5X,'VPU-1',10X,F5.2,10X,F5.2,9X,F7.4,25X,'PU-1',                ** 10/24/77
 *     - 2(8X,F7.4)/T7,'VPU-2',2(10X,F5.2),9X,F7.4,T83,'PU-2',2(8X,F7.4)/               ** 01/27/78
 *     - T7,'VPL-1',2(10X,F5.2),9X,F7.4,T83,'PL-1',2(8X,F7.4)/                          ** 01/27/78
 *     - T7,'VPL-2',2(10X,F5.2),9X,F7.4,T83,'PL-2',2(8X,F7.4)/                          ** 01/27/78
 *     - T7,'VPI-1',2(10X,F5.2),9X,F7.4,T83,'PI-1',2(8X,F7.4)/                          ** 01/27/78
 *     - T7,'VPI-2',2(10X,F5.2),9X,F7.4,T83,'PI-2',2(8X,F7.4)/                          ** 01/27/78
 *     - T83,'AMBIENT',T95,F7.4,8X,F7.4/1H ,T24,'AVERAGE VAPOR PRESSURES'/              ** 02/02/78
 *     - T86,'SUMMARY OF CORRECTED AVERAGE PRESSURES'/                                  ** 02/02/78
 *     - 1H ,T17,'UPPER CONTAINMENT (PSIA)',T47,F7.4/                                   ** 02/02/78
 *     - 1H ,T17,'LOWER CONTAINMENT (PSIA)',T47,F7.4,T81,                               ** 01/27/78
 *     - 'AVERAGE UPPER PRESSURE (PSIA)',T120,F7.4/1H ,T17,                             ** 01/27/78
```

```
*     -'ICE CONDENSER     (PSIA)',T47,F7.4,T81,'AVERAGE LOWER PRESSURE (P       ** 01/27/78
*     -SIA)',T120,F7.4/T81,'AVERAGE ICE CONDENSER PRESSURE (PSIA)',T120,        ** 01/27/78
*     -F7.4/T81,'AVERAGE CONTAINMENT PRESSURE   (PSIA)',T120,F7.4/T81,          ** 01/27/78
*     - 'AVERAGE CONTAINMENT PRESSURE   (PSIG)',T120,F7.4)                      ** 01/27/78
*       IF (IFR.EQ.99) GO TO 40                                                 ** 01/27/78
*C        CALCULATE NORMALIZED WEIGHT FRACTIONS; STORE WITH PRESSURES.          ** 01/27/78
*  747 WUCNUM = (PRESCU - VPAUC)/TMSMUR                                         ** 01/27/78
*      WLCNUM = (PRESCL - VPALC)/TMSMLR                                         ** 01/27/78
*      WICNUM = (PRESCI - VPAIC)/TMSMIR                                         ** 01/27/78
*      WNUM = VWF1*WUCNUM + VWF2*WLCNUM + VWF3*WICNUM                           ** 01/27/78
*       IF (WDEM.GT.0.0) GO TO 749                                              ** 02/22/78
*      WUCDEM = WUCNUM                                                          ** 01/27/78
*      WLCDEM = WLCNUM                                                          ** 01/27/78
*      WICDEM = WICNUM                                                          ** 01/27/78
*      WDEM   = WNUM                                                            ** 01/27/78
*  749 WUC(NR) = WUCNUM/WUCDEM                                                  ** 01/27/78
*      WLC(NR)=WLCNUM/WLCDEM                                                    **
*      WIC(NR)=WICNUM/WICDEM                                                    **
*      W(NR)=WNUM/WDEM                                                          **
*       ATUC(NR) = TMSMUC                                                       ** 02/02/78
*       ATLC(NR) = TMSMLC                                                       ** 02/02/78
*       ATIC(NR) = TMSMIC                                                       ** 02/02/78
*       APUC(NR) = PRESCU                                                       ** 02/02/78
*       APLC(NR) = PRESCL                                                       ** 02/02/78
*       APIC(NR) = PRESCI                                                       ** 02/02/78
*      AVPUC(NR) = VPAUC                                                        ** 02/02/78
*      AVPLC(NR) = VPALC                                                        ** 02/02/78
*      AVPIC(NR) = VPAIC                                                        ** 02/02/78
*   20 CONTINUE                                                                 ** 01/27/78
*      WRITE (10,903)                                                           ** 01/27/78
*  903 FORMAT (1H0,2X,'ILR006I D ***DATA SPACE EXCEEDED***')            02/24/78** 02/24/78
*      GO TO 23                                                                 ** 01/27/78
*C      END OF FILE AND OTHER ERROR MESSAGES                                    ** 01/27/78
*   12 WRITE (10,904) I                                                         ** 01/27/78
*  904 FORMAT (1H0,2X,'ILR002I D **END OF DATA IN SYSTEM GROUP ',       02/24/78** 02/24/78
*     - I2,2X,'**')                                                     02/24/78** 02/24/78
*   23 WRITE (10,905)                                                           ** 01/27/78
*  905 FORMAT (1H-,2X,'ILR008I D ***ABNORMAL RUN TERMINATION***')       02/24/78** 02/24/78
*      GO TO 24                                                                 ** 01/27/78
*   22 WRITE (10,906) I                                                         ** 01/27/78
*  906 FORMAT (1H0,2X,'ILR001I D **READ ERROR IN SYSTEM DATA GROUP ',   02/24/78** 02/24/78
*     - I2,2X,'**')                                                     02/24/78** 02/24/78
*      GO TO 23                                                                 ** 01/27/78
*   42 WRITE (10,907) NRD                                                       ** 01/27/78
*  907 FORMAT (1H0,2X,'ILR003I D **READ ERROR IN TEST GROUP ',I3,2X,'**')02/24/78** 02/24/78
*      GO TO 23                                                                 ** 01/27/78
*   62 WRITE (10,908) NRD                                                       ** 01/27/78
*  908 FORMAT (1H0,2X,'ILR004I D **END OF DATA IN TEST GROUP ',I3,'  **')02/24/78** 02/24/78
*      GO TO 23                                                                 ** 01/27/78
*C               RESULT PORTION OF PROGRAM                                      ** 01/27/78
*   40  IF (NR.GE.3) GO TO 41                                                   ** 01/27/78
*      WRITE (10,909)                                                           ** 01/27/78
*  909 FORMAT (1H0,2X,'ILR007I D **LESS THAN 3 TEST POINTS - MORE DATA NE02/24/78** 02/24/78
*     -EDED**')                                                         02/24/78** 02/24/78
*      GO TO 23                                                                 ** 01/27/78
*   41  TSS = TIME(1)*TIME(1) + TIME(2)*TIME(2)                                 ** 01/27/78
*       TS  =  TIME(1) + TIME(2)                                                ** 01/27/78
*       T2SW = TIME(1)*W(1) + TIME(2)*W(2)                                      ** 01/27/78
```

```
 *       WS = W(1) + W(2)                                                 ** 01/27/78
 *       WRITE (9,201)                                                    ** 01/27/78
 *   201 FORMAT(1H1,48X,'SUMMARY OF AVERAGES'///1H ,2X,'RUN #',2X,'ELAPSED    ** 01/27/78
 *      -',2X,3(34HAVG TEMP  AVG PRESS  AVG V PRESS  )/1H ,10X,'TIME',6X,'U   ** 01/27/78
 *      -PPER',6X,'UPPER',7X,'UPPER',6X,'LOWER',6X,'LOWER',7X,'LOWER',7X,'I   ** 02/02/78
 *      -CE',8X,'ICE',9X,'ICE'/)                                          ** 02/02/78
 *       DO 43 I=1,NR                                                     ** 01/27/78
 *    43 WRITE (9,202) NRA(I), TIME(I), ATUC(I),AFUC(I),AVPUC(I),ATLC(I),  ** 01/27/78
 *      -APLC(I),AVPLC(I),ATIC(I),APIC(I),AVPIC(I)                        ** 01/27/78
 *   202 FORMAT (1H ,2X, I3,4X,F6.2,2X,3(F9.4,2X,F9.4,3X,F9.4,2X))        ** 01/27/78
 *       WRITE (9,205)                                                    ** 01/27/78
 *   205 FORMAT(1H1,34X, 'RESULTS OF THE LINEAR REGRESSION ANALYSIS'///   ** 01/27/78
 *      -1H ,2X,'RUN #',8X,'W',11X,'LEAKAGE RATE',9X,'LEAKAGE',9X,        ** 05/23/78
 *      -          'W UPPER',7X,'W LOWER',9X,'W ICE'/1H ,10X,'EXPERIMENTAL', ** 05/23/78
 *      -6X,'UPPER LIMIT',11X,'RATE',8X,              'CONTAINMENT',3X,   ** 05/23/78
 *      -'CONTAINMENT',5X,'CONDENSER'/)                                   ** 01/27/78
 *C           REGRESSION LOOP                                            ** 01/27/78
 *       DO 44 I=3,NR                                                     ** 01/27/78
 *       TSS = TSS + TIME(I)*TIME(I)                                      ** 01/27/78
 *       TS  = TS + TIME(I)                                               ** 01/27/78
 *       WS  = WS + W(I)                                                  ** 01/27/78
 *       T2SW = T2SW + TIME(I)*W(I)                                       ** 01/27/78
 *        ANUM = TSS*WS - TS*T2SW                                         ** 01/27/78
 *        XNRR = I                                                        ** 01/27/78
 *       ADEM = XNRR*TSS - TS*TS                                          ** 01/27/78
 *        A = ANUM/ADEM                                                   ** 01/27/78
 *        BNUM = XNRR*T2SW - TS*WS                                        ** 01/27/78
 *       B = BNUM/ADEM                                                    ** 01/27/78
 *        II = I                                                          ** 01/27/78
 *       WSUM = 0.0                                                       ** 01/27/78
 *C       SUM OF SQUARED DIFFERENCES                                      ** 01/27/78
 *       DO 46 L=1,II                                                     ** 01/27/78
 *       WLR = A + B*TIME(L)                                              ** 01/27/78
 *       IF (DABS(W(L)-WLR).LE.1.0D-39) GO TO 46                          ** 01/27/78
 *       WSUM = WSUM + (W(L)-WLR)*(W(L)-WLR)                              ** 01/27/78
 *    46 CONTINUE                                                         ** 01/27/78
 *       AT = TS/XNRR                                                     ** 01/27/78
 *       TOT = AT*AT                                                      ** 01/27/78
 *       DO 48 M=2,II                                                     ** 01/27/78
 *    48 TOT = TOT + (TIME(M)-AT)*(TIME(M)-AT)                            ** 02/02/78
 *        B = 2400.0*B                                                    ** 01/27/78
 *       EKK = TABLE(II-2)                                                ** 01/27/78
 *       SIGMAB = DSQRT(WSUM/(TOT*(XNRR-2.0)))                            ** 01/27/78
 *       DEL = EKK*SIGMAB*2400.0                                          ** 01/27/78
 *       BU = B - DEL                                                     ** 05/23/78
 *       WRITE (9,206) NRA(II),W(II),BU,B,WUC(II),WLC(II),WIC(II)         ** 05/23/78
 *   206 FORMAT (T4,I3,5X,F9.5,2(9X,F9.5),7X,F9.5,5X,F9.5,6X,F9.5)        ** 05/23/78
 *    44 CONTINUE                                                         ** 01/27/78
 *C              END OF REGRESSION LOOP                                   ** 01/27/78
 *       WRITE (9,203) B,A                                                ** 01/27/78
 *   203 FORMAT(1H0,21X,'FINAL LEAKAGE RATE (% PER DAY) =',F9.5,5X,'INTERCE ** 01/27/78
 *      -PT=',F9.5)                                                       ** 01/27/78
 *       WRITE (9,204) BU                                                 ** 05/23/78
 *   204 FORMAT (1H0,21X,'UPPER CONFIDENCE LIMIT FOR THE RATE IS ',F9.5)  ** 05/23/78
 *    24 CALL EXIT                                                        ** 01/27/78
 *       END                                                              **
```

8.0 Data Analysis and Summaries

This section of the report contains graphical analysis of data obtained during the conduct of the ILRT. The 'ILRTEST' program summaries of average containment temperatures, pressures, and vapor pressures, and leak rate calculations appear in Section 8.2 of this report.

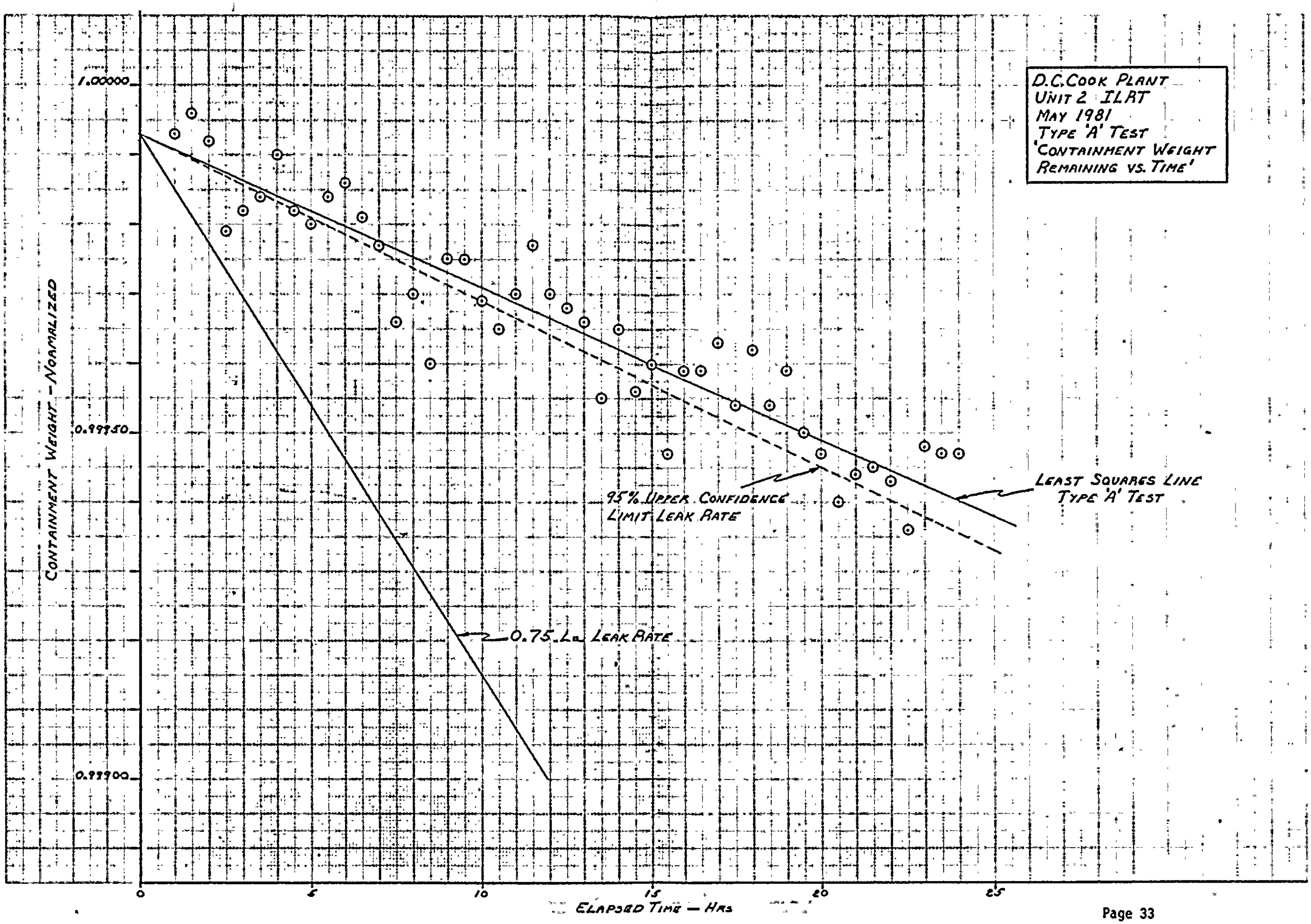
Past test experience has shown that the instrumentation package used for this test is quite capable of measuring the leak rate accurately, as evidenced by the rapid convergence of the 95% upper confidence limit of the leak rate and the excellent correlation of results between the 'Type A' and the Supplemental Test. The error analysis for the instrumentation system predicts $\pm$ 0.019% wt/day, and this test correlates well within that interval.

8.1 Graphical Analysis

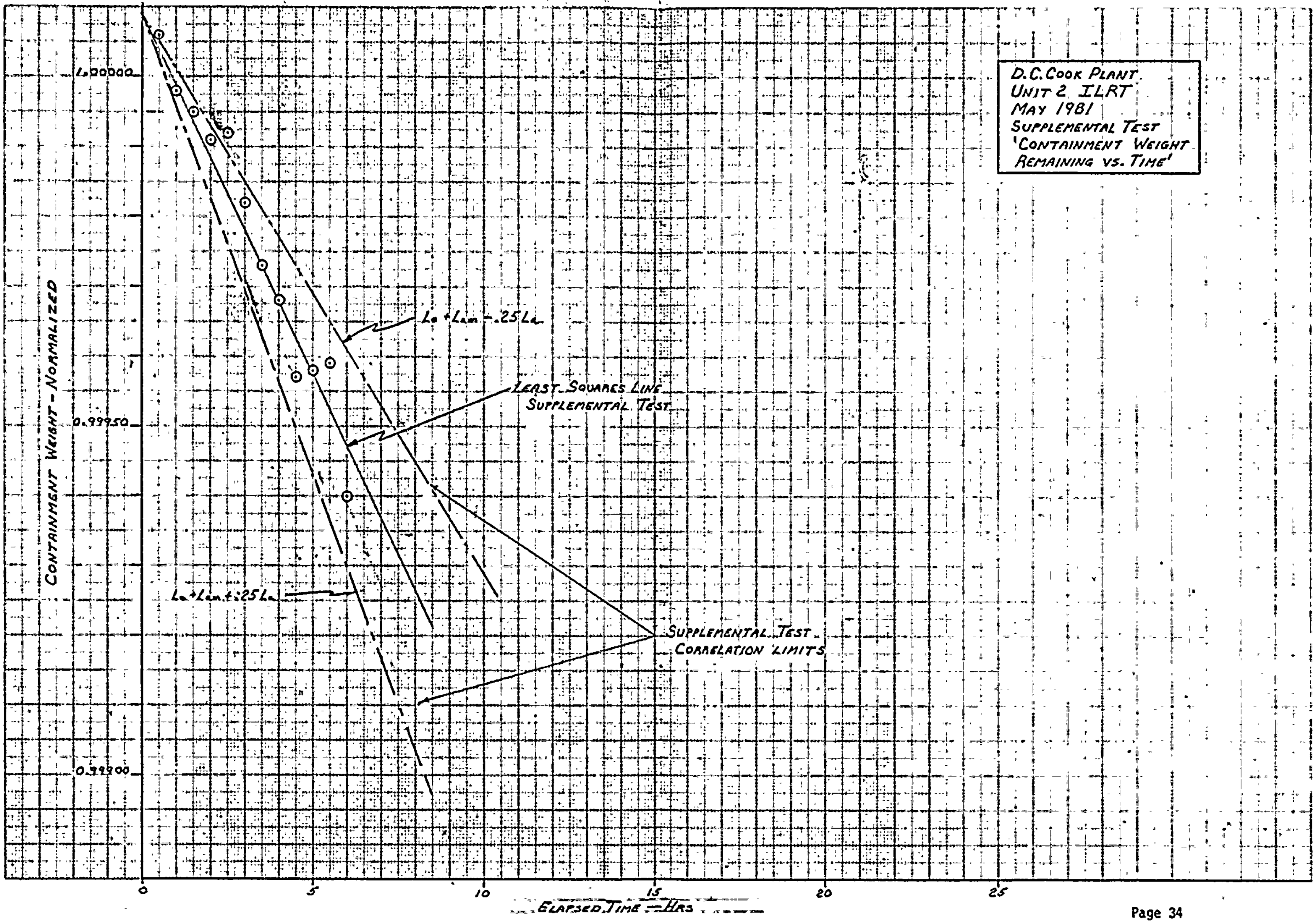
Figure 8.1.1 is a plot of containment weight remaining vs. time for the Type A Test, the slope of the least-squares line is the calculated leak rate. A second line is drawn using the vertical intercept of the least-squares line and a slope corresponding to the 95% upper confidence limit leakage. A line corresponding to the allowable leak rate (0.75 L_a) is also shown to illustrate the relatively wide margin by which the leakage criterion was met.

Figure 8.1.2 is a plot of the containment weight remaining vs. time for the Supplemental Test. The slope of the least-squares line is the composite leakage rate (L_c). Using the vertical intercept of this least-squares line, two additional lines are drawn corresponding to the Supplemental Test correlation limits

$$[(L_{am} + L_o + .25\ L_a) > L_c > (L_{am} + L_o - .25\ L_a0].$$



D.C.COOK PLANT
UNIT 2 ILRT
MAY 1981
TYPE 'A' TEST
'CONTAINMENT WEIGHT REMAINING VS. TIME'
1.00000
0.99950
0.99900
CONTAINMENT WEIGHT - NORMALIZED
0
5
10
15
20
25
ELAPSED TIME — HRS
LEAST SQUARES LINE TYPE 'A' TEST
95% UPPER CONFIDENCE LIMIT LEAK RATE
0.75 La LEAK RATE


D.C. Cook Plant
Unit 2 ILRT
May 1981
Supplemental Test
'Containment Weight Remaining vs. Time'
Containment Weight - Normalized
1.00000
0.99950
0.99900
Elapsed Time - Hrs
0
5
10
15
20
25
Lo + Lam - .25 La
Least Squares Line Supplemental Test
Lo + Lam + .25 La
Supplemental Test Correlation Limits

8.2 <u>'ILRTEST' Program Summaries</u>

D. C. Cook Unit 2, Integrated Leak Rate
Test April 30 - May 4, 1981

8.4.1	<u>Fixed Program Information</u>	<u>Page</u>
8.4.2	Pressurization Runs 1P-25P Summary of Averages	
8.4.3	Stabilization Runs 1S - 31A Summary of Averages Preliminary Leak Rate Analysis	
8.4.4	'Type A' Test Runs 1T - 49T Summary of Averages Type A Leak Rate Analysis	
8.4.5	Supplemental Test Runs 1Su - 13Su Summary of Averages Supplemental Leak Rate Analysis	

*** THIS IS A CHECK OF THE INPUT DATA ***

```
RTD MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS
      UPPER             LOWER             ICE
 2.00    0.0       2.00    0.0       2.00    0.0


HYGROMETER MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS
              UPPER-1                               LOWER-1                                   ICE-1
   0.0        18.00000   32.00000    0.00085     1.95681     0.04012     0.0         18.00000   32.00000

              UPPER-2                               LOWER-2                                   ICE-2
   0.0        18.00000   32.00000    0.0         0.0         0.0         0.0         18.00000   32.00000


MANOMETER PRESSURE CORRECTION COEFFICIENTS
                                          PU-1
30.0000 30.1730 27.0000 27.1560 26.5000 26.6460 26.0000 26.1530 25.0000 25.1490

                                          PU-2
30.0000 39.4860 27.0000 35.5430 26.5000 34.8910 26.0000 34.2350 25.0000 32.9250

                                          PL-1
30.0000 29.8070 27.0000 26.8260 26.5000 26.3300 26.0000 25.8330 25.0000 24.8420

                                          PL-2
30.0000 29.9620 27.0000 26.9700 26.5000 26.4700 26.0000 25.9740 25.0000 24.9750

                                          PI-1
30.0000 30.5610 27.0000 27.4920 26.5000 26.9760 26.0000 26.4700 25.0000 25.4490

                                          PI-2
29.6830 29.6970 27.0010 27.0030 26.4850 26.4950 26.0030 26.0020 25.0010 25.0030

                                          P-ATM
22.3090 44.6560 19.8200 39.9040 14.6600 29.2740 12.4900 24.9390  9.9800 19.8890


RTD WEIGHTING FACTORS
                              UPPER
.0628 .1161 .0831 .0831 .0960 .0960 .0950 .0960 .0296 .0296
.0296 .0296 .0740 .0105 .0167 .0513

                              LOWER
.0415 .0415 .0415 .0415 .0102 .0284 .0586 .0086 .0266 .0586 .1037
.1037 .1037 .1037 .0500 .0092 .0244 .0145 .0176 .0249 .0219 .0240 .0423 .0

                               ICE
.0730 .0730 .0706 .0706 .2237 .2796 .2094


VOLUME WEIGHTING FACTORS
 UPPER  LOWER   ICE
2.0144 1.0000 0.4482
```

SUMMARY OF AVERAGES

RUN #	ELAPSED TIME	AVG TEMP UPPER	AVG PRESS UPPER	AVG V PRESS UPPER	AVG TEMP LOWER	AVG PRESS LOWER	AVG V PRESS LOWER	AVG TEMP ICE	AVG PRESS ICE	AVG V PRESS ICE
1	0.0	68.9845	26.9463	0.1057	70.8930	26.9162	0.0809	17.3049	26.9462	0.0357
2	0.50	68.8887	26.9446	0.1049	70.8492	26.9152	0.0797	17.3487	26.9452	0.0354
3	1.00	68.8289	26.9412	0.1042	70.8101	26.9122	0.0790	17.3529	26.9417	0.0349
4	1.50	68.7654	26.9386	0.1034	70.7744	26.9071	0.0786	17.4967	26.9416	0.0348
5	2.00	68.5077	26.9278	0.1023	71.2822	26.8981	0.0829	17.4032	26.9284	0.0343
6	2.50	68.1160	26.9239	0.1023	71.3691	26.8941	0.0838	17.4082	26.9244	0.0329
7	3.00	68.1199	26.9167	0.1012	71.4725	26.8891	0.0839	17.3129	26.9194	0.0339
8	3.50	67.7060	26.9115	0.1005	71.4913	26.8841	0.0840	17.2448	26.9124	0.0337
9	4.00	67.8249	26.9016	0.1009	70.9852	26.8740	0.0816	17.2103	26.9030	0.0333
10	4.50	67.8274	26.8956	0.1009	70.8401	26.8675	0.0805	17.1687	26.8961	0.0327
11	5.00	67.7154	26.8905	0.1005	70.7948	26.8640	0.0792	17.1263	26.8967	0.0328
12	5.50	67.6623	26.8859	0.0994	70.6814	26.8574	0.0784	17.0988	26.8856	0.0325
13	6.00	67.5987	26.8832	0.0987	70.6384	26.8534	0.0775	17.0752	26.8811	0.0330
14	6.50	67.5686	26.8835	0.0980	70.5913	26.8524	0.0765	17.1103	26.8802	0.0348
15	7.00	67.4856	26.8783	0.0973	70.5408	26.8464	0.0761	17.1847	26.8732	0.0330
16	7.50	67.4403	26.8769	0.0963	70.5102	26.8449	0.0754	17.1387	26.8717	0.0337
17	8.00	67.4099	26.8748	0.0956	70.4629	26.8419	0.0729	17.2289	26.8703	0.0321
18	8.50	67.3518	26.8739	0.0946	70.4342	26.8414	0.0728	17.2171	26.8688	0.0321
19	9.00	67.2783	26.8696	0.0932	70.4104	26.8394	0.0727	17.1849	26.8643	0.0319
20	9.50	67.2562	26.8679	0.0922	70.3791	26.8369	0.0725	17.2020	26.8628	0.0317
21	10.00	67.2321	26.8657	0.0919	70.3509	26.8559	0.0724	17.1930	26.8593	0.0318
22	10.50	67.1276	26.8635	0.0912	70.3286	26.8534	0.0719	17.2140	26.8579	0.0318
23	11.00	67.1053	26.8589	0.0909	70.3380	26.8484	0.0721	17.1731	26.8519	0.0315
24	11.50	67.0480	26.8575	0.0899	70.2734	26.8459	0.0717	17.1361	26.8509	0.0322
25	12.00	67.0235	26.8541	0.0892	70.2524	26.8419	0.0715	17.1708	26.8479	0.0342
26	12.50	66.9882	26.8531	0.0886	70.2190	26.8429	0.0711	17.1431	26.8469	0.0336
27	13.00	66.9404	26.8505	0.0880	70.2169	26.8389	0.0710	17.1705	26.8430	0.0304
28	13.50	66.9130	26.8505	0.0873	70.2131	26.8384	0.0708	17.3090	26.7984	0.0307
29	14.00	66.8858	26.8466	0.0873	70.1762	26.8363	0.0710	17.1936	26.8395	0.0332
30	14.50	66.8549	26.8470	0.0851	70.1403	26.8343	0.0706	17.2635	26.8385	0.0317
31	15.00	66.8321	26.8440	0.0873	70.1512	26.8328	0.0707	17.2359	26.8371	0.0320

RESULTS OF THE LINEAR RE[illegible]SION ANALYSIS

RUN #	W EXPERIMENTAL	LEAKAGE RATE UPPER LIMIT	LEAKAGE RATE	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	1.00008	-0.70726	0.18712	1.00016	1.00008	0.99976
4	1.00003	-0.26726	0.04091	1.00021	0.99997	0.99946
5	0.99965	-0.92300	-0.35991	1.00034	0.99852	0.99919
6	0.99988	-0.62003	-0.26698	1.00093	0.99817	0.99908
7	0.99963	-0.57978	-0.33200	1.00070	0.99779	0.99906
8	0.99991	-0.43868	-0.22206	1.00132	0.99756	0.99895
9	0.99971	-0.38287	-0.21919	1.00071	0.99823	0.99869
10	0.99958	-0.37062	-0.24045	1.00048	0.99830	0.99854
11	0.99961	-0.33833	-0.23332	1.00051	0.99830	0.99864
12	0.99954	-0.31941	-0.23303	1.00048	0.99830	0.99830
13	0.99954	-0.29810	-0.22530	1.00053	0.99827	0.99817
14	0.99960	-0.27152	-0.20680	1.00062	0.99836	0.99799
15	0.99951	-0.25652	-0.20044	1.00061	0.99824	0.99764
16	0.99956	-0.23717	-0.18634	1.00069	0.99827	0.99766
17	0.99955	-0.21993	-0.17343	1.00069	0.99834	0.99747
18	0.99963	-0.20026	-0.15519	1.00081	0.99838	0.99744
19	0.99962	-0.18296	-0.13997	1.00084	0.99835	0.99735
20	0.99961	-0.16815	-0.12770	1.00085	0.99832	0.99727
21	0.99980	-0.14814	-0.10539	1.00083	0.99909	0.99715
22	0.99985	-0.12826	-0.08406	1.00097	0.99906	0.99705
23	0.99971	-0.11590	-0.07455	1.00085	0.99885	0.99693
24	0.99978	-0.10265	-0.06320	1.00095	0.99889	0.99694
25	0.99968	-0.09474	-0.05818	1.00089	0.99879	0.99669
26	0.99975	-0.08532	-0.05087	1.00094	0.99890	0.99673
27	0.99970	-0.07845	-0.04629	1.00096	0.99876	0.99664
28	0.99946	-0.08120	-0.05102	1.00104	0.99875	0.99469
29	0.99965	-0.07639	-0.04820	1.00094	0.99874	0.99636
30	0.99972	-0.07005	-0.04334	1.00110	0.99875	0.99624
31	0.99961	-0.06727	-0.04230	1.00095	0.99867	0.99623

FINAL LEAKAGE RATE (% PER DAY) = -0.04230   INTERCEPT= 0.99984

UPPER CONFIDENCE LIMIT FOR THE RATE IS -0.06727

SUMMARY OF [illegible]AGES

RUN #	ELAPSED TIME	AVG TEMP UPPER	AVG PRESS UPPER	AVG V PRESS UPPER	AVG TEMP LOWER	AVG PRESS LOWER	AVG V PRESS LOWER	AVG TEMP ICE	AVG PRESS ICE	AVG V PRESS ICE
1	0.0	69.1417	0.0	601.6130	71.9935	0.0	0.1216	16.8504	0.0	0.5266
2	1.00	69.6250	0.0	590.5125	72.0897	0.0	0.1265	16.8627	0.0	0.5330
3	2.00	69.7087	0.0	523.0715	72.1841	0.0	0.1294	16.8522	0.0	468.3241
4	2.50	69.7494	0.0	577.6485	72.1833	0.0	0.1303	16.8584	0.0	511.1095
5	3.00	69.7495	0.0	610.7735	72.1569	0.0	0.1310	16.9793	0.0	537.8050
6	4.00	69.7869	0.0	590.9403	72.2169	0.0	0.1320	17.0197	0.0	505.7419
7	5.00	69.8168	0.0	603.2279	72.1790	0.0	0.1344	16.9073	0.0	542.9652
8	6.00	69.8557	0.0	609.1247	72.1753	0.0	0.1334	16.9747	0.0	516.2228
9	7.00	69.8588	0.0	670.8578	72.1192	0.0	0.1304	17.0934	0.0	420.0445
10	8.00	69.8956	0.0	659.2614	72.0877	0.0	0.1264	17.0955	0.0	372.0063
11	9.00	69.9198	0.0	636.1914	71.9969	0.0	0.1216	16.9156	0.0	364.2604
12	10.00	69.9078	0.0	608.3686	71.9208	0.0	0.1170	16.8032	0.0	314.8742
13	11.00	69.9333	0.0	111.9387	71.6806	0.0	0.1129	16.6725	0.0	244.0879
14	12.00	69.9612	0.0	0.1335	71.8281	0.0	0.1090	16.7524	0.0	0.0321
15	13.00	69.9278	0.0	0.1580	71.7335	0.0	0.1046	16.7894	0.0	0.1600
16	14.00	69.9736	0.0	0.1530	71.6629	0.0	0.1010	16.9264	0.0	0.1549
17	15.00	69.9950	0.0	0.1020	71.5913	0.0	0.0967	16.9594	0.0	0.1508
18	16.00	70.0228	25.4803	0.1122	71.4495	25.4663	0.0944	17.1786	25.4932	0.0345
19	17.00	70.0340	26.1857	0.1103	71.4489	26.1586	0.0898	17.1752	26.1833	0.0345
20	17.50	70.0658	26.5290	0.1095	71.3925	26.5045	0.0887	17.2175	26.5321	0.0321
21	18.00	69.8084	26.7918	0.1072	71.2694	26.7611	0.0874	17.6705	26.7914	0.0334
22	18.50	69.2748	26.7733	0.1072	71.1176	26.7435	0.0857	17.2442	26.7741	0.0345
23	19.00	69.2124	26.8254	0.1072	71.0603	26.7962	0.0847	17.2955	26.8271	0.0342
24	19.50	69.0284	26.8167	0.1068	70.9698	26.7862	0.0827	17.2903	26.8152	0.0336
25	20.00	69.1597	26.9550	0.1064	70.9595	26.9257	0.0819	17.3240	26.9556	0.0348

SUMMARY OF AVERAGES

RUN #	ELAPSED TIME	AVG TEMP UPPER	AVG PRESS UPPER	AVG V PRESS UPPER	AVG TEMP LOWER	AVG PRESS LOWER	AVG V PRESS LOWER	AVG TEMP ICE	AVG PRESS ICE	AVG V PRESS ICE
1	0.0	66.7830	26.8445	0.0845	70.1368	26.8323	0.0706	17.3049	26.8360	0.0320
2	0.50	66.7376	26.8419	0.0839	70.1013	26.8313	0.0705	17.3665	26.8336	0.0314
3	1.00	66.7123	26.8406	0.0839	70.1037	26.8283	0.0704	17.4323	26.8321	0.0317
4	1.50	66.6744	26.8371	0.0836	69.9175	26.8268	0.0704	17.4091	26.8276	0.0330
5	2.00	66.6635	26.8367	0.0830	70.0615	26.8258	0.0704	17.3703	26.8286	0.0346
6	2.50	66.6330	26.8329	0.0827	70.0747	26.8238	0.0704	17.4405	26.8266	0.0359
7	3.00	66.6055	26.8324	0.0824	70.0718	26.8258	0.0703	17.4342	26.8276	0.0355
8	3.50	66.5672	26.8306	0.0818	70.0412	26.8223	0.0705	17.4499	26.8261	0.0321
9	4.00	66.5371	26.8316	0.0812	69.9891	26.8233	0.0706	17.5510	26.8271	0.0333
10	4.50	66.5323	26.8277	0.0812	70.0530	26.8193	0.0659	17.4661	26.8242	0.0337
11	5.00	66.5045	26.8274	0.0800	70.1528	26.8193	0.0674	17.4688	26.8232	0.0325
12	5.50	66.5028	26.8265	0.0788	70.0425	26.8173	0.0678	17.4322	26.8212	0.0327
13	6.00	66.4503	26.8256	0.0791	70.0217	26.8168	0.0680	17.4613	26.8212	0.0331
14	6.50	66.4509	26.8243	0.0791	69.9966	26.8153	0.0679	17.4902	26.8197	0.0334
15	7.00	66.4131	26.8217	0.0791	69.9924	26.8128	0.0679	17.4744	26.8177	0.0334
16	7.50	66.4350	26.8196	0.0786	69.9941	26.8097	0.0680	17.4416	26.8147	0.0339
17	8.00	66.3852	26.8217	0.0785	70.0762	26.8107	0.0681	17.5867	26.8157	0.0339
18	8.50	66.4364	26.8191	0.0782	69.9601	26.8102	0.0682	17.5760	26.8147	0.0419
19	9.00	66.3590	26.8204	0.0779	69.9514	26.8097	0.0679	17.6157	26.8152	0.0340
20	9.50	66.3619	26.8204	0.0777	69.9601	26.8097	0.0686	17.6625	26.8157	0.0341
21	10.00	66.3548	26.8178	0.0777	69.9509	26.8082	0.0684	17.5424	26.8127	0.0354
22	10.50	66.3523	26.8151	0.0765	69.9454	26.8052	0.0686	17.4649	26.8098	0.0334
23	11.00	66.3750	26.8170	0.0765	69.9362	26.8062	0.0686	17.4381	26.8108	0.0330
24	11.50	66.2996	26.8160	0.0757	69.9194	26.8042	0.0686	17.4179	26.8108	0.0332
25	12.00	66.3189	26.8143	0.0757	69.9083	26.8027	0.0686	17.3818	26.8098	0.0331
26	12.50	66.3068	26.8139	0.0757	69.8942	26.8027	0.0692	17.4531	26.8088	0.0330
27	13.00	66.2969	26.8126	0.0757	69.8884	26.8007	0.0688	17.3927	26.8068	0.0324
28	13.50	66.2478	26.8096	0.0757	69.9496	26.7987	0.0692	17.3603	26.8023	0.0310
29	14.00	66.2972	26.8113	0.0757	69.8589	26.7997	0.0688	17.2942	26.8028	0.0318
30	14.50	66.2706	26.8083	0.0754	69.8535	26.7972	0.0689	17.3431	26.8003	0.0340
31	15.00	66.2378	26.8083	0.0754	69.8570	26.7977	0.0693	17.3166	26.8008	0.0342
32	15.50	66.2644	26.8061	0.0751	69.8292	26.7912	0.0692	17.3225	26.7979	0.0321
33	16.00	66.2098	26.8074	0.0737	69.8367	26.7947	0.0697	17.3976	26.7984	0.0335
34	16.50	66.2057	26.8045	0.0740	69.8299	26.7927	0.0641	17.2756	26.7959	0.0331
35	17.00	66.2095	26.8057	0.0740	69.8240	26.7942	0.0643	17.3158	26.7969	0.0327
36	17.50	66.2180	26.8027	0.0732	69.8198	26.7917	0.0649	17.3017	26.7964	0.0331
37	18.00	66.1955	26.8046	0.0735	69.7956	26.7942	0.0646	17.3835	26.7974	0.0327
38	18.50	66.1969	26.8015	0.0735	69.7904	26.7922	0.0645	17.3844	26.7964	0.0308
39	19.00	66.1497	26.8020	0.0735	69.7880	26.7937	0.0647	17.4915	26.7964	0.0311
40	19.50	66.1576	26.8002	0.0735	69.7929	26.7887	0.0644	17.3098	26.7944	0.0318
41	20.00	66.1393	26.7993	0.0735	69.7775	26.7877	0.0640	17.4762	26.7934	0.0322
42	20.50	66.1038	26.7959	0.0732	69.7724	26.7846	0.0643	17.4246	26.7904	0.0333
43	21.00	66.1119	26.7967	0.0732	69.7623	26.7872	0.0644	17.4468	26.7904	0.0333
44	21.50	66.1010	26.7959	0.0729	69.7468	26.7872	0.0645	17.4732	26.7910	0.0322
45	22.00	66.0914	26.7950	0.0718	69.7379	26.7861	0.0642	17.4947	26.7895	0.0340
46	22.50	66.0929	26.7928	0.0721	69.7379	26.7826	0.0644	17.4018	26.7870	0.0329
47	23.00	66.0701	26.7946	0.0711	69.7374	26.7846	0.0639	17.4218	26.7890	0.0327
48	23.50	66.0320	26.7928	0.0716	69.7231	26.7836	0.0641	17.3683	26.7865	0.0321
49	24.00	66.0173	26.7924	0.0716	69.7118	26.7836	0.0642	17.4288	26.7865	0.0311

RESULTS OF THE LINEAR REGRESSION ANALYSIS

RUN #	W EXPERIMENTAL	LEAKAGE RATE UPPER LIMIT	LEAKAGE RATE	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	0.99993	-0.60674	-0.17631	1.00061	0.99992	0.99961
4	0.99996	-0.26068	-0.08977	0.99997	1.00021	0.99944
5	0.99992	-0.17554	-0.09563	1.00003	0.99990	0.99950
6	0.99979	-0.27916	-0.17289	0.99992	0.99980	0.99923
7	0.99982	-0.23460	-0.16258	0.99996	0.99981	0.99929
8	0.99984	-0.19644	-0.13756	1.00000	0.99981	0.99929
9	0.99990	-0.15976	-0.09668	1.00009	0.99994	0.99912
10	0.99982	-0.14239	-0.09283	0.99997	0.99984	0.99916
11	0.99980	-0.13090	-0.09097	1.00006	0.99960	0.99917
12	0.99984	-0.11406	-0.07886	1.00007	0.99972	0.99916
13	0.99986	-0.09792	-0.06521	1.00013	0.99973	0.99909
14	0.99981	-0.08961	-0.06156	1.00008	0.99972	0.99896
15	0.99977	-0.08691	-0.06274	1.00005	0.99964	0.99892
16	0.99966	-0.09692	-0.07332	0.99994	0.99952	0.99886
17	0.99970	-0.09702	-0.07611	1.00013	0.99940	0.99859
18	0.99960	-0.10498	-0.08459	0.99995	0.99960	0.99828
19	0.99975	-0.09728	-0.07790	1.00015	0.99961	0.99851
20	0.99975	-0.09028	-0.07190	1.00019	0.99956	0.99842
21	0.99969	-0.08725	-0.07062	1.00007	0.99953	0.99852
22	0.99965	-0.08620	-0.07112	1.00002	0.99942	0.99864
23	0.99970	-0.08232	-0.06829	1.00004	0.99948	0.99875
24	0.99977	-0.07628	-0.06203	1.00018	0.99943	0.99878
25	0.99970	-0.07265	-0.05929	1.00008	0.99940	0.99883
26	0.99968	-0.06993	-0.05749	1.00009	0.99940	0.99865
27	0.99966	-0.06790	-0.05635	1.00006	0.99935	0.99872
28	0.99955	-0.07033	-0.05924	0.99997	0.99915	0.99868
29	0.99965	-0.06806	-0.05764	1.00001	0.99937	0.99880
30	0.99956	-0.06868	-0.05869	0.99996	0.99928	0.99852
31	0.99960	-0.06743	-0.05826	1.00002	0.99928	0.99859
32	0.99947	-0.06987	-0.06091	0.99990	0.99909	0.99855
33	0.99959	-0.06830	-0.05982	1.00010	0.99919	0.99835
34	0.99959	-0.06658	-0.05850	0.99909	0.99934	0.99853
35	0.99963	-0.06422	-0.05631	1.00003	0.99940	0.99850
36	0.99954	-0.06356	-0.05610	0.99993	0.99929	0.99850
37	0.99962	-0.06133	-0.05398	1.00004	0.99944	0.99838
38	0.99954	-0.06054	-0.05357	0.99991	0.99938	0.99841
39	0.99959	-0.05894	-0.05220	1.00003	0.99943	0.99817
40	0.99950	-0.05867	-0.05227	0.99994	0.99925	0.99829
41	0.99947	-0.05876	-0.05267	0.99995	0.99925	0.99805
42	0.99940	-0.05986	-0.05393	0.99989	0.99914	0.99801
43	0.99944	-0.06001	-0.05434	0.99991	0.99925	0.99797
44	0.99945	-0.05984	-0.05444	0.99991	0.99927	0.99797
45	0.99943	-0.05969	-0.05453	0.99996	0.99926	0.99780
46	0.99936	-0.06042	-0.05541	0.99984	0.99913	0.99794
47	0.99948	-0.05940	-0.05453	0.99999	0.99922	0.99799
48	0.99947	-0.05843	-0.05370	0.99998	0.99920	0.99803
49	0.99947	-0.05748	-0.05287	0.99990	0.99922	0.99794

FINAL LEAKAGE RATE (% PER DAY) = -0.05287 Y-INTERCEPT= 0.99993

UPPER CONFIDENCE LIMIT FOR THE RATE IS -0.05748

SUMMARY OF [illegible]GES

RUN #	ELAPSED TIME	AVG TEMP UPPER	AVG PRESS UPPER	AVG V PRESS UPPER	AVG TEMP LOWER	AVG PRESS LOWER	AVG V PRESS LOWER	AVG TEMP ICE	AVG PRESS ICE	AVG V PRESS ICE
1	0.0	65.9482	26.7813	0.0705	69.6664	26.7726	0.0639	17.5456	26.7781	0.0327
2	0.50	65.9211	26.7817	0.0708	69.6478	26.7766	0.0641	17.5942	26.7781	0.0331
3	1.00	65.8956	26.7778	0.0708	69.6518	26.7691	0.0616	17.4517	26.7746	0.0335
4	1.50	65.9656	26.7783	0.0700	69.6357	26.7696	0.0623	17.4546	26.7751	0.0303
5	2.00	65.9304	26.7757	0.0703	69.6392	26.7671	0.0623	17.3863	26.7721	0.0306
6	2.50	65.8933	26.7753	0.0705	69.6416	26.7666	0.0624	17.3786	26.7716	0.0318
7	3.00	65.8828	26.7723	0.0705	69.6091	26.7631	0.0622	17.3872	26.7681	0.0321
8	3.50	65.9042	26.7714	0.0708	69.6121	26.7621	0.0624	17.4723	26.7676	0.0322
9	4.00	65.9025	26.7688	0.0705	69.5984	26.7616	0.0625	17.4711	26.7661	0.0317
10	4.50	65.9304	26.7667	0.0705	69.5950	26.7590	0.0627	17.4224	26.7637	0.0324
11	5.00	65.9242	26.7667	0.0705	69.5948	26.7590	0.0625	17.4143	26.7622	0.0322
12	5.50	65.9266	26.7654	0.0703	69.5842	26.7570	0.0628	17.2215	26.7622	0.0327
13	6.00	65.9557	26.7624	0.0695	69.5940	26.7540	0.0626	17.4470	26.7607	0.0329

RESULTS OF THE LINEAR RE[illegible]ON ANALYSIS

RUN #	W EXPERIMENTAL	LEAKAGE RATE UPPER LIMIT	LEAKAGE RATE	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	0.99998	-1.39701	-0.05509	0.99996	0.99998	1.00003
4	0.99995	-0.40246	-0.10993	0.99987	1.00000	1.00017
5	0.99991	-0.28909	-0.14493	0.99983	0.99991	1.00019
6	0.99992	-0.21488	-0.12636	0.99988	0.99988	1.00014
7	0.99982	-0.22165	-0.15421	0.99979	0.99982	0.99998
8	0.99973	-0.25223	-0.18959	0.99970	0.99976	0.99978
9	0.99968	-0.26284	-0.21035	0.99962	0.99977	0.99975
10	0.99957	-0.28690	-0.23688	0.99949	0.99967	0.99973
11	0.99958	-0.28017	-0.23981	0.99950	0.99968	0.99970
12	0.99959	-0.26445	-0.22956	0.99946	0.99961	1.00008
13	0.99940	-0.28030	-0.24631	0.99932	0.99949	0.99955

FINAL LEAKAGE RATE (% PER DAY) = -0.24631 INTERCEPT= 1.00009

UPPER CONFIDENCE LIMIT FOR THE RATE IS -0.28030

9.0 Local Leak Test Program

9.1 Past Test Results Summary

Local leak tests have been conducted periodically on Unit 2 in accordance with guidelines specified in 10 CFR 50 Appendix J, the FSAR, and the Plant Technical Specifications. Testing is performed under plant procedure 12 THP 4030 STP.203, 'Type B and C Leak Rate Test'. The program consists of 'Type B' tests designed to determine leakage through the containment electrical and pipe penetrations, air lock door seals and overall air lock leakage, and 'Type C' tests designed to determine leakage through containment isolation valves. Table 9.1.1 summarizes the test results for Type B and C testing performed since the Unit 2 Preoperational test.

The leakage detection instrumentation used in the conduct of the 'Type B and C' tests is certified, traceable to NBS, and calibrated prior to the tests. The instruments consist of 4 calibrated flow meters, of different ranges, connected in parallel. A test is performed by isolating a test volume bound by the containment isolation barriers under examination. The test volume is pressurized to 12.0 psig. A regulator in the air supply line to the leak rate monitor maintains the test volume pressure at 12.0 psig while the flowmeters measure the air flow required to maintain this pressure. This flow is equivalent to the leakage out of the test volume. Exact test pressure and temperature is recorded and used to convert the measured leakage to standard conditions.

Table 9.1.1

Type B and C Test Results Summary
(Leakage Expressed as Fraction of L_a)

Test Date	Type B	Type C	Type B & C
Allowable	0.147	0.443	0.6
May 1979	0.0033	0.1261	0.129
Dec. 1979	0.0041	0.2090	0.213
May 1981	0.0116	0.1633	0.175

Table 9.1.2 shows the valves which were found to leak in excess of the guideline leakage during the two previous surveillance tests, May - June 1979 and October - December 1979. The valves marked with an asterisk (*) were also found to exhibit excessive leakage during the most recent surveillance, May 1981. (See, also Table 9.1.3). Table 9.1.4 lists those valves which were repaired, during the May 1981 surveillance, and also gives a short synopsis of the repair.

It should be noted that the guideline leakage is not an acceptance criteria. It is strictly a guide for the Test Engineer to use in determining whether repairs should be made.

Seventeen of the thirty-eight valves which failed the Type C test were found in the Non-Essential Service Water System (NSW). Three of these valves (check valves NSW-415-1, NSW-417-1, NSW-244-1) have failed the two previous surveillance tests, while 9 other check valves failed the last test. Three of the seven air operated valve failures were repeats from the previous test.

The check valves were repaired by cleaning the seating surfaces and replacing the gaskets. If the check valve had a neoprene seat, the entire valve was replaced. The air operated valves were repaired by cleaning and lapping the seating surfaces.

The other group of valves found leaking above guideline values the Containment Purge valves. The valves in this group which failed were:

VCR-101 & VCR-201	Instr. Rm. Supply
VCR-102 & VCR-202	Instr. Rm. Exhaust
VCR-104 & VCR-204	Lower Cont. Exhaust

The Instrument Room Supply and the Lower Containment Exhaust Purge Valves have failed the previous two tests while the Instrument Room Exhaust Purge Valves failed for the first time in 1981. All of these valves were repaired by cleaning the neoprene seal, and then lubricating with Dow-Corning Silicone III. When VCR-104 and VCR-204 were tested after the above mentioned repair, the leakage was still excessive (27,000 SCCM). A bead was then welded to the edge of the valve flapper to increase the tightness of the neoprene seal when the valve was closed. This repair reduced the leakage in VCR-104 and VCR-204 to 50 SCCM.

Table 9.1.2

Valves	May-June 1979 Leakage		Oct.-Dec. 1979 Leakage	
	As Found (sccm)	As Left (sccm)	As Found (sccm)	As Left (sccm)
* NSW-415-1	5000	4	39,900	125
* NSW-415-3	Passed		14,000	0
NSW-415-4	5000	681	46,000	718
* NSW-419-2	Passed		24,000	0
* NSW-419-3	Tested Against WCR-930		47,000	62
* NSW-419-4	Tested Against WCR-934		47,000	150
* NSW-244-1	5000	0	5,000	764
* NSW-244-2	Passed		37,000	220
NSW-244-3	Passed		14,000	0
NSW-244-4	5000	0	37,000	219
* NSW-417-3	Passed		8,000	100
* NSW-417-4	2000	0	40,000	1000
WCR-930	5000	0	Passed	
WCR-934	5000	0	Tested Against NSW-419-4	
WCR-967	2000	8	Passed	
WCR-901	Passed		7,400	0
* WCR-909	Passed		8,000	5618
WCR-921	5000	4	17,000	0
WCR-933	Passed		5,000	125
* WCR-951	Passed		24,000	137
* WCR-952	Passed		14,000	0
WCR-954	Passed		24,000	400
* WCR-958	Passed		Tested Against WCR-954	
WCR-961	Passed		10,000	0
* VCR-101	Passed		Tested Against VCR-201	
* VCR-201	2000	4	25,000	325
VCR-103	Tested Against VCR-203		Passed	
VCR-203	6000	44	Passed	
* VCR-104	Tested Against VCR-204		Tested Against VCR-204	
* VCR-204	6000	301	41,000	3000
VCR-105	Tested Against VCR-205		Passed	
VCR-205	2000	2472	Passed	
ECR-18	Passed		Tested Against ECR-28	
ECR-28	Passed		75	75
CS-442-1	5000	105	4,000	0
* SI-189	Passed		838	838
* SM-1	5000	360	Passed	
N-102	Passed		500	500
VCR-10	Tested Against VCR-11		Passed	
VCR-11	4959	975	Passed	
VCR-20	Tested Against VCR-21		Passed	
VCR-21	29	0	Passed	
* N-160	Passed		1300	520

Table 9.1.2 Continued

Valves	May-June 1979 Leakage As Found (sccm)	As Left (sccm)	Oct.-Dec. 1979 Leakage As Found (sccm)	As Left (sccm)
* DCR-620	Tested Against DCR-620		Passed	
* DCR-621	2000	3	Passed	
DCR-205	Passed		Tested Against DCR-206	
DCR-206	Passed		3500	0
* DCR-600	Passed		Tested Against DCR-601	
* DCR-601	Passed		4000	150
QCM-250	Passed		1800	1000
* ECR-33	2000	51	100	100
* ECR-31	Tested Against ECR-32		Tested Against ECR-32	
* ECR-32	2000	213	2092	2092
* GCR-301	Passed		130	130
* XCR-102	Tested Against XCR-103		Passed	
* XCR-103	551	551	Passed	
CCR-457	Tested Against CCW-135		Passed	
CCW-135	363	363	Passed	
PPP-303	251	251	Passed	
PPA-310	Tested Against PPA-311		Passed	
PPA-311	171	171	Passed	
PPA-312	Tested Against PPA-313		Passed	
PPA-313	50	50	Passed	
ICM-250	5000	0	Passed	
ICM-251	5000	0	Passed	
* CCW-243-25	Passed		160	160
CCW-243-72	Passed		165	165
* CCW-244-72	Passed		450	450
CCM-430	Passed		18000	77
* CCM-431	Passed		550	550
CCR-440	Passed		125	125
CCR-441	Passed		1200	101
R-156	1305	160	Passed	
R-159	Tested Against R-156		Passed	

Table 9.1.3 - Type C Failures - May 1981

TABLE NO. 2? VALVES [illegible] LEAKAGE IN EXCESS OF THE [illegible] LEAKAGE

VOLUME DESCRIPTION	LEAKAGE GUIDELINE (SCCM)	LEAKAGE AS FOUND (SCCM)	LEAKAGE AS LEFT (SCCM)
CLV 1 NSW-415-1 AND WCR-903 CPN-17,21	720.00	29943.55	0.0
CUV 1 NSW-419-1 AND WCR-922 CPN-26	480.00	1502.84	35.10
CUV 4 NSW-419-4 AND WCR-934 CPN-84	480.00	> 2000.00	2090.16
RCP 1 NSW-244-1 AND WCR-945 CPN-26	360.00	> 2000.00	0.0
RCP 1 WCR-951 AND WCR-955 CPN-26	360.00	> 2000.00	10.05
RCP 4 NSW-244-4 AND WCR-948 CPN-84	360.00	> 2000.00	0.0
RCP 4 WCR-954 AND WCR-958 CPN-84	360.00	> 2000.00	239.32
CLV 2 NSW-415-2 AND WCR-906 CPN-22	720.00	> 2000.00	0.0
CLV 3 NSW-415-3 AND WCR-911 CPN-23	720.00	> 2000.00	0.0
CLV 3 WCR-909 AND WCR-910 CPN-23	720.00	> 2000.00	651.23
CUV 2 NSW-419-2 AND WCR-926 CPN-27	480.00	> 2000.00	1996.24
CUV 3 NSW-419-3 AND WCR-930 CPN-85	480.00	> 2000.00	64.88
CUV 3 WCR-929 AND WCR-931 CPN-85	480.00	> 2000.00	0.0
RCP 2 NSW-244-2 AND WCR-946 CPN-27	360.00	> 2000.00	0.0
RCP 2 WCR-952 AND WCR-956 CPN-27	360.00	> 2000.00	0.0
INSTR. RM. EAST NSW-417-4,WCR-963 CPN-73	240.00	> 2000.00	0.0
INSTR. RM. WEST NSW-417-3,WCR-967 CPN-73	240.00	> 2000.00	0.0
INSTR. RM. PURGE SUPPLY VCR-101,201	1680.00	4470.57	24.84
INSTR. RM. EXHAUST VCR-102,202 (PURGE)	1680.00	>40000.00	204.61
LOWER PURGE EXH. VCR-104,204 CPN-63	3600.00	>40000.00	49.77
RELIEF VLVE. HDR. TO PRT SI-189 CPN-15	120.00	401.67	401.67
AIR PART/RAD GAS MONITOR SM-1 CPN-31	60.00	2340.08	2340.08
N-2 AND VENT HDR FOR RCDT N160,DCR-201	120.00	> 2000.00	0.0

TABLE NO. 2: VALVES SHOWING LEAKAGE IN EXCESS
------------ OF THE GUIDELINE LEAKAGE

VOLUME DESCRIPTION	LEAKAGE GUIDELINE (SCCM)	LEAKAGE AS FOUND (SCCM)	LEAKAGE AS LEFT (SCCM)
CLV AND CUV DRAIN HDR DCR-620,621 CPN-31	120.00	1298.78	0.0
CONT SUMP TO HUT'S DCR-600,601 CPN-41	360.00	748.59	748.59
RHR RECIRC 'E' ICM-305 CPN-45	1080.00	1390.00	1390.00
REFUELING CAV. DRAIN SF-159,160 CPN-42	360.00	> 2000.00	0.0
RCDT SAMPLE RCR-100,101 CPN-81	60.00	119.89	119.89
AIR PART/RAD GAS MONITOR ECR-33 CPN-31	60.00	1401.32	1401.32
AIR PART/RAD GAS MON ECR-31,32 CPN-32	120.00	3303.12	3303.12
CON AIR TO CONT. XCR-102,103 CPN-29	120.00	399.25	399.25
N-2 TO PRT GCR-301 CPN-74	45.00	119.77	119.77
BORON INJ. ICM-250 CPN-44	240.00	>40000.00	99.62
CCW TO CPN COILS 2,5 CCW-243-25 CPN-25	60.00	1009.57	0.0
CCW TO CPN COILS 2,5 CCW-244-25 CPN-25	60.00	807.66	0.0
CCW TO CPN COILS 3,4 CCW-244-72 CPN-72	60.00	1801.70	250.47
CCW FROM CEO-1 CCM-431 CPN-25	90.00	> 2000.00	0.0
CCW TO CEO-2 CCM-432 CPN-72	90.00	124.76	0.0
CCW FROM CEO-2 CCM-433 CPN-72	90.00	179.66	0.0

Table 9.1.4

Leak Rates of Containment Isolation Valves, and Corrective Actions Taken

Valve	As Found (SCCM)	As Left (SCCM)	Corrective Action
NSW-415-1	30,000.0	0.0	Replaced disc, replaced gaskets (SJO - 07592-4)
NSW-419-1	1,500.0	35.0	Cleaned seating surface (SJO - 07592-1)
NSW-419-4	2,000.0	2100.0	Cleaned valve, replaced gaskets (SJO - 07592-12)
NSW-244-1	2,000.0	0.0	Clean seat, replace gaskets (SJO - 07592-13)
WCR-951	2,000.0	10.0	Lap seats, replaced gaskets (SJO - 07592-14)
WCR-948	2,000.0	0.0	Lapped seat, replaced gaskets (SJO - 07592-16)
WCR-958	2,000.0	240.0	Lapped seat (SJO - 07592-17, 39)
NSW-415-2	2,000.0	0.0	Lapped seats, replaced gaskets, disc (SJO - 07592-9, 45)
NSW-415-3	2,000.0	0.0	Replaced valve (SJO - 07592-3, 40)
WCR-909	2,000.0	650.0	Cleaned & replaced gaskets (SJO - 07592-2)
NSW-419-2	2,000.0	2000.0	Replaced valve (SJO - 07592-5, 41)
NSW-419-3	2,000.0	65.0	Replaced valve (SJO - 07592-6)
WCR-929	2,000.0	0.0	Lap seats, replaced gaskets (SJO - 07592-7)
NSW-244-2	2,000.0	0.0	Replaced valve (SJO - 07592-10)
WCR-952	2,000.0	0.0	Cleaned valve (SJO - 07592-11)
NSW-417-4	2,000.0	0.0	Lapped, replaced gaskets (SJO - 07592-33, 48)
NSW-417-3	2,000.0	0.0	Lapped seat, replaced gaskets (SJO - 07592-32)

Table 9.1.4 Continued

Valve	As Found (SCCM)	As Left (SCCM)	Corrective Action
VCR-101, 201	4,500.0	25.0	Cleaned internals, tubed with Silicone 111 (SJO - 07592-42)
VCR-102, 202	40,000.0	205.0	Cleaned, lubed seal with Silicone 11 (SJO - 07592-49)
VCR-104, 204	40,000.0	50.0	Welded S.S. to valve so it would seat against the neoprene seal (SJO - 07592-43)
SM-1	2,340.1	2340.0	Cancelled (SJO - 07592-31)
N-160	2,000.0	0.0	Lapped seat and cleaned (SJO - 07592-46
DCR-620	1,300.0	Tested Against DCR-621	Cleaned, blued seat (SJO - 07592-24)
DCR-621	1,300.0	0.0	Cleaned and blued seat (SJO - 07592-25, 50)
SF-159	2,000.0	0.0	Replaced diaphragm (SJO - 07592-27)
ECR-33	1,400.0	1400.0	Cancelled (SJO - 07592-28)
ECR-31, 33	3,300.0	3300.0	Cancelled (SJO - 07592-29)
CCW-243-25	1,000.0	0.0	Replaced seats (SJO - 07592-22)
CCW-244-25	800.0	0.0	Replaced seats (SJO - 08592-23)
CCW-244-72	1,800.0	250.0	Installed new disc, lapped seat (SJO - 08592-21)
CCM-431	2,000.0	0.0	Lapped seat, cleaned (SJO - 08592-18)
CCM-432	125.0	0.0	Lapped seat, cleaned (SJO - 08592-19)
CCM-433	180.0	0.0	Lapped seat, cleaned (SJO - 07592-20)
NSW-244-4	2,000.0	0.0	Replaced valve (SJO - 08592-15)

Table 9.1.4 Continued

Valve	As Found (SCCM)	As Left (SCCM)	Corrective Action
CTS-131-W	15.491 CCM	0.0 CCM	Cleaned, blued seat (SJO - 07592-34)
CTS-131-E	3.853 CCM	0.861 CCM	Cleaned, blued seat (SJO - 07592-36)
ICM-250	40,000.0	0.0	Lapped seat (SJO - 07592-51)

9.2 May 1981 Local Leak Test Results

********** D. C. COOK NUCLEAR PLANT, UNIT NO. 2 **********
TYPE "B" AND "C" LEAK RATE TEST OF CONTAINMENT ISOLATION VALVES DURING APRL 1981 OUTAGE

TYPE "B" DATA INFORMATION

COMPLETED TEST VOLUMES

TEST VOLUME	DESCRIPTION	GUIDELINE LEAKAGE	CORRECTED LEAKAGE	TRIAL NO WHEN VOLUME PASSED
1	PERSONNEL AIRLOCKS 612' EL. CPN-N/A	5511.0	58.0	1
2	PERSONNEL AIRLOCKS 650' EL. CPN-N/A	5511.0	1.0	1
3	ZONE 3 PENETRATIONS(ELECTRICAL) CPN-N/A	1173.0	0.0	1
4	ZONE 4 PENETRATIONS(MECHANICAL) CPN-N/A	1173.0	171.7	1
5	BLIND FLANGE-FUEL TRANSFER CPN-1	1200.0	850.0	1
6	BLIND FLANGE-PLANT AIR TO CONT CPN-29	1200.0	0.0	1
7	BLIND FLANGE-ICE LOADING CPN-57	480.0	0.0	1
8	BLIND FLANGE-ICE LOADING CPN-80.	720.0	120.1	1
9	BLIND FLANGE-FLUX THMBLE HANDLE CPN-76	960.0	74.9	1
10	BLIND FLANGE-SPARE(UNIT 2 ONLY) CPN-67	240.0	0.0	1

TYPE "C" DATA INFORMATION

COMPLETED TEST VOLUMES

TEST VOLUME	DESCRIPTION	GUIDELINE LEAKAGE	CORRECTED LEAKAGE	TRIAL NO WHEN VOLUME PASSED
1	CLV 1 NSW-415-1 AND WCR-903 CPN-17,21	720.0	0.0	2
2	CLV 1 WCR901 AND WCR-902 CPN-17,21	720.0	350.3	1
3	CLV 4 NSW-415-4 AND WCR-915 CPN-20,24	720.0	149.4	1
4	CLV 4 WCR-913 AND WCR-914 5 CPN-20,24	720.0	0.0	1
5	CUV 1 NSW-419-1 AND WCR-922 CPN-26	480.0	35.1	2
6	CUV 1 WCR-921 AND WCR-923 CPN-26	480.0	99.8	1
7	CUV 4 NSW-419-4 AND WCR-934 CPN-84	480.0	2090.2	2
8	CUV 4 WCR-933 AND WCR-935 CPN-84	480.0	99.8	1
9	RCP 1 NSW-244-1 AND WCR-945 CPN-26	360.0	0.0	2
10	RCP 1 WCR-951 AND WCR-955 CPN-26	360.0	10.0	2
11	RCP 4 NSW-244-4 AND WCR-948 CPN-84	360.0	0.0	2
12	RCP 4 WCR-954 AND WCR-958 CPN-84	360.0	239.3	3
13	CLV 2 NSW-415-2 AND WCR-906 CPN-22	720.0	0.0	3
14	CLV 2 WCR-905 AND WCR-907 CPN-22	720.0	185.2	1
15	CLV 3 NSW-415-3 AND WCR-911 CPN-23	720.0	0.0	3
16	CLV 3 WCR-909 AND WCR-910 CPN-23	720.0	651.2	2
17	CUV 2 NSW-419-2 AND WCR-926 CPN-27	480.0	1996.2	3
18	CUV 2 WCR-925 AND WCR-927 CPN-27	480.0	0.0	1
19	CUV 3 NSW-419-3 AND WCR-930 CPN-85	480.0	64.9	3
20	CUV 3 WCR-929 AND WCR-931 CPN-85	480.0	0.0	2
21	RCP 2 NSW-244-2 AND WCR-946 CPN-27	360.0	0.0	2
22	RCP 2 WCR-952 AND WCR-956 CPN-27	360.0	0.0	2
23	RCP 3 NSW-244-3 AND WCR-947 CPN-85	360.0	0.0	1
24	RCP 3 WCR-953 AND WCR-957 CPN-85	360.0	0.0	1
25	INSTR. RM. EAST NSW-417-4,WCR-963 CPN-73	240.0	0.0	3
26	INSTR. RM. EAST WCR-961,WCR-962 CPN-73	240.0	0.0	1
27	INSTR. RM. WEST NSW-417-3,WCR-967 CPN-73	240.0	0.0	2
28	INSTR. RM. WEST WCR-965,WCR-966 CPN-73	240.0	90.0	1
29	INSTR. RM. PURGE SUPPLY VCR-101,201	1680.0	24.8	2
30	INSTR. RM. EXHAUST VCR-102,202 (PURGE)	1680.0	204.6	2
31	LOWER PURGE SUPPLY VCR-103,203 CPN-64	2880.0	79.5	1
32	LOWER PURGE EXH. VCR-104,204 CPN-63	3600.0	49.8	2
33	UPPER PURGE SUPPLY VCR-105,205 CPN-59	3600.0	124.2	1
34	UPPER PURGE EXH. VCR-106,206 CPN-60	2880.0	794.8	1
35	PRESS. RELIEF PURGE VCR-107,207 CPN-65	1440.0	0.0	1
36	HYD. RETURN LINE ECR-10,20 CPN-95	60.0	0.0	1
37	HYD. SAMPLE ECR-11,21 CPN-95	60.0	48.9	1
38	HYD. SAMPLE ECR-12,22 CPN-95	60.0	0.0	1
39	HYD. SAMPLE ECR-13,23 CPN-95	60.0	0.0	1
40	HYD. SAMPLE ECR-14,24 CPN-93	60.0	39.9	1
41	HYD. SAMPLE ECR-15,25 CPN-95	60.0	0.0	1
42	HYD. SAMPLE ECR-16,26 CPN-93	60.0	0.0	1
43	HYD. SAMPLE ECR-17,27 CPN-93	60.0	0.0	1

********** D. C. COOK NUCLEAR PLANT, UNIT NO. 2 **********
TYPE "B" AND "C" LEAK RATE TEST OF CONTAINMENT ISOLATION VALVES DURING APRL 1981 OUTAGE

TYPE "C" DATA INFORMATION

COMPLETED TEST VOLUMES

TEST VOLUME	DESCRIPTION	GUIDELINE LEAKAGE	CORRECTED LEAKAGE	TRIAL NO WHEN VOLUME PASSED
44	HYD. SAMPLE ECR-18,28 CPN-93	60.0	26.7	1
45	HYD. SAMPLE ECR-19,29 CPN-93	60.0	19.8	1
46	RCP-1 SEAL WATER CS-442-1 CPN-11	120.0	0.0	1
47	RCP-4 SEAL WATER CS-442-4 CPN-14	120.0	25.4	1
48	RCP-2 SEAL WATER CS-442-2 CPN-12	120.0	20.3	1
49	RCP-3 SEAL WATER CS-442-3 CPN-13	120.0	30.5	1
50	RELIEF VLVE. HDR. TO PRT SI-189 CPN-15	120.0	401.9	1
51	AIR PART/RAD GAS MONITOR SM-1 CPN-31	60.0	2340.1	1
52	N-2 TO ACCUMULATORS N102 CPN-32	60.0	0.0	1
53	N-2 TO PRT N159 CPN-74	45.0	0.0	1
54	PRIMARY WATER TO PRT PW-275 CPN-33	180.0	10.2	1
55	CHG TO REGEN HEAT EX. CS-321 CPN-35	180.0	60.6	1
56	DEAD WEIGHT CALIB. NPX-151-V1 CPN-30	30.0	0.0	1
57	GLYCOL SUPPLY VCR-10,11 CPN-86	480.0	0.0	1
58	GLYCOL RETURN VCR-20,21 CPN-56	480.0	0.0	1
59	N-2 AND VENT HDR FOR RCDT DCR-203,207	120.0	25.0	1
60	N-2 AND VENT HDR FOR RCDT N160,DCR-201	120.0	0.0	2
61	ICE COND AHU DRAIN HDR DCR-610,611	300.0	10.0	1
62	CLV AND CUV DRAIN HDR DCR-620,621 CPN-31	120.0	0.0	4
63	RCDT DRAIN HDR DCR-205,206 CPN-40	480.0	0.0	1
64	CONT SUMP TO HUT'S DCR-600,601 CPN-41	360.0	748.6	1
65	RCS LETDOWN QCR-300 CPN-34	120.0	0.0	1
66	RCP SEAL WATER RETURN QCM-250,350 CPN-37	480.0	50.0	1
67	RHR RECIRC 'E' ICM-305 CPN-45	1080.0	1390.0	1
68	RHR RECIRC 'W' ICM-306 CPN-46	1080.0	105.0	1
69	PW FOR RX CAV SCR DW209(212),210(211)	120.0	0.0	1
70	REFUELING H2O RX CAV SF151(152),153(154)	300.0	0.0	1
71	REFUELING CAV. DRAIN SF-159,160 CPN-42	360.0	0.0	2
72	HOT LEG SAMPLES NCR-105,106 CPN-66	60.0	0.0	1
73	PRESS LIQ SAMPLE NCR-107,108 CPN-66	60.0	0.0	1
74	STEAM SAMPLE NCR-109,110 CPN-66	60.0	0.0	1
75	RCDT SAMPLE RCR-100,101 CPN-81	60.0	119.9	1
76	PRT SAMPLE DCR-202,204 CPN-81	60.0	0.0	1
77	ACCUM SAMPLES ICP-5,6 CPN-81	60.0	0.0	1
78	AIR PART/RAD GAS MONITOR ECR-33 CPN-31	60.0	1401.3	1
79	'N' SI PP DISCH. ICM-260 CPN-43(68)	240.0	0.0	1
80	'S' SI PP DISCH. ICM-265 CPN-68(43)	240.0	49.6	1
81	AIR PART/RAD GAS MON ECR-31,32 CPN-32	120.0	3303.1	1
82	CON AIR TO CONT. XCR-100,101 CPN-74	120.0	0.0	1
83	CON AIR TO CONT. XCR-102,103 CPN-29	120.0	399.2	1
84	N-2 TO PRT GCR-301 CPN-74	45.0	119.8	1
85	N-2 TO ACCUMULATORS SV-101,GCR-314	60.0	0.0	1
86	SI TEST LINE SI-171,172,194 CPN-32	270.0	0.0	1

********** D. C. COOK NUCLEAR PLANT, UNIT NO. 2 **********
TYPE "B" AND "C" LEAK RATE TEST OF CONTAINMENT ISOLATION VALVES DURING APRL 1981 OUTAGE

TYPE "C" DATA INFORMATION

COMPLETED TEST VOLUMES

TEST VOLUME	DESCRIPTION	GUIDELINE LEAKAGE	CORRECTED LEAKAGE	TRIAL NO WHEN VOLUME PASSED
87	PW TO PRT NCR-252 CPN-33	180.0	139.7	1
88	CCW FOR RCP OIL CLRS CCM-452,454,458	1200.0	79.6	1
89	CCW FOR RCP OIL CLRS CCM-451,453,459	1200.0	99.7	1
90	CCW FOR EXCESS LD HX CCR-460,462 CPN-75	360.0	119.7	1
91	CCW FOR RX SUPPORTS CCR-457,CCW-135	240.0	159.7	1
92	CCW FOR RX SUPPORTS CCR-455,456 CPN-82	240.0	109.8	1
93	GRAB SAMPLE SM-4,6 CPN-92	60.0	74.9	1
94	CONT PRESS A,B ISOL PPP-300 CPN-94	0.0	0.0	1
95	CONT PRESS A,B ISOL PPP-301 "&N-92	0.0	0.0	1
96	CONT PRESS A,B ISOL PPP-302 CPN-91	0.0	0.0	1
97	CONT PRESS A,B ISOL PPP-303 CPN-96	0.0	0.0	1
98	CONT PFESS ALARM PPA-310,311 CPN-97	0.0	0.0	1
99	CONT PRESS ALARM PPA-312,313 CPN-98	0.0	49.8	1
100	BORON INJ. ICM-250 CPN-44	240.0	99.6	2
101	BORON INJ. ICM-251 CPN-44	240.0	0.0	1
102	WELD CHANNEL PRESS CA-181S CPN-83	30.0	0.0	1
103	WELD CHANNEL PRESS CA-181N CPN-83	30.0	0.0	1
104	GRAB SAMPLE SM-8,10 CPN-89	60.0	5.0	1
105	CCW TO CPN COILS 2,5 CCW-243-25 CPN-25	60.0	0.0	2
106	CCW TO CPN COILS 2,5 CCW-244-25 CPN-25	60.0	0.0	2
107	CCW TO CPN COILS 3,4 CCW-243-72 CPN-72	60.0	0.0	1
108	CCW TO CPN COILS 3,4 CCW-244-72 CPN-72	60.0	250.5	2
109	CCW TO CEO-1 CCM-430 CPN-25	90.0	0.0	1
110	CCW FROM CEO-1 CCM-431 CPN-25	90.0	0.0	2
111	CCW FROM CPN COILS 2,5 CCR-440 CPN-25	90.0	0.0	1
112	CCW TO CEO-2 CCM-432 CPN-72	90.0	0.0	2
113	CCW FROM CEO-2 CCM-433 CPN-72	90.0	0.0	2
114	CCW FROM CPN COILS 3,4 CCR-441 CPN-72	90.0	35.0	1
115	GLYCOL SUPPLY EXP. R-156,159 CPN-86	60.0	0.0	1
116	GLYCOL RETURN EXP. R-157,158 CPN-56	60.0	0.0	1
117	POST ACCIDENT SAMPLING RETURN CPN-67	30.0	24.7	1
118	POST ACCIDENT SAMPLING SUPPLY CPN-67	30.0	90.3	1
119	POST ACCIDENT SAMPLING R-11/12 CPN-32	60.0	0.0	1

********** D. C. COOK NUCLEAR PLANT, UNIT NO. 2 **********
TYPE "B" AND "C" LEAK RATE TEST OF CONTAINMENT ISOLATION VALVES DURING APRL 1981 OUTAGE

CONTAINMENT SPRAY CHECK VALVES

CHECK VALVE	START TIME	FINISH TIME	START ELEVATION	FINISH ELEVATION	LEAK RATE TO PASS	LEAK RATE ACTUAL	DATE TESTED	SUPPLEMENTAL JOB ORDER
CTS-127E	12:11	16:11	634.000	634.000	21.210	0.0	3-27	
CTS-127W	12:11	16:11	634.000	633.990	22.550	0.237	3-27	
CTS-131E	12:11	16:11	640.000	639.906	3.000	3.853	3-27	36
CTS-131E	9: 0	13: 0	640.000	640.000	3.000	0.0	4-20	
CTS-131W	12:11	16:11	640.000	639.622	3.730	15.491	3-27	34
CTS-131W	9: 0	13: 0	640.000	639.979	3.730	0.861	4-20	

********** D. C. COOK NUCLEAR PLANT, UNIT NO. 2 **********
TYPE "B" AND "C" LEAK RATE TEST OF CONTAINMENT ISOLATION VALVES DURING APRL 1981 OUTAGE

L E A K   R A T E   S U M M A R Y

	SCCM	LA
TYPE "B"	1275.65	0.0116
TYPE "C"	19423.07	0.1762
TOTAL	20698.71	0.1878

C O M P L E T I O N   R A T E   S U M M A R Y

TOTAL TESTED INITIALLY-	129	TOTAL RETESTED-	30
FAILED-	30	FAILED-	0
PASSED-	99	PASSED-	30

OUT OF 129 VOLUMES TO TEST, 0 STILL HAVE TO BE TESTED

OVERALL COMPLETION RATE IS 100.00%

10.0 REFERENCES

10.1 Donald C. Cook Nuclear Plant Final Safety Analysis Report

10.1.1 Initial Leakage Rate Testing of Containment
Section 5.2.1

10.1.2 Containment Leakage Test Program
Question 5.93, Appendix Q

10.1.3 Containment Integrated Leak Rate (Type A) Testing
Question 022.14, Appendix Q (Unit 2)

10.1.4 Local Leak Rate (Type B and C) Testing
Question 022.15, Appendix Q (Unit 2)

10.2 Donald C. Cook Nuclear Plant Unit No. 1 Technical Specifications

10.2.1 Containment Systems - Containment Leakage

Specifications: 3.6.1.2
Surveillance Requirements: 4.6.1.2

10.2.2 Containment Systems - Containment Air Locks

Specifications: 3.6.1.3
Surveillance Requirements: 4.6.1.3

10.3 American National Standards Institute (ANSI)

10.3.1 ANS N 45.4-1972 'Leakage Rate Testing of Containment Structures for Nuclear Reactors'

10.3.2 ANS N 274 Draft No. 1, 'Containment System Leakage Testing Requirements'

10.4 Code of Federal Regulations, 10 CFR 50 Appendix J, 'Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors.

10.5 Donald C. Cook Plant, Unit 2 'Reactor Containment Building Integrated Leak Rate Test (Preoperational) Test Report'.

10.6 Donald C. Cook Plant Surveillance Test Procedures

10.6.1 12 THP 4030 STP.202, 'Integrated Leak Rate Test'

10.6.2 12 THP 4030 STP.203, 'Type B and C Leak Rate Test'

10.6.3 12 THP 4030 STP.204, 'Personnel Air Lock Leakage Test'

Attachment No. 1 to AEP:NRC:00500E

Additional Information on Hydrogen Mitigation and Control

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2

Supplement to AEP:NRC:00500C

1.0 Distributed Ignition System (DIS)

1.1 Instrument Room Isolation

Our review of the communication paths between the instrument room and the lower volume subcompartments has revealed that limited communication exists through several small openings and a number of pipe sleeves which are not sealed. Therefore, the DIS design described in Attachment No. 2 to our AEP:NRC:00500A letter has been modified to include two additional igniters (one per train) in the instrument room. These two additional igniters will be installed in Unit 1 during the current refueling outage and in Unit 2 during the next ice weighing surveillance shutdown (late 1981) (See Section 3.0 below for a discussion of Clasix results). Thus, the Cook Plant DIS will employ a total of seventy (70) igniters per Unit.

1.2 DIS Technical Specifications

Proposed Technical Specification Table 3.6-1A, submitted by our AEP:NRC:00500C letter dated May 29, 1981, has been modified to reflect the addition of two igniters (one per train) in the instrument room. Revised pages reflecting this change for each Unit of the Cook Plant are contained in Attachment No. 4.

2.0 Ice Condenser Insulation

The ice condensers in Cook Units 1 and 2 are very similar to those in McGuire and Sequoyah. However, instead of polyurethane foam, fiberglass encapsulated in polyethylene bags is employed in the Cook Units for insulation purposes. The insulation is located between the containment wall and the crane wall and the air handling ducts, and is covered by galvanized steel sheets with joints between panels sealed to prevent vapor penetration.

Fiberglass exhibits very stable material characteristics even at high temperatures. Existing data indicate that fiberglass begins to soften(1) at about 1350°F, and that significant decomposition is not expected except at much higher temperatures.

The other component which makes up the insulation assemblies is polyethylene sheets. The thickness of these sheets is about 6 mils. Review of existing literature on the thermophysical properties of polyethylene shows that significant degradation (greater than a few percent per hour) has been observed at temperatures in excess of 700°F(2). The energy content of polyethylene is reported to be about $1.3\times10^4 \frac{BTU}{lb.}$ (3).

Recent analysis performed for the Cook Units using the modified CLASIX code predicts upper plenum temperatures of approximately 1100°F for short durations (see Attachment No. 2). Burns in the upper plenum exist for no more than 10 seconds. The shortest interval between burns is approximately 60 seconds. The Cook temperature profile of the upper plenum generated by CLASIX is similar to that of Sequoyah. Using the CLASIX results at the upper plenum as temperature inputs, TVA has calculated the heat-up rate of equipment, such as igniter assembly box and cable within conduits, in the region and found that the inside surface temperature of the metal casing does not exceed 270°F. Therefore, it is reasonable to believe that, due to the similarity between the transient temperature input data for Cook and Sequoyah, the results obtained by TVA can be used as a good approximation for the inside surface temperature of the galvanized steel cover on the insulation. Given these conditions at the upper plenum, the insulation behind the steel covers is not expected to be exposed to temperatures which might lead to substantial amount of polyethylene degradation.

Calculation of the energy content for all the polyethylene in the upper plenum reveals that there would be about $7x10^6$ BTU released into the containment even in the unlikely event of its complete decomposition. This amount of energy is less than forty percent of the energy calculated by Duke Power for the intermediate deck doors and is less than ten percent of the energy generated from hydrogen combustion for a typical CLASIX analysis.

Moreover, based on the heat transfer calculations performed on insulation heat-up in the ice-bed region by Duke Power for the McGuire Plant, the temperature of the surface adjacent to the insulation is estimated to be about 370°F. Due to the similar configuration of the Cook and McGuire ice condensers, the heat transfer results reported by Duke are applicable to Cook. Hence, the polyethylene in the ice-bed region of the ice condenser is not likely to experience substantial degradation under these predicted conditions.

Therefore, despite the fact that a different type of insulation is used at the Cook ice condensers, it appears that the potential impact of insulation degradation on the containment is similar to that of McGuire and Sequoyah.

3.0 <u>CLASIX Code Results</u>

Attachment No. 2 to this submittal contains the preliminary results of a Cook-specific CLASIX analysis utilizing passive heat sinks, a fan flow/head curve and a separate nodal volume representation

of the ice condenser upper plenum. This analysis indicates that the peak pressure due to hydrogen combustion remains below the containment design pressure. As expected, no combustion occurred in the upper volume, the fan/accumulator rooms, or the dead-ended volume. A total of thirty seven (37) burns are predicted; seven in the lower volume and thirty in the upper plenum. Slightly less than one million pounds of ice remain at the completion of the transient.

4.0 Containment Air Recirculation/Hydrogen Skimmer (HYS) Fans

The results of the CLASIX analysis mentioned in Section 3.0 indicate that maximum differential pressure between the fan/accumulator room and upper volume of 2.5 psi; with the higher pressure existing in the upper volume.

In the course of our investigation of the fan survivability, we have identified a potential failure mechanism due to the possible development of a differential pressure across the fan housing when the upper compartment pressure is greater than the fan/accumulator room pressure. In such case the fan housing could collapse. We are investigating various modifications to the HYS fans which would eliminate this concern and will report to you on the schedule for the completion of the selected modifications in a later submittal.

References:

(1) Baumeister, T., et al, 'Standard Handbook for Mechanical Engineers,' McGraw-Hill

(2) Madorsky, S., 'Thermal Degradation of Organic Polymers,' Interscience, 1964

(3) Tewarson, A., et al, 'Categorization of Cable Flammability,' EPRI Report NP-1200, Part 1, 1979

(4) 'Resolution of Equipment Survivability Issues for the Sequoyah Nuclear Plant,' TVA, May 1981

Attachment No. 2 to AEP:NRC:00500E

Additional Information on Hydrogen Mitigation and Control

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2

CLASIX Code Analysis

TABLE 1

Cook CLASIX Input

MARCH Reactor Coolant Mass and Energy Release Rates

S2D Sequence

Time (seconds)	H_2O Mass Release Rate (lbm/sec)	H_2O Energy Release Rate (Btu/sec)
0.0	197.2	1.167×10^5
2172	190.5	1.097×10^5
2478	44.85	5.230×10^4
3180	53.53	6.547×10^4
3804	34.82	4.262×10^4
4428	21.40	2.842×10^4
4752	48.42	5.558×10^4
5700	19.42	2.182×10^4
6012	14.07	1.583×10^4
6960	5.253	5.989×10^3
7062	4.718	5.388×10^3
7206	4.060	4.693×10^3

TABLE 2

Cook CLASIX Input

MARCH Hydrogen Generation Rates and Temperatures

S2D Sequence

Time (seconds)	H_2 Mass Release Rate (lbm/sec)	H_2 Temperature (F)
0.0	0.0	61
3480	0.0	61
3804	0.0413	67
4116	0.260	1582
4428	0.740	795
4752	1.07	771
5700	0.430	612
6330	0.223	555
6648	0.160	535
6960	0.117	519
8070	0.0367	519

TABLE 3

Cook CLASIX Input

MARCH Fission Product Energy Release Rates

S2D Sequence

Time (seconds)	Energy Release Rate (Btu/sec)
0.0	0.0
3810	0.0
4116	1803
4428	4800
4752	6708
5376	7000
7080	7135

TABLE 4

Cook CLASIX Input

Burn Parameters

	Lower Compartment	Ice Condenser Lower Plenum	Ice Condenser Upper Plenum	Upper Compartment	Dead Ended Region	FAN/ACC Rooms
Hydrogen V/F for Ignition	0.08	0.08	0.08	0.08	0.08	0.08
Hydrogen V/F for Propagation	0.08	0.08	0.08	0.08	0.08	0.08
Hydrogen Fraction Burned	0.85	0.85	0.85	0.85	0.85	0.85
Minimum Oxygen V/F for Ignition	0.05	0.05	0.05	0.05	0.05	0.05
Minimum Oxygen V/F to Support Combustion	0.0	0.0	0.0	0.0	0.0	0.0
Burn Time (sec)*	9	6	7	13	4	3

*Based on a flame speed of 6 ft/sec.

TABLE 5

Cook CLASIX Input

Compartment Initial Conditions

	Lower Compartment	Ice Condenser Lower Plenum	Ice Condenser Upper Plenum	Upper Compartment	Dead Ended Region	FAN/ACC Rooms
Volume (ft^3)	2494681	24700	47010	681283	61105	54828
Temperature (F)	110	32	32	75	98	110
O_2 Pressure (psia)	3.14	3.18	3.18	3.17	3.16	3.14
N_2 Pressure (psia)	11.67	11.81	11.81	11.77	11.71	11.67
H_2O Pressure (psia)	0.19	0.01 9	0.01 9	0.06	0.13	0.19

TABLE 6

Cook CLASIX Input

Flow Path Parameters

	LC-LP	LP-UP	UP-UP	UC-LC	DE-LC	F/A-LC
Minimum Flow Area (ft^2)	**	**	**	2.2	40	308
Flow Loss Coefficient	2.05	3.04	1.45	1.5	4.2	4.2
Burn Propagation Delay Time (sec)*	9	6	1	9	9	9

*Based on a flame speed of 6 ft/sec.
**Function of door opening.

TABLE 7

Cook CLASIX Input

Ice Bed Parameters

Parameter	Value
Initial Ice Mass	2.37×10^6 lbm
Initial Ice Heat Transfer Area	2.93×10^5 ft^2
Heat of Fusion of Ice	248 Btu/lbm*
Flow Loss Coefficient	0.42
Initial Net Free Gas Volume	86780 ft^3

*Includes 150 Btu/lbm actual heat of fusion plus 98 Btu/lbm to raise ice condenser drain temperature from 32 F to 130 F.

TABLE 8

Cook CLASIX Input

Ice Condenser Door Parameters

Lower Inlet Doors	
Maximum Opening Angle	55^o
Minimum Differential Pressure for Maximum Opening	0.0069 psi
Maximum Flow Area	990 ft^2
Bypass Flow Area	0
Intermediate Deck Doors	
Maximum Opening Angle	89^o
Minimum Differential Pressure for Maximum Opening	5.5 psi
Maximum Flow Area	1326 ft^2
Bypass Flow Area	20 ft^2
Top Deck Doors	
Maximum Opening Angle	89^o
Minimum Differential Pressure for Maximum Opening	1.15 psi
Maximum Flow area	2040 ft^2
Bypass Flow Area	20 ft^2
Minimum Differential Pressure to Initiate Door Opening	0.005 psi

TABLE 9

Cook CLASIX Input

Air Return Fan/Hydrogen Skimmer System Parameters

Parameter	Value
Number of Trains	2
Initiation Time	*
Flow Fractions per Train	
UC-F/A	0.9569
LC-F/A	0.0359
DE-F/A	0.0024
Flow Rate Head (in H_2O)	Flow Rate Per Train (cfm)
0.0	5.30×10^4
1.0	5.05×10^4
2.0	4.75×10^4
3.0	4.45×10^4
4.0	4.15×10^4
4.5	3.97×10^4
5.0	3.80×10^4
6.0	3.42×10^4
6.5	3.10×10^4
6.8	2.50×10^4
6.9	1.60×10^4
6.9	0.0

*Initiated 10 minutes after the containment reaches 3.0 psig pressure.

TABLE 10

Cook CLASIX Input

Spray System Parameters

Parameter	UC	LC	F/A
Drop Diameter (in)	0.0276	0.0276	0.0276
Drop Fall Time	10.66	5.75	1.68
Flow Rate gpm	4000	1800	528
Temperature (F)	125	125	125
Drop Film Coefficient (Btu/hr ft^2 F)	20	20	20
Initiation Time sec	*	*	*

*Initiated 30 seconds after the containment reaches 3.0 psig pressure.

TABLE 11

Cook CLASIX Input

Compartment Dependent Passive Heat Sink Parameters

Parameter	Compartment	Value
Temperature	Lower Compartment	110 F
	Ice Condenser Lower Plenum	*
	Ice Condenser Upper Plenum	15 F
	Upper Compartment	75 F
	Dead Ended Region	98 F
	Fan/Accumulator Rooms	110 F
Radiant Heat Transfer Beam Length	Lower Compartment	25.0 ft
	Ice Condenser Lower Plenum	8.5 ft
	Ice Condenser Upper Plenum	8.5 ft
	Upper Compartment	59.0 ft
	Dead Ended Region	8.5 ft
	Fan/Accumulator Rooms	8.5 ft

*See Table 15.

TABLE 12

Cook CLASIX Input

Material Dependent Passive Heat Sink Parameters

Parameter	Material	Value
Emmissivity*	Concrete	0.9
	Carbon Steel	0.9
	Paint	0.9
	Stainless Steel	0.4
Thermal Conductivity* (Btu/hr ft F)	Paint on Steel (UC)	0.21
	Paint on Steel (LC, DE, F/A½, UP)	0.22
	Paint on Concrete	0.087
	Concrete	0.84
	Carbon Steel	27.3
	Stainless Steel	9.87
	Paint on concrete**	0.87
Volumetric Heat Capacity* (Btu/ft^3 F)	Paint on Steel (UC)	29.8
	Paint on Steel (LC, DE, F/A½, UP)	14.7
	Paint on Concrete	29.8
	Concrete	30.2
	Carbon Steel	59.2
	Stainless Steel	59.2
	~~Panel~~	~~(later)~~
Exit Heat Transfer Coefficient* (Btu/hr ft^2 F)	Paint to Steel or Concrete	10^4
	Concrete to Concrete	10^8
	Concrete to Steel	10
	Steel to Concrete	10
	Steel to Steel	10^8
	Last Layer Adiabatic Wall	0
	~~Steel to Panel~~	~~(later)~~

*See individual lower plenum wall data in Table 15.

** Wall 12 - input error, considered insignificant, but will be corrected on subsequent runs

TABLE 13

Cook CLASIX Input

Upper Compartment Passive Heat Sinks

CLASIX Wall Number	Description	Initial Wall Temperature (F)	Surface Area (ft^2)	Layer Number	Number of Nodes	Layer Material	Layer Thickness (ft)
1		75	26086	1	2	Paint	0.001
				2	15	Carbon steel	0.03
				3	12	Concrete	1
				4	10	Concrete	1.89
2		75	~~620~~ 310	1	2	Paint	0.001
				2	15	Carbon steel	0.03
				~~3~~	~~20~~	~~Panel~~	~~0.20~~
3		75	5284	1	2	Paint	0.001
				2	25	Carbon steel	0.05
				3	12	Concrete	1
				4	6	Concrete	1
				5	3	Concrete	1.5
4		75	595	1	2	Paint	0.001
				2	30	Carbon steel	0.06
				3	10	Concrete	0.83
5		75	350	1	3	Concrete	0.15
				2	15	Carbon steel	0.03
				3	8	Concrete	0.63
6		75	25433	1	12	Concrete	1
				2	3	Concrete	~~0.28~~ 0.3
7		75	4381	1	12	Concrete	1
				2	8	Concrete	1.53

TABLE 14

Cook CLASIX Input

Lower Compartment Passive Heat Sinks

CLASIX Wall Number	Description	Initial Wall Temperature (F)	Surface Area (ft^2)	Layer Number	Number of Nodes	Layer Material	Layer Thickness (ft)
8		110	540	1	2	Paint	0.001
				2	15	S. steel	0.03
9		110	595	1	2	Paint	0.001
				2	30	S. steel	0.06
				3	10	concrete	0.83
10		110	3224	1	2	Paint	0.001
				2	15	S. steel	0.03
				3	12	Concrete	1
				4	6	Concrete	1
				5	4	Concrete	2.05
11		110	~~17972~~ 29306.	1	2	Paint	0.001
				2	12	Concrete	1
				3	3	Concrete	0.49
12		110	~~10609~~ 9275	1	2	Paint	0.001
				2	12	Concrete	1
				3	6	Concrete	1
				4	3	Concrete	1.61

TABLE 15

Cook CLASIX Input

Ice Condenser Lower Plenum Passive Heat Sinks

CLASIX Wall Number	Initial Wall Temperature (F)	Surface Area (ft^2)	Layer Number	Number of Nodes	Layer Material	Layer Thickness (ft)	Layer Conductivity (Btu/hr ft F)	Layer Heat Capacity (Btu/ft^3 F)	Layer Heat Heat Transfer (Btu/hr ft^2 F)
13	80	19100	1	5	insulation	1	0.15	2.75	0.7
			2	31	steel	0.0625	26.0	56.4	0.0
14	80	13055	1	5	insulation	1	0.2	3.663	0.7
			2	12	concrete	1	0.8	28.8	0.0
15	15	~~336.0~~ 3336	1	2	paint	.000833	0.0833	28.4	10^6
			2	4	concrete	.33	0.8	28.8	0.0

TABLE 16

Cook CLASIX Input

Ice Condenser Upper Plenum Passive Heat Sinks

CLASIX Wall Number	Description	Initial Wall Temperature (F)	Surface Area (ft^2)	Layer Number	Number of Nodes	Layer Material	Layer Thickness (ft)
16		15	9453	1	2	paint	0.001
				2	~~30~~ 10	carbon steel	~~0.06~~ 0.021
				3	10	carbon steel	0.083
				4	10	carbon steel	0.606

TABLE 17

Cook CLASIX Input

Dead Ended Region Passive Heat Sinks

CLASIX Wall Number	Description	Initial Wall Temperature (F)	Surface Area (ft^2)	Layer Number	Number of Nodes	Layer Material	Layer Thickness (ft)
17		98	6590	1	2	paint	0.001
				2	25	carbon steel	0.05
				3	12	concrete	1
				4	6	concrete	1
				5	3	concrete	1.5
18		98	16789	1	2	paint	0.001
				2	12	concrete	1
				3	3	concrete	~~0.5~~ 0.43

TABLE 18

Cook CLASIX Input

Fan/Accumulator Rooms Passive Heat Sinks

CLASIX Wall Number	Description	Initial Wall Temperature (F)	Surface Area (ft^2)	Layer Number	Number of Nodes	Layer Material	Layer Thickness (ft)
19		110	5640	1	2	paint	0.001
				2	25	carbon steel	0.05
				3	12	concrete	1
				4	6	concrete	1
				5	3	concrete	1.5
20		110	10134	1	2	paint	0.001
				2	12	concrete	1
				3	3	concrete	0.54

TABLE 19

Cook CLASIX Analysis

Summary of Results

	Lower Compartment	Ice Condenser Lower Plenum	Ice Condenser Upper Plenum	Upper Compartment	Dead Ended Region	Fan/Acc Rooms
Number of Burns	7	0	30	0	0	0
Magnitude of Burns (lbm)	62-73	-	15-40	-	-	-
Total H_2 Burned (lbm)	481	-	595	-	-	-
H_2 Remaining (lbm)	88	47	26	256	24	21
Peak Temperature (F)	828	383	1155	168	216	205*
Peak Pressure (psig)	10.9	10.8	10.8	10.5	10.9	10.8

Ice Remaining in Ice Bed at 7080 sec. 9.9×10^5 lbm.

*Occurs before burn period.

[illegible]AEP S[illegible] CASE1 [illegible]CFM FAN [illegible]GPM SPRAY BURN [illegible]PCT AT [illegible] [illegible]FPS

	MAXIMUM TEMPERATURE / TIME (F) (SEC)	MAXIMUM PRESSURE / TIME (PSIA) (SEC)	MAXIMUM PRESSURE / TIME (PSIG) (SEC)
LC	362.0 / 5906	25.6 / 5034	10.9 / 5034
LP	332.9 / 5218	25.5 / 5034	10.8 / 5034
UP	1154.6 / 5271	25.5 / 5034	10.8 / 5034
UC	162.1 / 5036	25.2 / 5036	10.5 / 5036
DE	216.1 / 5625	25.6 / 5034	10.9 / 5034
FA	206.2 / 707	25.5 / 5034	10.8 / 5034

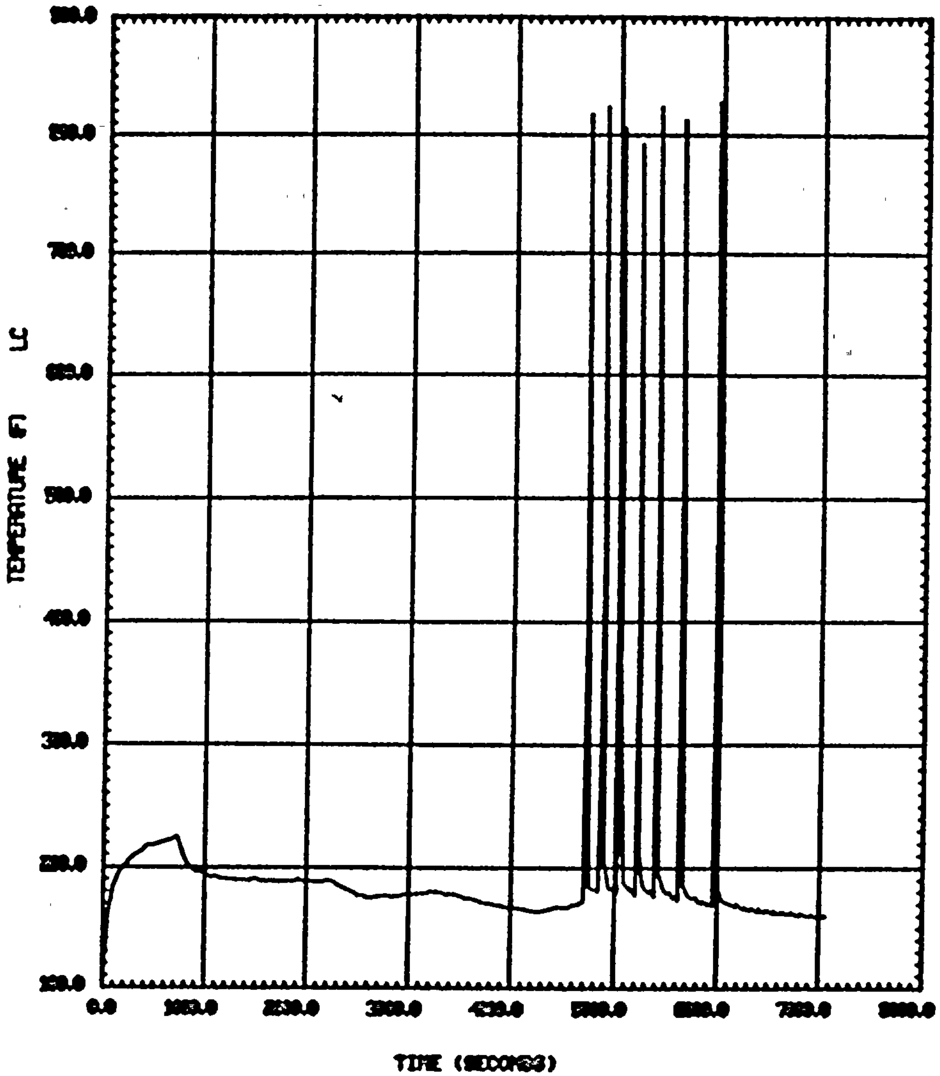
MAXIMUM DIFFERENTIAL PRESSURE / TIME(SEC)

\TO FROM\	LC	LP	UP	UC	DE	FA
LC	0.0 / 0	.9 / 5208	1.4 / 5208	1.6 / 5262	.4 / 5028	.2 / 5630
LP	2.4 / 5220	0.0 / 0	1.1 / 4710	1.5 / 5030	2.4 / 5220	2.4 / 5220
UP	2.5 / 5219	2.1 / 5215	0.0 / 0	1.4 / 5030	2.5 / 5219	2.5 / 5219
UC	2.5 / 5218	2.2 / 5215	.3 / 4844	0.0 / 0	2.5 / 5219	2.5 / 5219
DE	.3 / 5036	.2 / 5210	1.2 / 5208	1.5 / 4708	0.0 / 0	.2 / 5036
FA	.1 / 5213	.9 / 5268	1.4 / 5208	1.6 / 5262	.4 / 5062	0.0 / 0

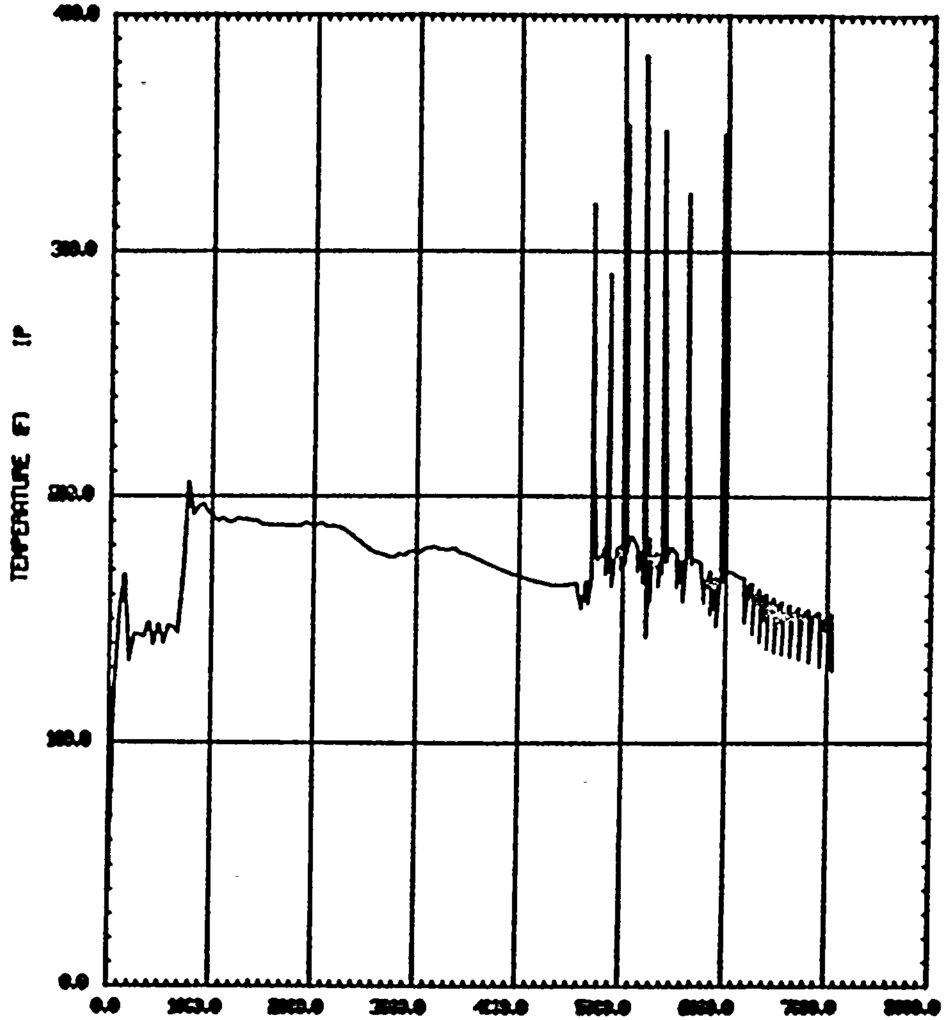
*AEP S20 CASE1 80000CFM FAN 6328GPM SPRAY BURN 85PCT AT 8V/0 6FPS

***** SHORT OUTPUT

TIME (SEC)	PRESSURE(PSIA)/TEMPERATURE(F) LC	LP	UP	UC	DE	PR
5.200E+03	21.5/ 181.7	21.5/ 160.5	21.5/ 812.5	21.5/ 140.1	21.4/ 173.3	21.5/ 129.2
5.201E+03	21.2/ 180.1	21.2/ 162.4	21.1/ 463.0	21.2/ 138.4	21.3/ 173.8	21.2/ 128.7
5.202E+03	21.1/ 178.9	21.1/ 164.1	21.0/ 316.7	21.0/ 137.2	21.1/ 173.4	21.1/ 128.5
5.203E+03	20.9/ 178.2	20.9/ 165.5	20.9/ 235.8	20.9/ 136.2	21.0/ 173.1	20.9/ 128.2
5.204E+03	20.8/ 177.6	20.8/ 166.8	20.8/ 184.2	20.8/ 135.3	20.8/ 171.9	20.9/ 128.1
5.205E+03	20.8/ 177.3	20.8/ 167.9	20.7/ 143.4	20.7/ 134.5	20.7/ 171.7	20.8/ 128.0
5.206E+03	20.7/ 177.1	20.7/ 169.0	20.7/ 138.2	20.7/ 133.8	20.8/ 172.6	20.7/ 127.9
5.207E+03	21.9/ 282.5	21.9/ 187.3	21.1/ 136.2	21.0/ 134.4	21.8/ 178.6	21.9/ 136.8
5.208E+03	22.9/ 409.3	22.0/ 216.0	21.5/ 134.4	21.5/ 135.7	22.8/ 186.7	22.9/ 148.1
5.209E+03	23.3/ 523.8	23.0/ 264.7	22.4/ 133.5	22.0/ 136.7	23.3/ 193.2	23.3/ 155.5
5.210E+03	23.7/ 629.8	22.9/ 301.3	22.8/ 131.9	22.4/ 137.5	23.7/ 198.4	23.7/ 164.5
5.211E+03	23.7/ 716.4	23.1/ 346.4	22.8/ 130.1	22.8/ 138.3	23.7/ 199.8	23.7/ 168.4
5.212E+03	23.8/ 791.3	23.6/ 382.9	23.1/ 128.7	23.0/ 138.6	23.8/ 201.8	23.8/ 173.3
5.213E+03	23.0/ 764.0	22.8/ 379.1	23.2/ 127.4	23.2/ 138.5	23.2/ 198.4	23.2/ 172.9
5.214E+03	21.4/ 614.1	21.3/ 252.1	22.9/ 126.7	23.0/ 137.2	21.5/ 188.1	21.5/ 163.9
5.215E+03	20.5/ 519.0	20.5/ 176.7	22.6/ 126.1	22.7/ 135.7	20.6/ 181.4	20.6/ 158.1
5.216E+03	20.1/ 453.2	21.1/ 170.8	22.4/ 126.0	22.4/ 134.4	20.1/ 177.2	20.1/ 153.7
5.217E+03	19.7/ 403.8	21.5/ 168.9	22.1/ 125.0	22.2/ 133.2	19.7/ 174.0	19.7/ 150.4
5.218E+03	19.5/ 365.9	21.7/ 167.0	22.0/ 124.6	22.0/ 132.2	19.5/ 171.8	19.5/ 147.6
5.219E+03	19.3/ 336.4	21.7/ 165.0	21.8/ 124.3	21.8/ 131.3	19.3/ 170.2	19.3/ 145.2
5.220E+03	19.2/ 312.8	21.6/ 163.1	21.7/ 123.9	21.7/ 130.5	19.2/ 170.2	19.2/ 143.3
5.221E+03	19.2/ 293.8	21.5/ 161.2	21.6/ 123.9	21.6/ 129.7	19.2/ 169.1	19.2/ 141.7
5.222E+03	19.2/ 278.1	21.4/ 159.3	21.4/ 123.6	21.4/ 129.1	19.1/ 169.1	19.2/ 140.3
5.223E+03	19.2/ 264.9	21.3/ 157.5	21.3/ 123.0	21.3/ 128.4	19.2/ 170.1	19.2/ 139.1
5.224E+03	19.3/ 255.3	21.2/ 155.8	21.2/ 122.7	21.2/ 127.8	19.2/ 169.3	19.3/ 138.2
5.225E+03	19.3/ 247.3	21.1/ 154.1	21.1/ 122.6	21.1/ 127.2	19.3/ 169.6	19.3/ 137.3
5.226E+03	19.4/ 240.5	21.0/ 152.4	21.0/ 122.1	21.0/ 126.7	19.4/ 169.9	19.4/ 136.6
5.227E+03	19.5/ 234.7	20.9/ 150.8	20.9/ 121.8	20.9/ 126.1	19.5/ 170.1	19.5/ 135.9
5.228E+03	19.7/ 229.7	20.8/ 149.2	20.8/ 121.5	20.8/ 125.7	19.7/ 171.4	19.7/ 135.3
5.229E+03	19.8/ 225.5	20.7/ 147.6	20.7/ 121.2	20.7/ 125.2	19.8/ 171.8	19.8/ 134.8
5.230E+03	19.9/ 221.9	20.6/ 146.1	20.6/ 120.9	20.6/ 124.8	19.9/ 172.1	19.9/ 134.4
5.231E+03	20.0/ 218.6	20.5/ 144.6	20.5/ 120.7	20.5/ 124.4	20.0/ 171.4	20.0/ 133.9
5.232E+03	20.2/ 215.9	20.4/ 143.2	20.4/ 120.4	20.4/ 124.0	20.1/ 171.8	20.2/ 133.5
5.233E+03	20.3/ 213.6	20.3/ 141.8	20.4/ 120.5	20.4/ 123.6	20.3/ 172.1	20.3/ 133.2
5.234E+03	20.3/ 211.1	20.3/ 142.8	20.3/ 119.0	20.3/ 123.3	20.3/ 172.3	20.3/ 132.6
5.235E+03	20.3/ 208.6	20.3/ 146.1	20.3/ 117.2	20.3/ 123.1	20.4/ 173.3	20.3/ 131.9
5.236E+03	20.3/ 206.3	20.3/ 149.3	20.3/ 115.4	20.3/ 123.0	20.3/ 172.3	20.3/ 131.2
5.237E+03	20.3/ 204.3	20.3/ 152.3	20.3/ 113.6	20.3/ 122.8	20.3/ 173.3	20.3/ 130.6
5.238E+03	20.3/ 202.5	20.3/ 155.2	20.3/ 111.8	20.3/ 122.6	20.3/ 173.3	20.3/ 130.1
5.239E+03	20.3/ 200.9	20.3/ 157.9	20.3/ 110.1	20.3/ 122.4	20.3/ 172.2	20.3/ 129.5
5.240E+03	20.3/ 199.5	20.3/ 160.4	20.3/ 108.4	20.3/ 122.2	20.3/ 173.2	20.3/ 129.0
5.241E+03	20.3/ 198.2	20.3/ 162.8	20.3/ 106.8	20.3/ 122.0	20.3/ 173.2	20.3/ 128.6
5.242E+03	20.3/ 197.0	20.3/ 165.1	20.3/ 105.1	20.3/ 121.8	20.3/ 172.2	20.3/ 128.4
5.243E+03	20.3/ 196.0	20.3/ 167.1	20.3/ 103.5	20.3/ 121.6	20.3/ 173.2	20.3/ 128.3
5.244E+03	20.3/ 195.0	20.3/ 169.0	20.3/ 102.0	20.3/ 121.4	20.3/ 173.2	20.3/ 128.2
5.245E+03	20.3/ 194.1	20.3/ 170.8	20.3/ 100.5	20.2/ 121.2	20.3/ 173.1	20.3/ 128.0
5.246E+03	20.3/ 193.3	20.3/ 172.4	20.2/ 98.9	20.2/ 120.9	20.3/ 173.2	20.3/ 128.3
5.247E+03	20.3/ 192.6	20.3/ 173.9	20.2/ 97.5	20.2/ 120.7	20.3/ 172.1	20.3/ 127.8
5.248E+03	20.3/ 192.0	20.3/ 175.3	20.2/ 96.1	20.2/ 120.6	20.3/ 172.2	20.3/ 127.7
5.249E+03	20.3/ 191.4	20.3/ 176.5	20.2/ 94.7	20.2/ 120.8	20.3/ 172.2	20.3/ 127.9



NAEP SID CASE1 8000CFM FAN 6320GPM SPRAY BURN 85PCT AT 5U/0 GFPS



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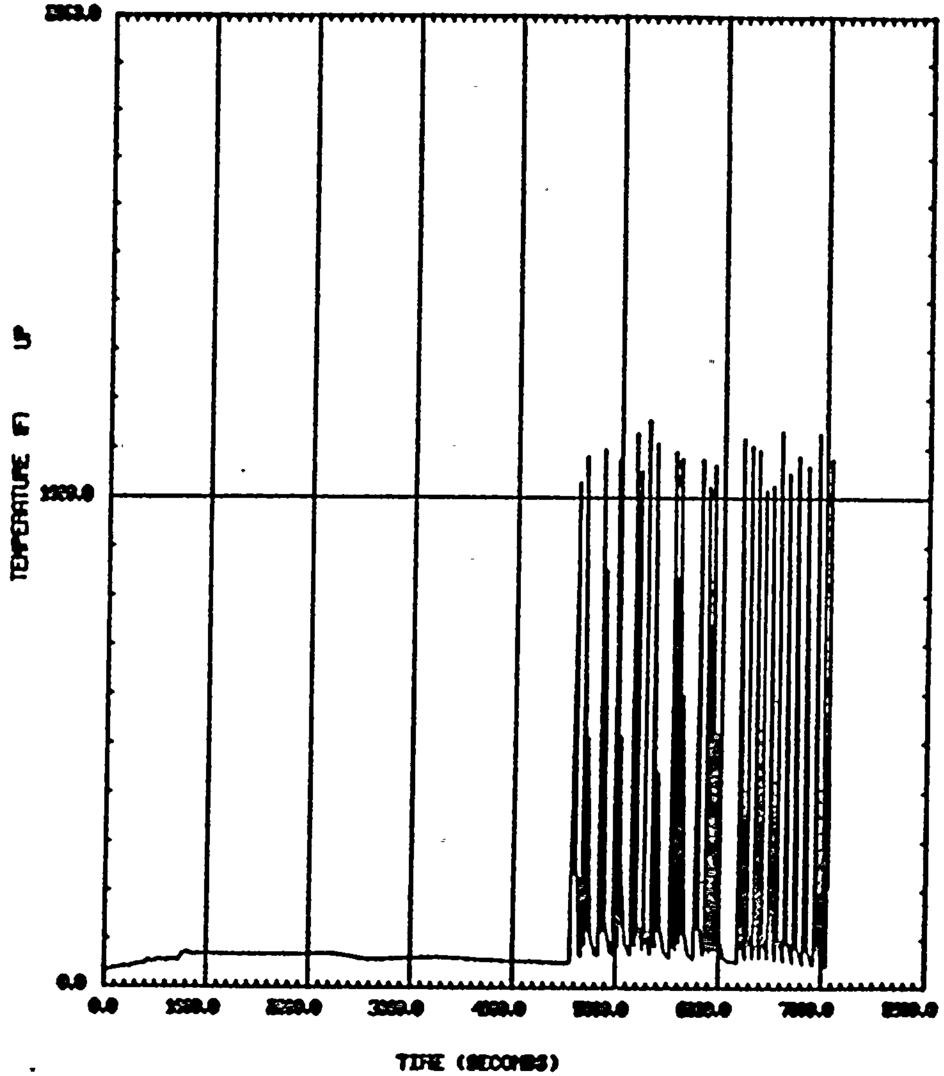

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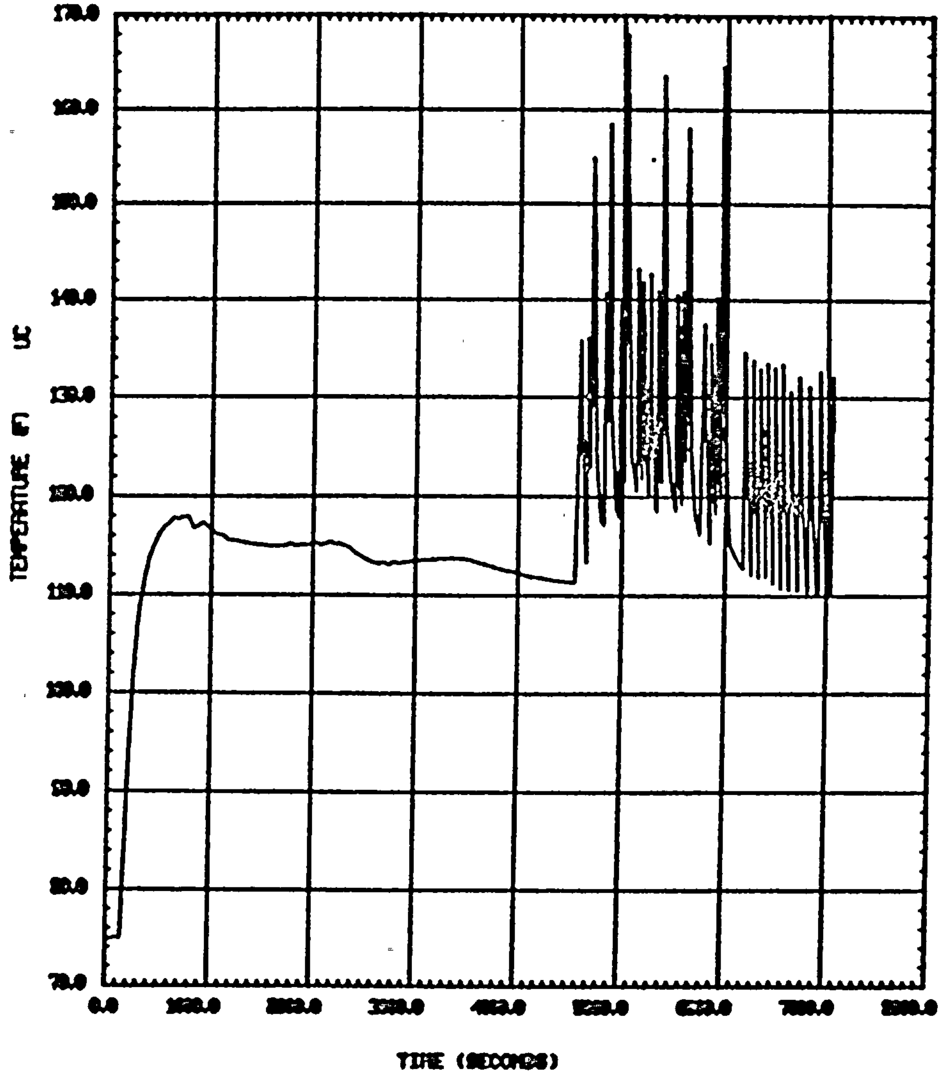

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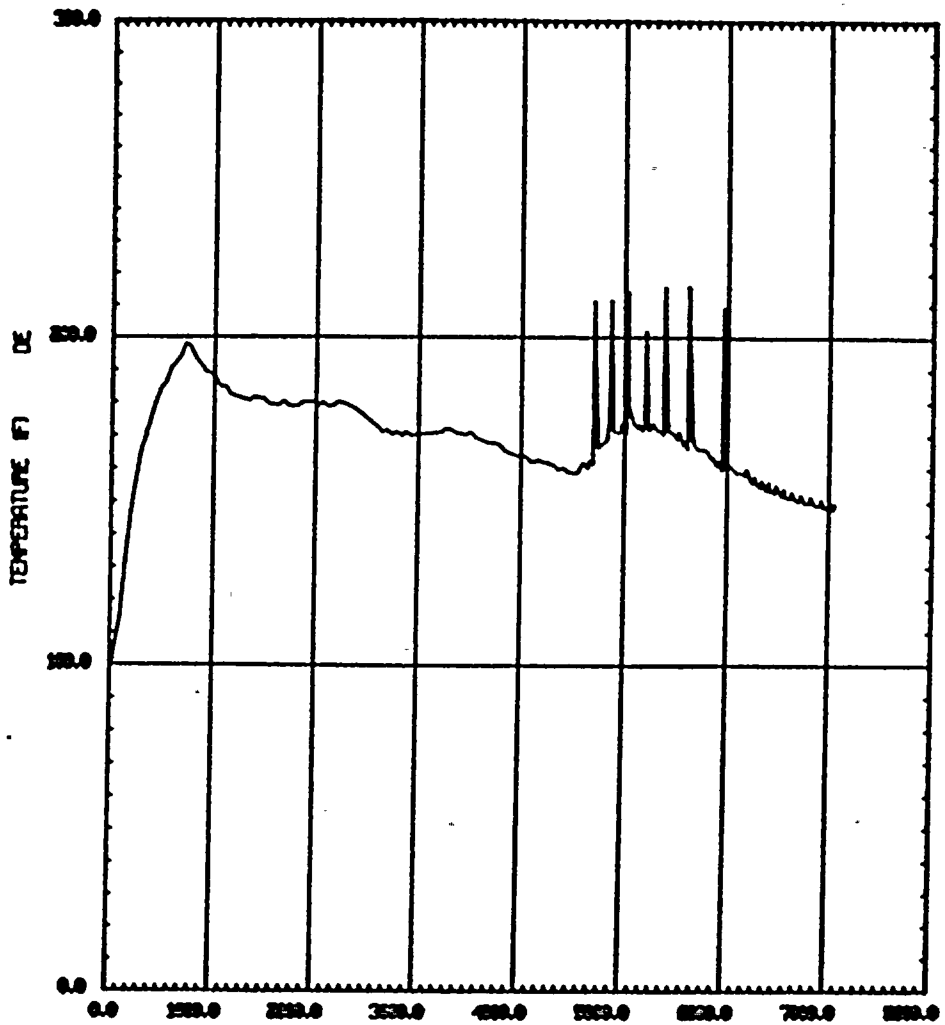
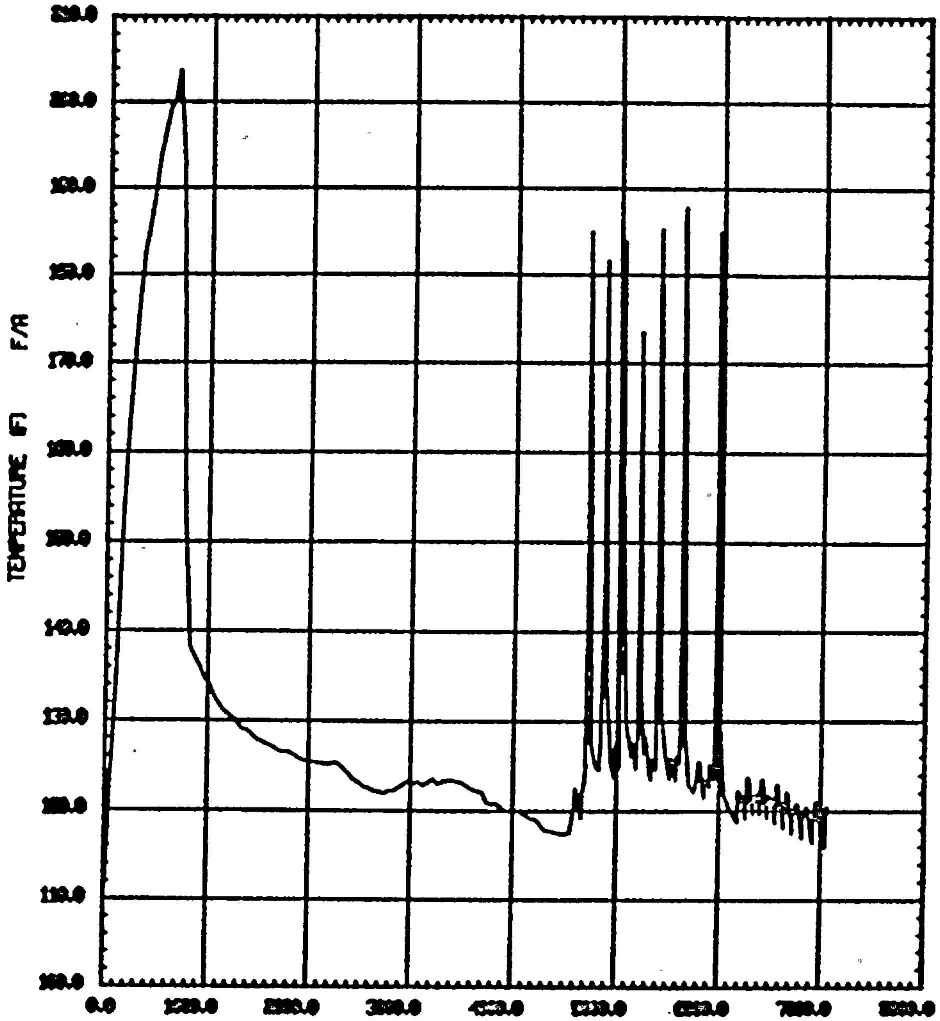


XAEP SRD CASE1 90000CFM FAN 6020GPM SPRAY BURN 8PCT AT 3U/0 FPS



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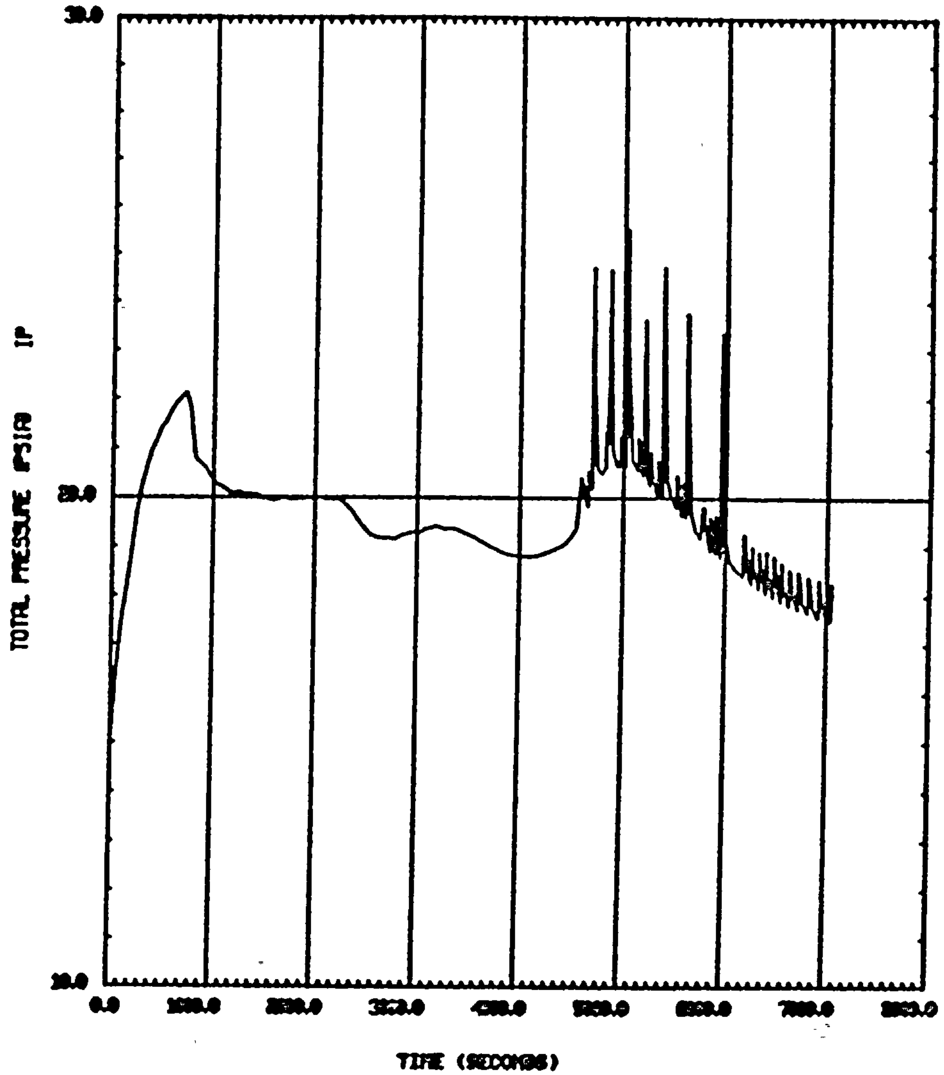
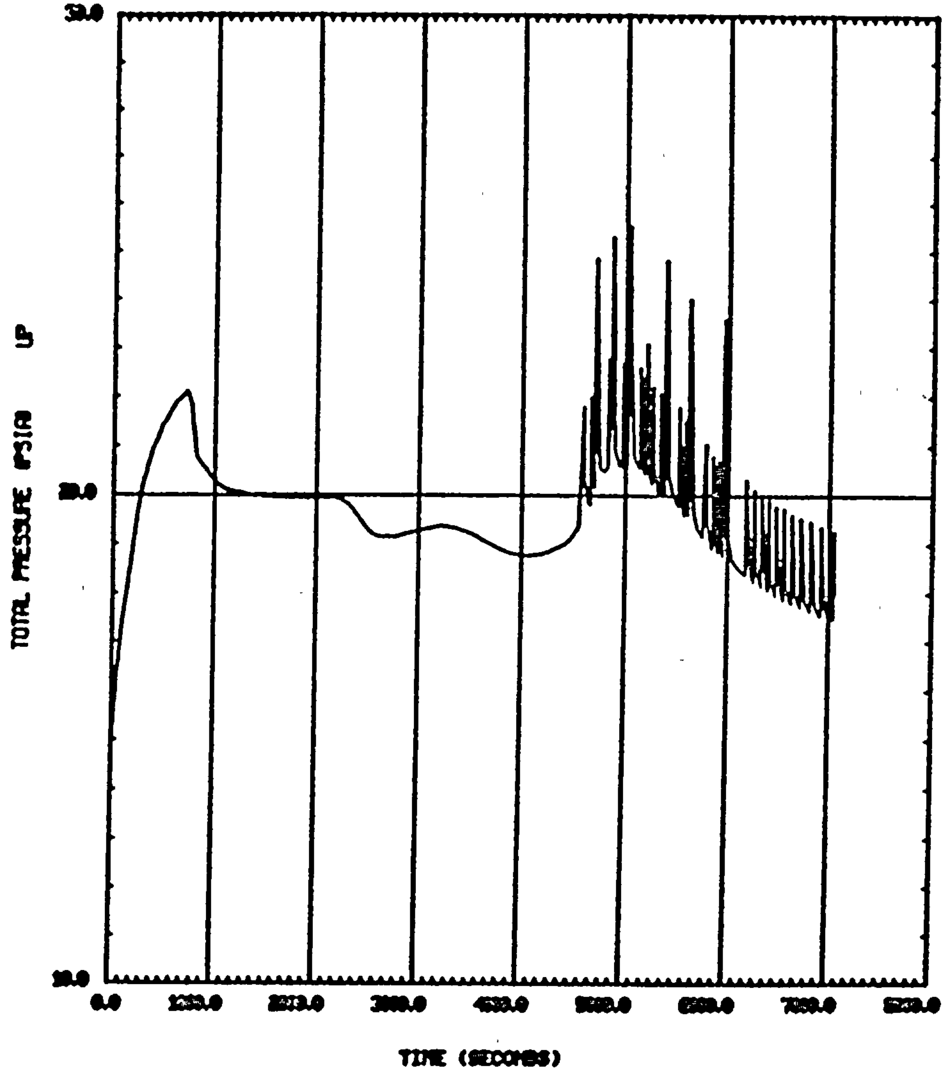
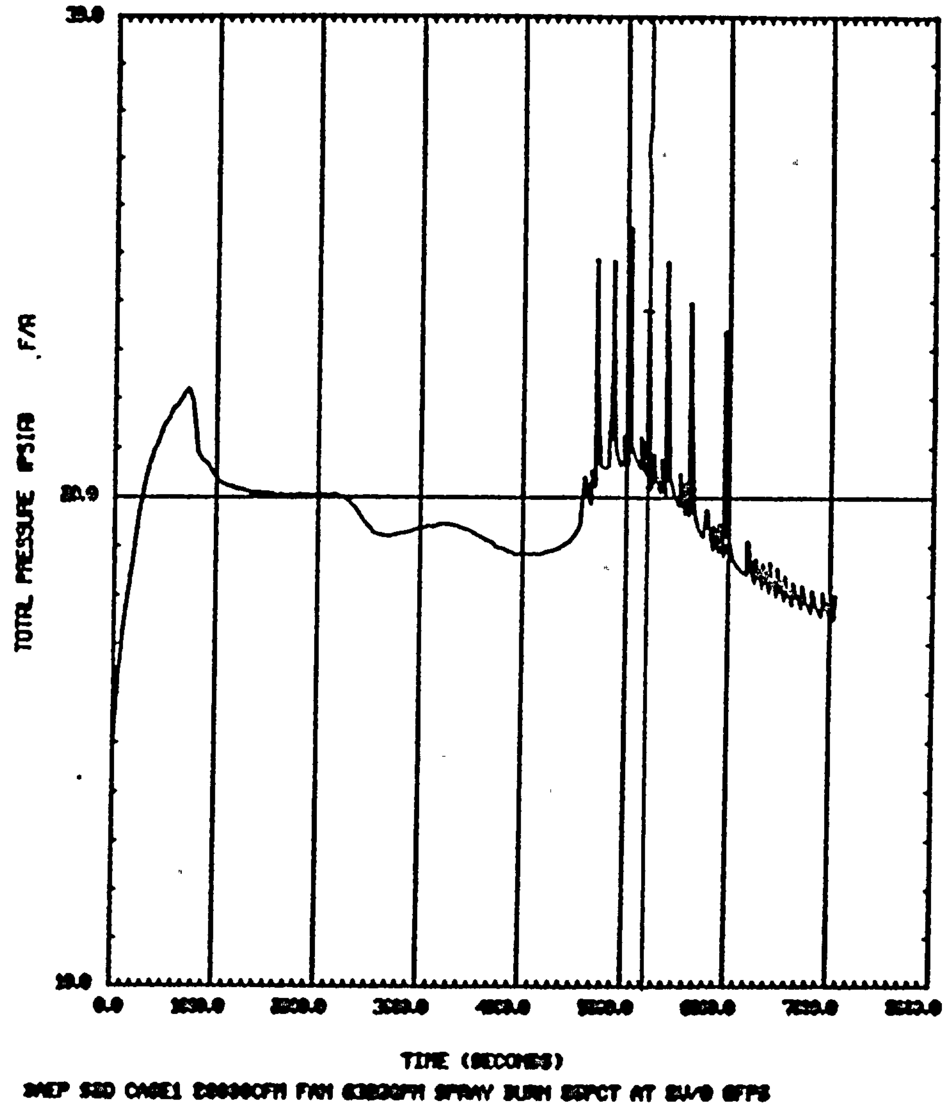


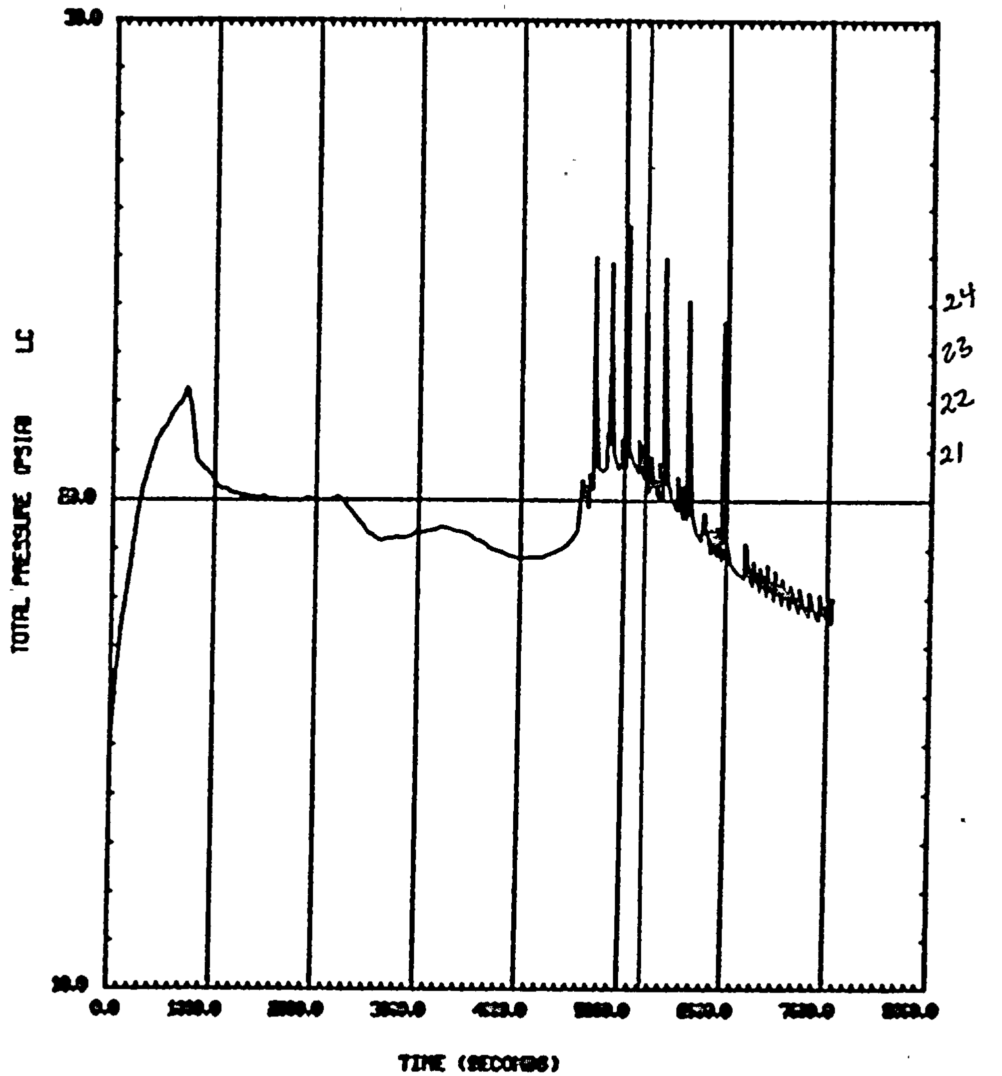
AEP S3D CASE1 30000CFM FAN 6300CFM SPRAY BURN 50PCT AT 3U/0 6FPS



[illegible] CASE1 [illegible] FAN [illegible] SPRAY BURN [illegible] AT [illegible]



30.0
20.0
10.0
TOTAL PRESSURE PSIA
F/A
0.0
TIME (SECONDS)



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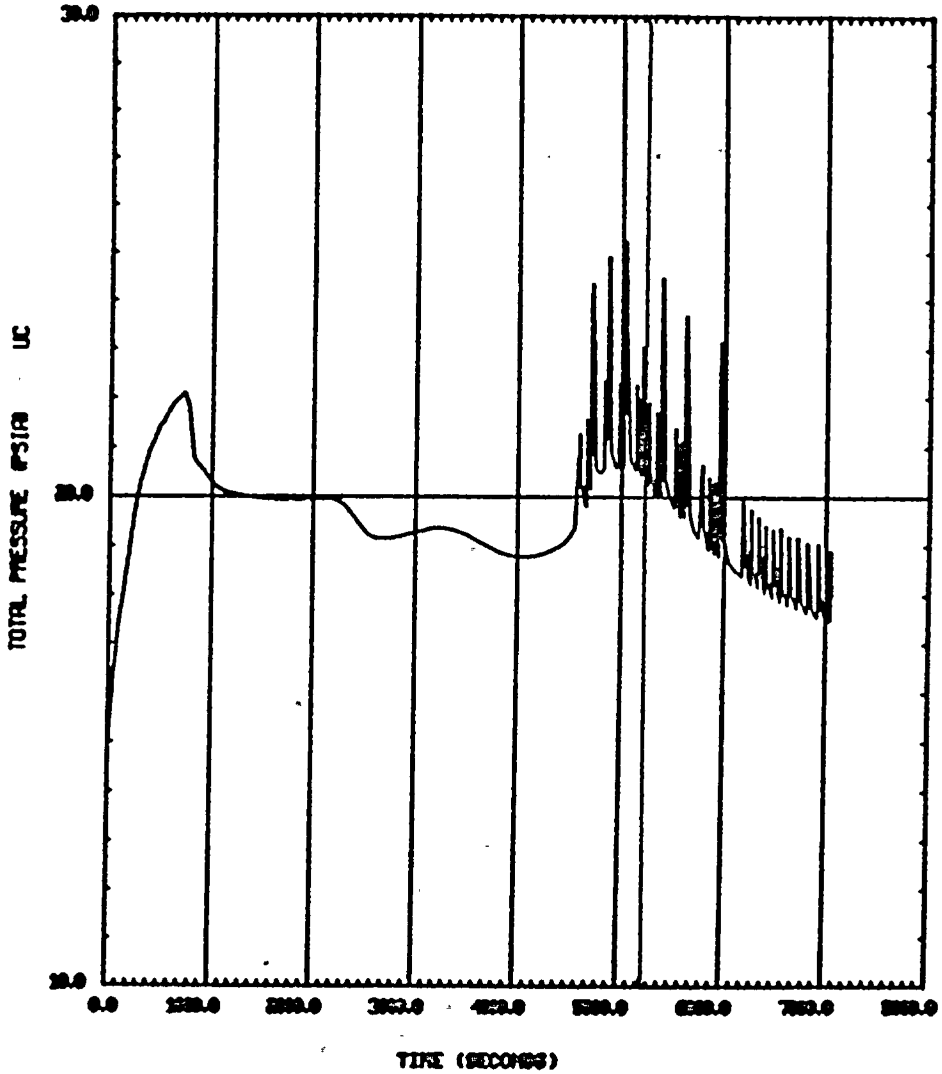
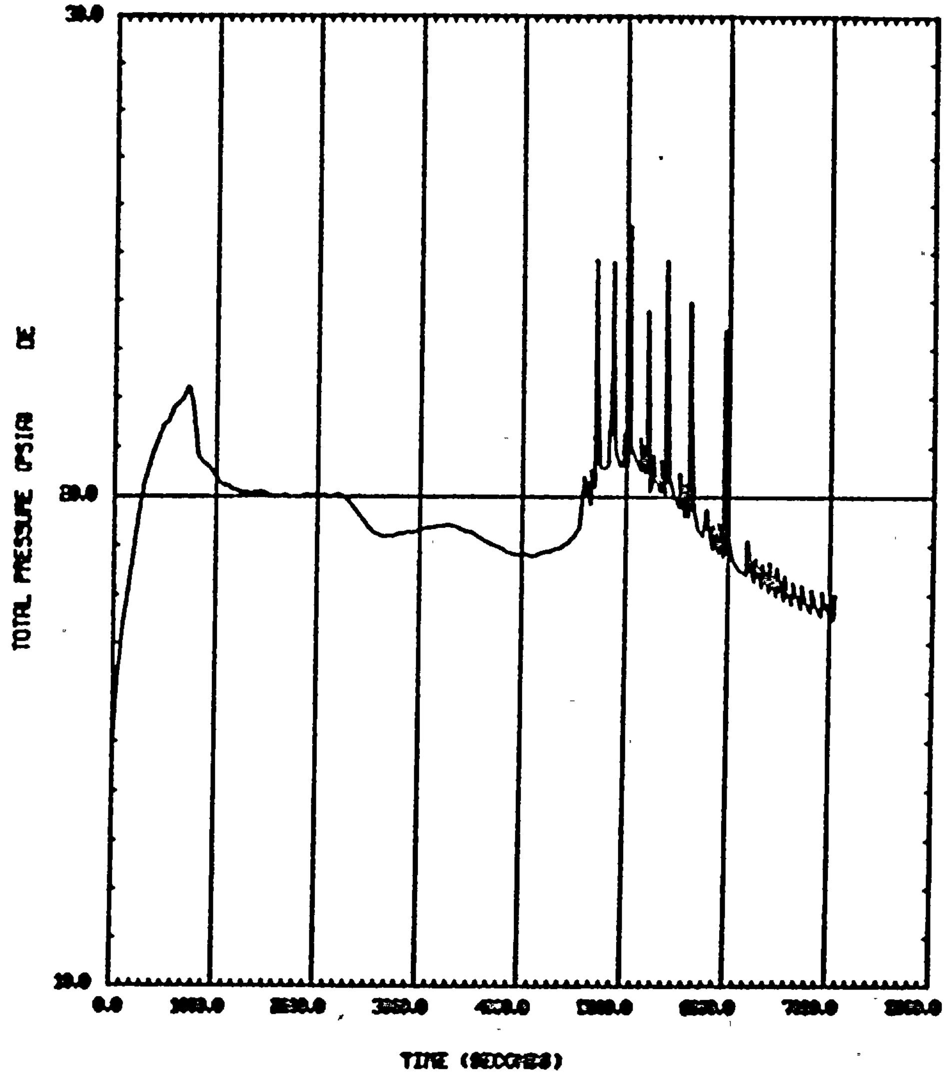


SWEP S20 CASE1 80000CFM FAN 6300CFM SPRAY BURN 80PCT AT 8V/0 6FPS



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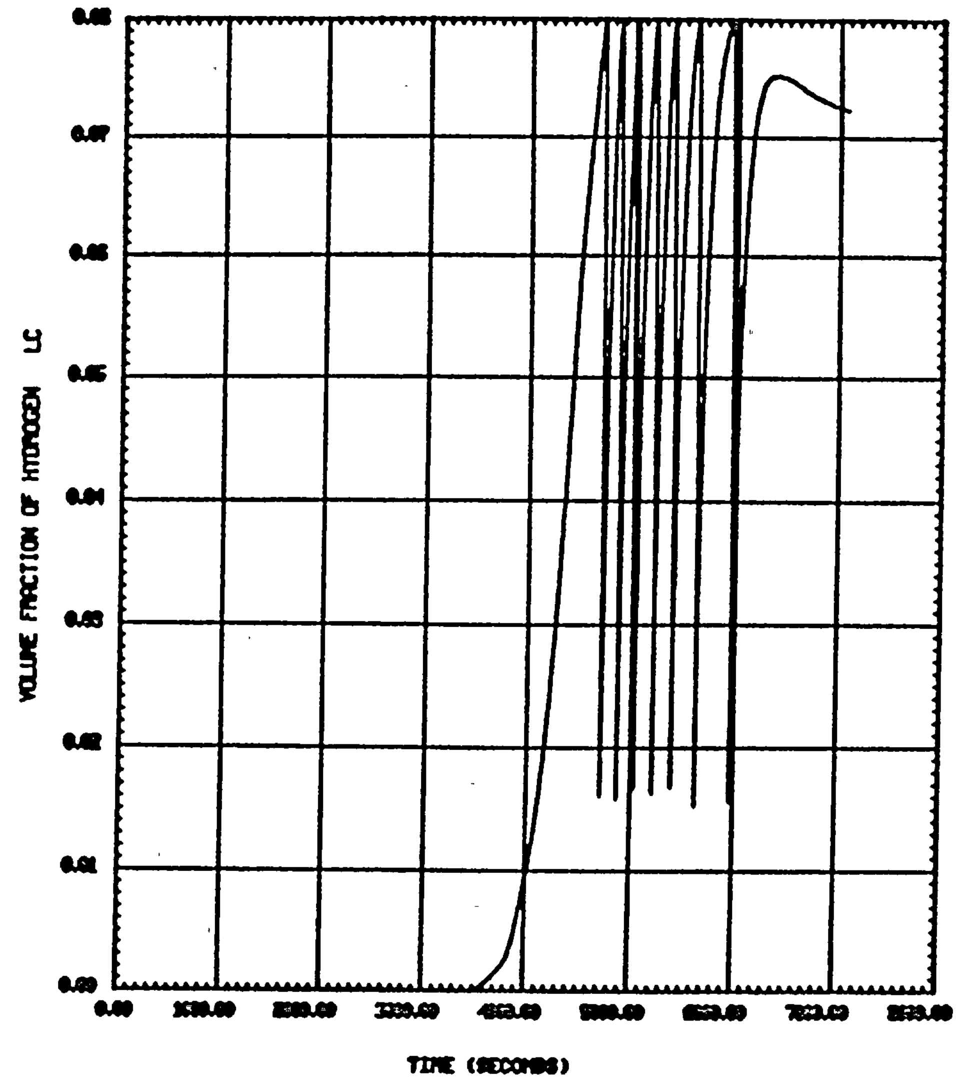
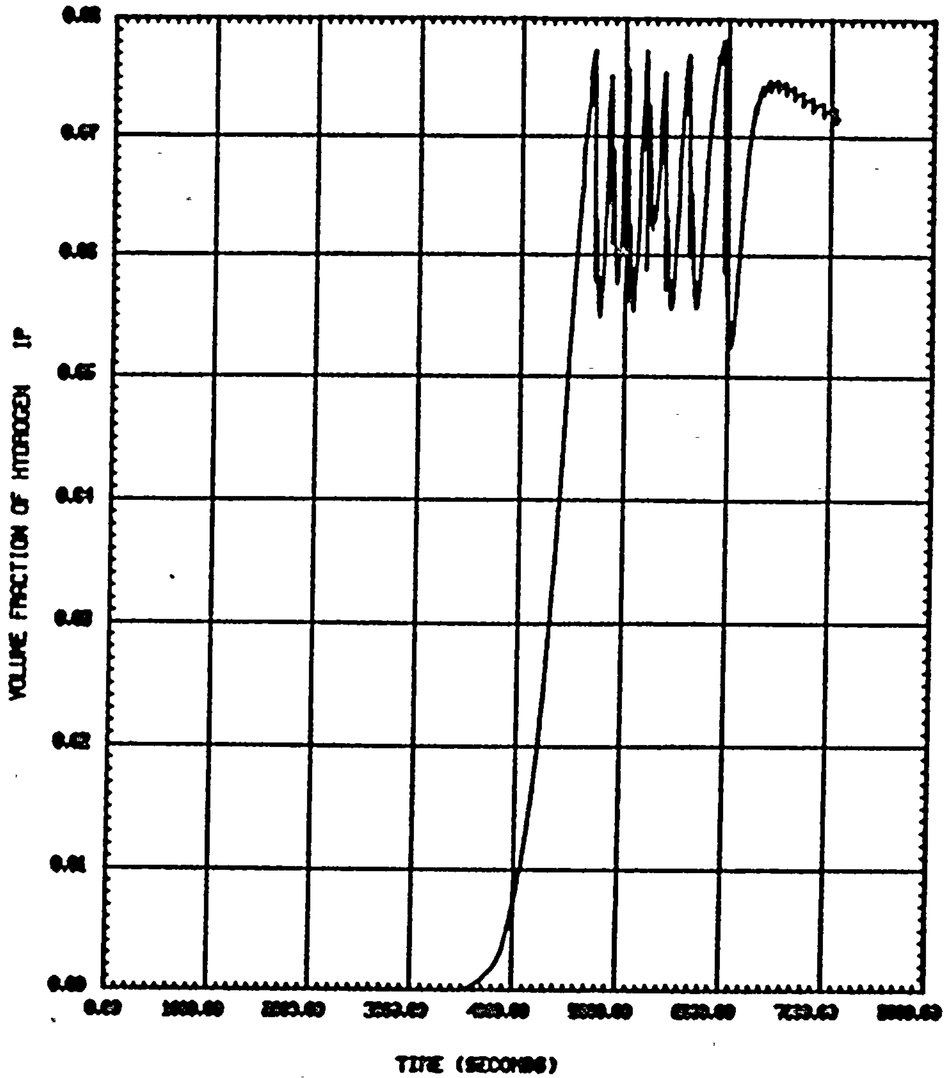


WEP S2D CASE1 36000CFM FAN 6320GPM SPRAY BURN 8PCT AT 8U/0 6FPS



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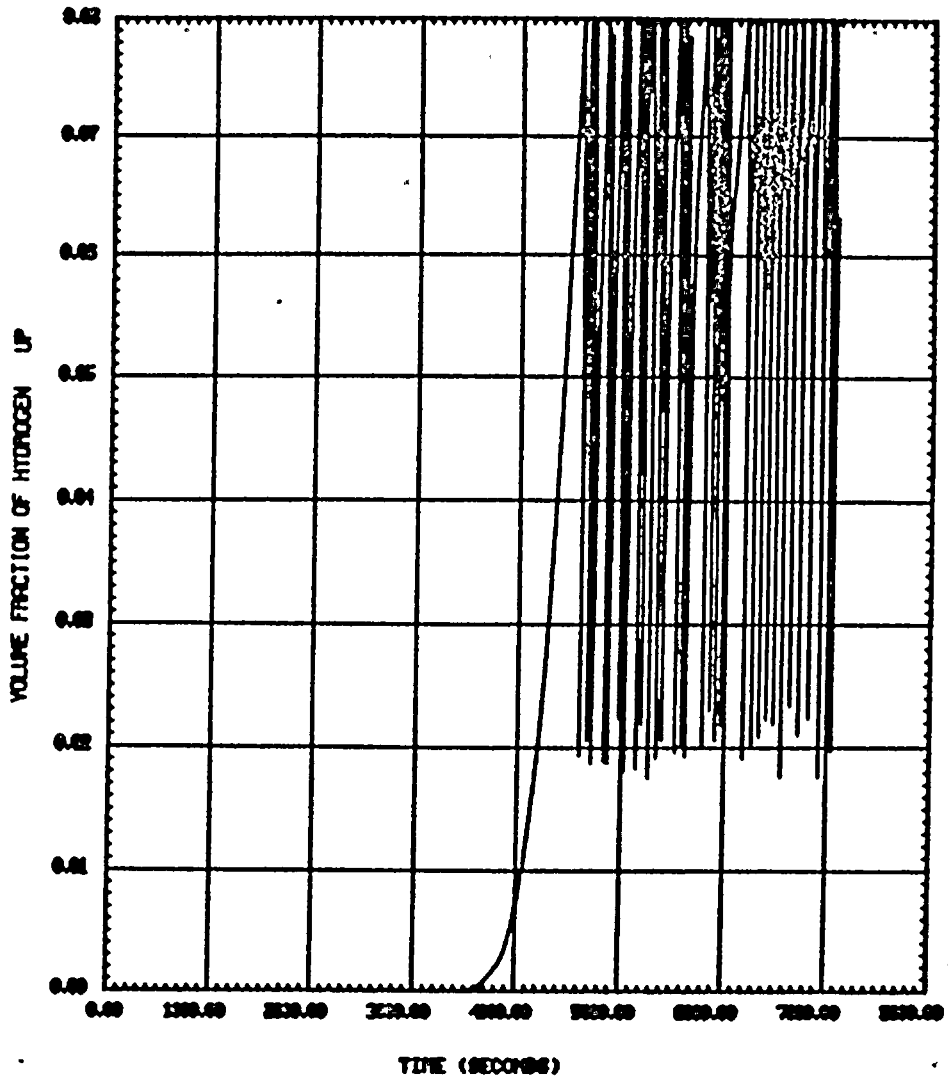
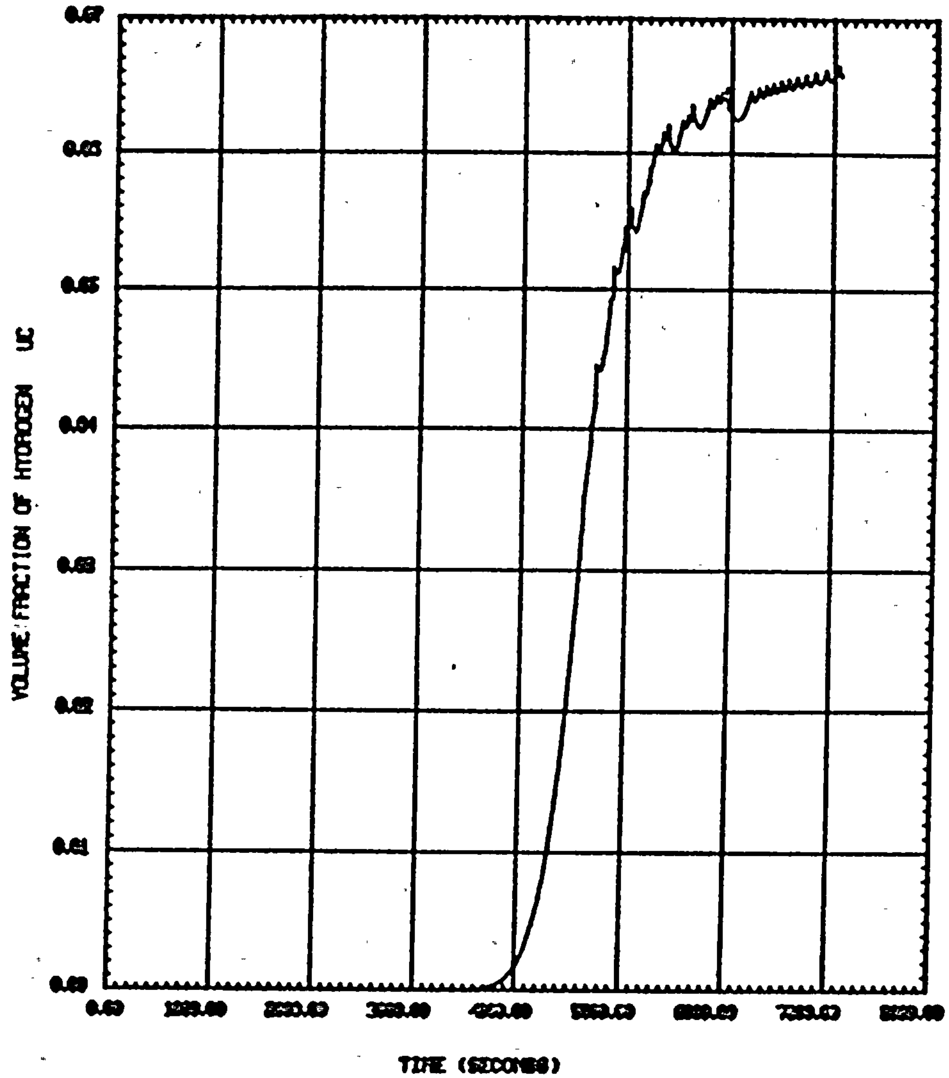
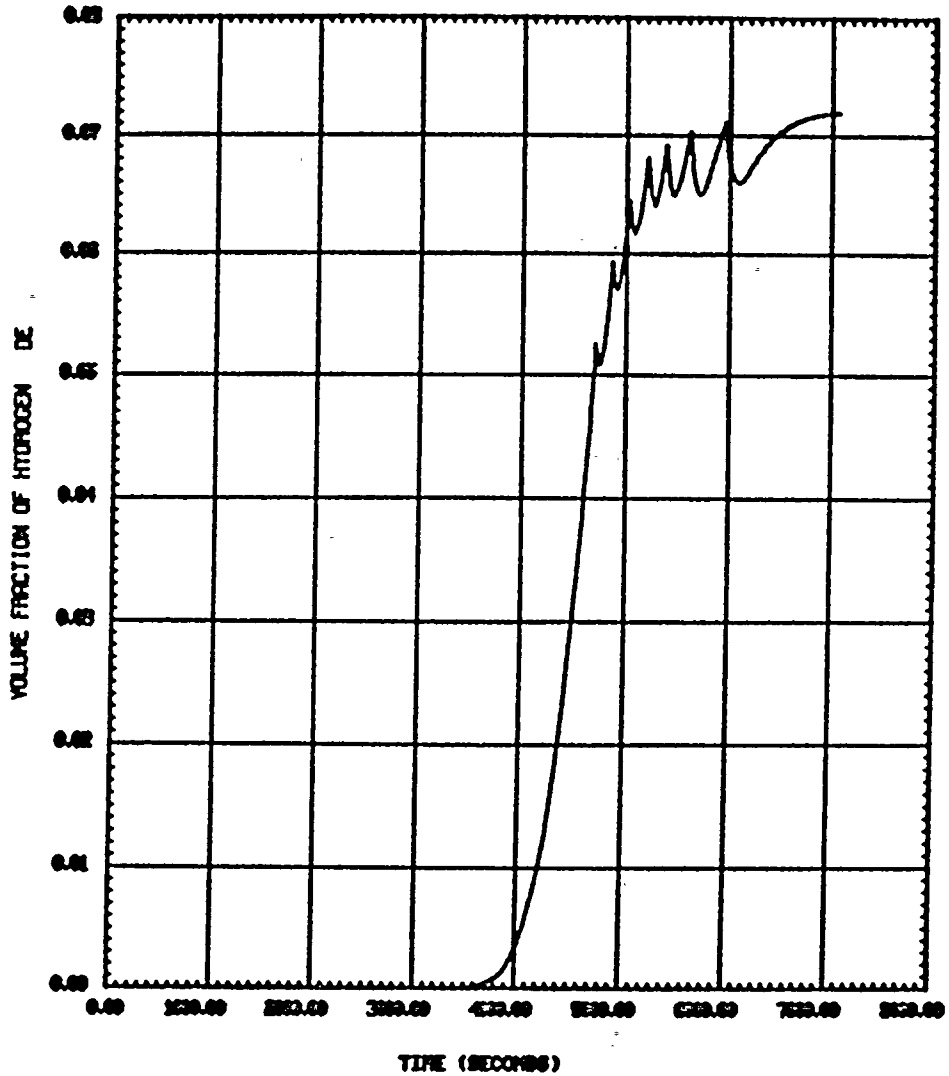

VOLUME FRACTION OF HYDROGEN UP
TIME (SECONDS)

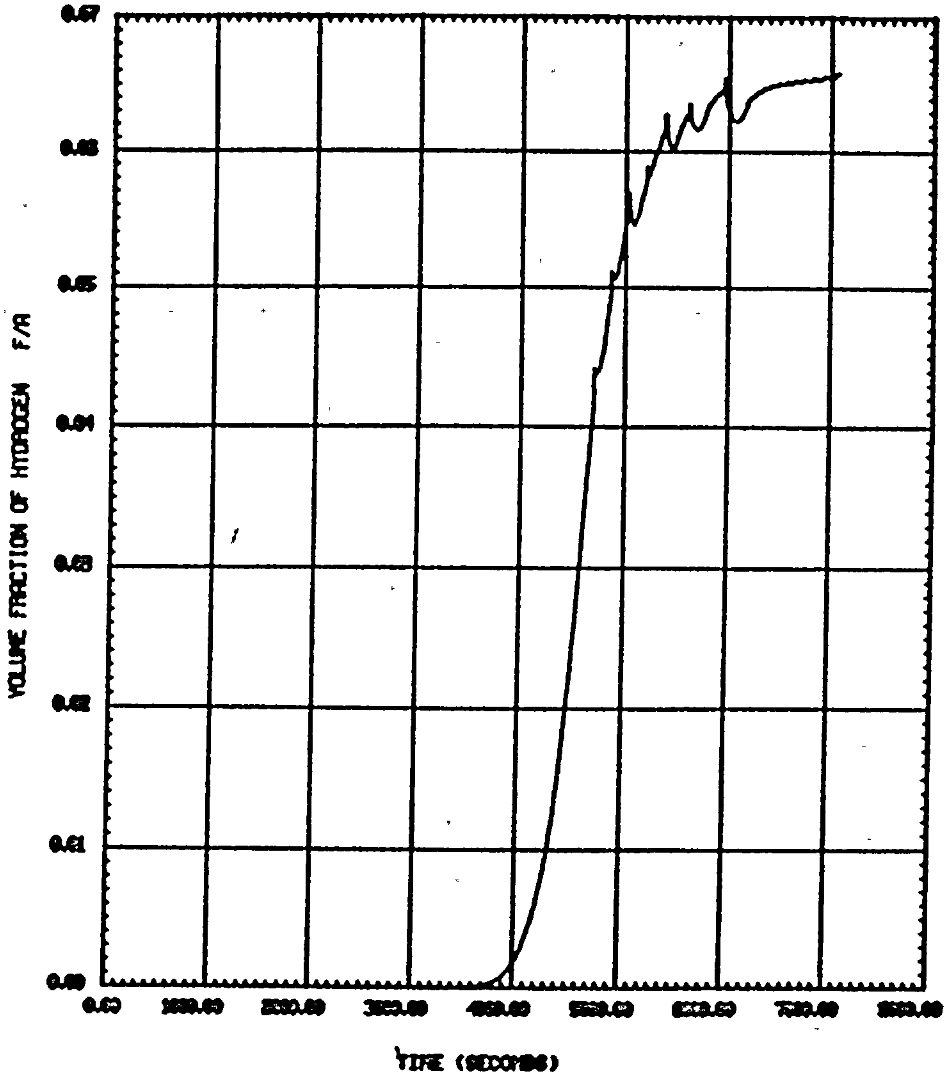
[illegible]



AEP SED CASE1 80000CFM FAN 6000GPM SPRAY BURN 8PCT AT 6.0 FPS



SAEP SED CASE1 8000CFM FAN 6000GPM SPRAY BURN 8PCT AT 8U/0 6FPS



[illegible] [illegible] CASE1 [illegible]CFM FAN [illegible]CFM SPRAY BURN [illegible]PCT AT [illegible] [illegible]

Attachment No.. 3 to AEP:NRC:00500E

Additional Information on Hydrogen Mitigation and Control

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2

SMA Report on Containment Ultimate Strength