AEP:NRC:0720

D. C. COOK PLANT

UNIT NO. 1

REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST

JULY 13 - JULY 30, 1981

INDIANA & MICHIGAN ELECTRIC COMPANY

D.C. COOK PLANT
UNIT NO. 2
CONTAINMENT INTEGRATED LEAK RATE TEST
JULY 13 - JULY 30, 1981

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1.0 Introduction

The second periodic Integrated Leak Rate Test (ILRT) for the Donald C. Cook Nuclear Plant - Unit 1 reactor containment was successfully completed on July 30, 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 1 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.

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

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 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}	-0.04862	-0.1875**
B. ILRT 'Type A' 95% Upper Confidence Limit Leak Rate, L_{am}/95%	0.23276 La -0.05819	0.75 L_a - Type C Leakage Penalty ++ = -0.1875 - (-0.02994) = -0.15756
C. Type C Leakage Penalty	-0.02994	N/A
D. Imposed Leak Rate, L_o	-0.19268	$0.5\ L_a < L_o < L_a$ $-0.125 < L_o < -0.25$
E. Supplemental Test Composite Leakage, L_c	-0.27151	N/A
F. Supplemental Test Correlation	$L_{am} - (L_c - L_o)$ 0.03027	$L_{am} - (L_c - L_o) < .25\ L_a$ ** $L_{am} - (L_c - L_o) < .0625$

* 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 out 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.

Item A, 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.

Item B, $L_{am}/95\%$, 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.

Item C, 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 1 FSAR.

Item D, 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 1 Technical Specifications the rate of the air bleed, in weight %/day, was established at .19268 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	47.7
RC System accumulator fill lines	68	ICM-256	0.0
Refueling water line to Refueling Cavity	36	SF-151 SF-153	502.5
Cont. Sump Line to Waste Hold up Tanks	41	DCR-600 DCR-601	0.0
NESW to and from Containment	--	---	12630.4
RCP Seal Water Lines	11 12 13 14	CS-442-1 CS-442-2 CS-442-3 CS-442-4	0.0
CVCS Letdown and Excess Letdown Lines	34 37	QCR-300 QCM-250 & -350	19.8
Sample Lines from Accumulators	81	ICR-5 ICR-6	0.0
Sample Lines from Pressurizer	66	NCR-109 & 110 NCR-107 & 108	0.0
CVCS Charging Line	35	CS-321	0.0
Glycol Lines to and From Ice Condenser AHU's	86 56	VCR-10 & 11 VCR-20 & 21	0.0 0.0

Total Type C Leakage
Penalty (SCCM) = 13200.4
Expressed in % La = 0.12
Expressed in % wt/day = 0.02994

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 .03027% wt/day or 0.12 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 1 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 ORGAINZATION

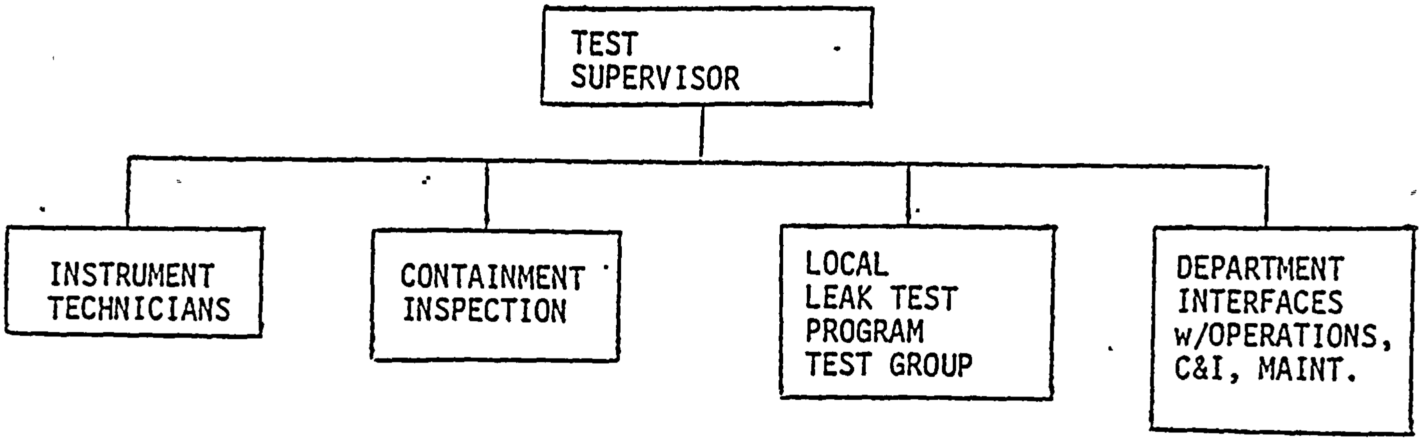
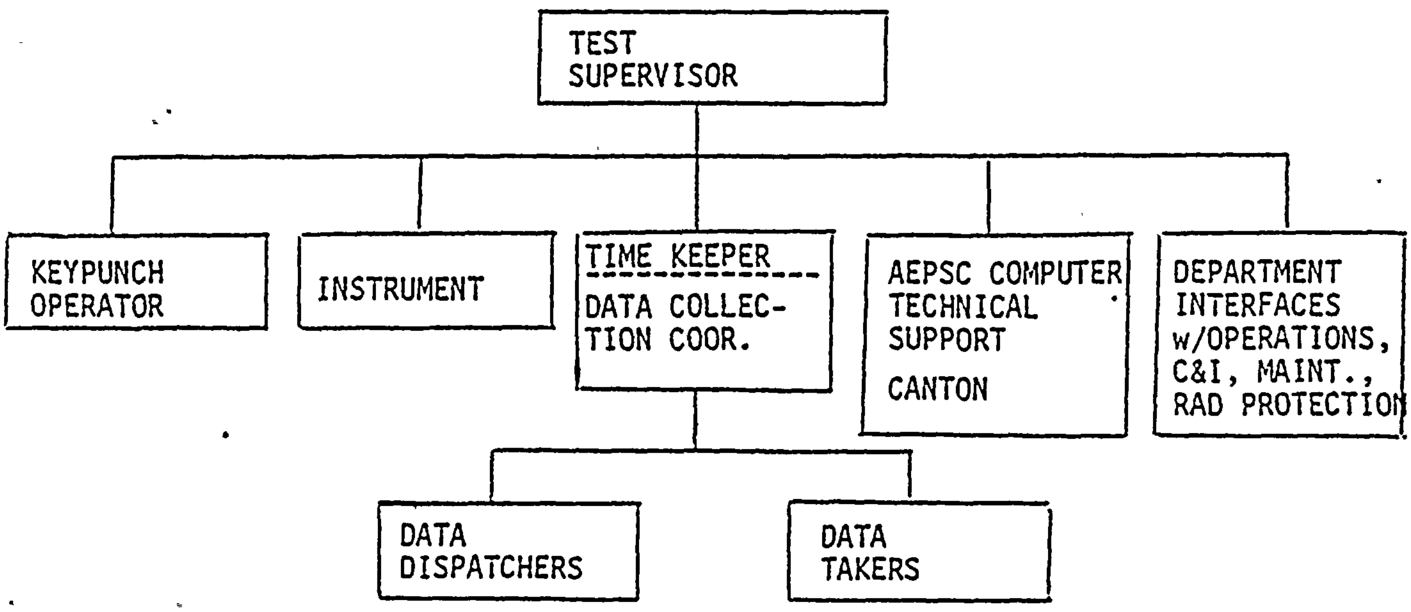


FIGURE 4.1.2 - TEST ORGANIZATION



AEPSC Computer Technical Support - Canton - On call in case of a failure of either the data analysis 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 lineup, initial conditions, and all other test prerequisites, pressurization of the Containment was initiated.

Pressurization of the Unit 1 Reactor Containment began at 2033 hours on July 15, 1981. Containment temperatures, pressures, vapor pressures, ambient temperatures, and barometric pressure were logged on an hourly basis. Each data set collected was assigned a 'Run Number' starting with Run #1 at 2000 hours on July 15, 1981.

At 1300 hours a tour outside of containment was made in a search to find leaks. Three valves were found to be leaking. ECR-33, an isolation valve to the containment radiation monitors was found leaking at the flange connecting the valve to the pipe, the flange was then tightened down. GCR-314 noticed to have a small packing leak, this was tightened down. CA-181N was noticed as having air blowing out the vent. It was isolated and repaired under Supplemental Job Order #21. By 1630 the above was completed.

At approximately 1800 hours the Containment was entered to change a 992 Hygrometer with a 660 spare. Also a sample valve to the hygrometer for the Ice Condenser was found closed. The valve was opened.

At 1900 the Containment was then pressurized to nullify the effects caused by the Containment entrances and exits. Pressurization was ended at 1920 hours with Containment pressure at 12.47 psig.

The stabilization period was initiated at 1930 hours on July 16. After a 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 stabilization period has exceeded the minimum 4 hours.

b. The Containment has been maintained at a pressure of 12 (+ 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 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 1930 a check was made of all valves outside of Containment in prescribed ILRT valve lineup list. This was completed after discovering lineups on other primary systems could have effected the ILRT lineup. All subsequent lineups on primary systems were stopped during the remaining duration of the ILRT.

At 2000 the Containment was then entered again to check on the abnormally high Ice Condenser dew point of approximately 31°F. The local inspection and measurement verified the high dew point was correct. Exit from the Containment was at 2345 hours.

At 0000 hours on 7-17-81, the stabilization period was re-initiated to nullify the effects of the Containment entry and exits. Therefore, Run Number 10 starts the beginning of the stabilization period.

At 1720 hours on 7-17-81 the Techncial Department was notified of being cited due to repairing the 3 valves mentioned earlier without measuring their leakrates first. The NRC inspectors stated the test would be considered a failure. After being informed of the citation the NRC inspectors were asked and gave the permission to continue the current test.

At 2000 hours on 7-17-81 all stabilization criteria had been met and the Type 'A' ILRT was started. Preliminary calculations indicated that the Type 'A' test criterion has been satisfied. After 24 hours of data collection the Type 'A' test was declared successfully complete.

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 3.00 scfm, which is in accordance with the Unit One 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 2200 on 7-18-81 the first supplemental test run was conducted. At 0230 on 7-19-81 Operations inadvertently put approximately 210 gallons into the RCS thru the charging line when testing the Centrifugal Charging Pump. This required restart of the supplemental test at 0230 on 7-19-81.

At 0900 hours on 7-19-81, the supplemental test and the ILRT was declared successfully complete. The supplemental test showed a correlation between the measured leak and the imposed leak within the requirement of less than .25 L_a. The Containment was subsequently depressurized and systems were restored to normal by plant operations.

4.3 Resolution of 'Failed' ILRT

Following pressurization, routine inspection of the valve lineups outside the containment building was performed. During this inspection, three leakage paths were identified and repaired as noted in Section 4.2. There was no attempt to measure the leakage on these three leakage paths as the engineers responsible for the ILRT believed that the requirement noted in 10 CFR 50, Appendix J, Section III.A.1 (a) did not apply during this period. It was believed that this requirement applied only after the start of the stabilization period and prior to the actual overall leak rate measurements. The interpretation of the appropriate sections of Appendix J at the time of the test and its specification in the testing procedure was that the 'official' start of the test was the beginning of the stabilization period rather than after containment inspection. This interpretation is supported by the fact that in the test procedure all valve lineups, instrument and tank venting operations, system draining, test instrument setup, etc. as well as the containment inspection and containment pressurization were listed as part of the 'Initial Conditions' that had to be completed prior to carrying out the procedure. As the test procedure had been utilized and approved in four previous ILRTs at the Cook Plant site, it was considered acceptable by the engineers responsible for the test. As such, it was believed by these test personnel that it was acceptable to make 'equipment repairs or adjustments' prior to beginning the Type A test while completing the required 'Initial Conditions'. This understanding was partly based on the interpretation of Appendix J, Section III.A.1 (b) which reads in part that 'Repairs of maloperating or leaking valves shall be made as necessary'.

In the future, to avoid confusion in the interpretation of 10 CFR 50, Appendix J, the ILRT procedure has been revised to specify that no repairs or adjustments are to be made once the containment inspection has commenced. The procedure also indicates that if during the period between the initiation of the containment inspection, through and including the performance of a Type A test, potentially excessive leakage paths are identified as stipulated in Appendix J, that the test shall be terminated and the leakage through these paths will be measured utilizing local leakage testing methods.

Indiana & Michigan Electric Company proposes to schedule subsequent Type A tests at the existing 40 ± 10 month intervals specified in Appendix J. We do not feel that a more frequent test schedule is warranted for the following reasons. First, this was the only single periodic test of the three ILRTs performed on Unit 1 which could possibly be considered a failure; second, there is some possibility that the acceptance criteria would have been met if the adjustments had not been made; and, third, the final measured leakage rate was less than the maximum allowable by 10 CFR 50, Appendix J. We therefore propose to conduct the fourth ILRT on Unit 1 during the 1985 Refueling Outage within the 10 year Plant Inservice Inspection Program.

5.0 Test Instrumentation & Equipment

Table 5.1 Test Instrumentation

Item	Manufacturer	Type	Model	Range	Accuracy	Test ID
Pressure Measurement	Mensor	Quartz	QM10100-01	0-100 psia 75 psia*	± 0.015 reading .0001 psi resolution	PU-1, PL-1, PL PI-1, PI-2 PU-2*
	Texas Instr.	Manometer	145	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)	±0.5°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	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) 100Ω 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 started at 80.4 F and 8.51 psig. The final temperature and pressure for the supplemental test was 80.1 F, and 8.55 psig. The temperature was obtained from the lower volume temperature - the volume where the rotameter inlet line originates. Pressure was measured at the inlet to the rotamteer 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:

$$W_{CORR} = W_{ind} \times \frac{530}{460 + T_{LOWER}} \times \frac{P_{Gage} + P_{atm}}{14.7}$$

W_{CORR}	=	Corrected rotameter flow in path
W_{ind}	=	Indicated rotameter flow in cfm
T_{LOWER}	=	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

SUBJECT: ILRT INSTRUMENT ERROR ANALYSIS

1.0 ILRT INSTRUMENTATION SPECIFICATIONS AND ASSOCIATED ERROR

1.1 Containment Pressure

Manufacturer: Mensor

Type: Quartz Manometer Model 10100-001

Maximum Reading 26.8 psia

Accuracy: ± 0.015% of reading

Thus error for pressure = $E_p = \pm 0.004$ PSI

1.2 Containment Temperature

Manufacturer: Hy-Cal Engineering

Type: 100Ω Platinum RTD w/Linearized Bridge
Model RTS-4233-B ESD-9050-A

Range: 0 - 100°F

Accuracy: ± 0.1°F

Manufacturer: Fluke

Type: Linear Readout/Printer; Model 2240

Range: 0 - 400 mV

Calibrated Span: 0 - 50 mV

Accuracy: ± 0.01% reading + 0.005% span*
Worst Case = ± 0.025 mV = ± 0.05°F
*Full range used for worst case calculation

Overall Temperature Monitoring System Error

$$E_T = \sqrt{(0.1)^2 + (0.05)^2}$$

$$E_T = \pm 0.11°F \text{ or } \pm 0.11°R$$

1.3 CONTAINMENT VAPOR PRESSURE (DEW POINT)

Manufacturer: Cambridge (EG&G)
Type: Mirror Surface; Model 992
Range: -100 to +100°F Dew Point
Accuracy: ±0.5°F

Manufacturer: Fluke
Type: Linear Readout/Printer; Model 2240
Accuracy: ±0.05°F

Overall Dew Point System Error

$$\text{Error} = \sqrt{(0.5)^2 + (0.05)^2}$$

Error = ±0.50°F (In Dew Point)

Overall error in dew point to vapor pressure conversion.

UPPER VOLUME

*Experienced dew points between

44 to 51°F VPU-1
44 to 50°F VPU-2

For VPU-1; Average Δ Vapor Press/°F = 0.0061

Thus error in lower Vol #1 is

VPU-1 = (0.50°F)(0.0061 psia/°F)
VPU-1 = ±0.0030 psia

For VPU-2; Average Δ Vapor Press/°F = 0.0060
VPU-2 = (0.50°F)(0.0060 psia/°F)
VPU-2 = ±0.0030 psia

An average value for Upper Volume Vapor Pressure is used in the leak rate calculations; thus:

$$E\ VPU = \sqrt{\frac{(E\ VPU\text{-}1)^2 + (E\ VPU\text{-}2)^2}{2}}$$

E_{VPU} = ±0.003 PSIA

LOWER VOLUME

*Experienced dew points between:

46 to 50°F VPL-1

48 to 53°F VPL-2

*See Appendix 'A' of this calculation.

For VPL-1; Average Δ Vapor Press./°F = 0.0062 PSIA/°F

Thus error in Lower Volume #1 is:

VPL-1 = (0.50°F)(0.0062 PSIA/°F)

VPL-1 = ±0.0031 PSIA

For VPL-2; Average Δ Vapor Press./°F = 0.0067 PSIA/°F

Thus error in Lower Volume #2 is:

VPL-2 = (±0.50°F)(0.0067 PSIA/°F)

VPL-2 = ±0.0034 PSIA

But an average value for Lower Volume Vapor Pressure is used in the leak rate claculation; thus:

E_{VPL} = ±0.003 PSIA

ICE CONDENSER VOLUME

*Experienced dew points between:

18 to 28°F VPI-1

20 to 27°F VPI-2

For VPI-1 Average Δ Vapor Press./°F is 0.0032

Thus error in Ice Condenser Vol Vapor Pressure is:

VPI-1 = (0.50°F)(0.0032 PSIA/°F)

VIP-1 = ±0.0016°F

For VPI-2 Average Δ Vapor Press./°F is 0.0032

VPI-2 = (0.50)(0.0032 PSIA/°F)

VIP-2 = ±0.0016°F

E_{VPI} = 0.002°F

*See Appendix 'A' of this calculation.

2.0 AFFECT OF INSTRUMENT ERROR ON ILRT CALCULATIONS

2.1 ERROR FOR P-VP

If: A = B-C

Then: $E_A^2 = E_B^2 + E_C^2$

Where: E_A = Error in A

E_B = Error in B

E_C = Error in C

Substituting:

$$E^2_{P-VP} = E_P^2 + E_{VP}^2$$

Where: E_P^2 = Error in Pressure Measurement

E_{VP}^2 = Error in Vapor Pressure Measurement

2.1.1 E^2_{P-VP} for Upper Volume

$$E^2_{P-VP} = (0.004)^2 + (0.003)^2$$

$$(E^2_{P-VP})_{UPPER} = 2.5 \times 10^{-5}$$

2.1.2 E^2_{P-VP} for Lower Volume

$$E^2_{P-VP} = (0.004)^2 + (0.003)^2$$

$$(E^2_{P-VP})_{LOWER} = 2.5 \times 10^{-5}$$

2.1.3 E_{P-VP} for Ice Condenser Volume

$$E^2_{P-VP} = (0.004)^2 + (0.002)^2$$

$$(E^2_{P-VP})_{ICE} = 2.0 \times 10^{-5}$$

2.2 ERROR FOR $\frac{P-VP}{T}$

If: A = B/C

Then: $$\frac{E_A^2}{A^2} = \frac{E_B^2}{B^2} + \frac{E_C^2}{C^2} \quad \text{or} \quad E_A^2 = \left[\frac{E_B^2}{B^2} + \frac{E_C^2}{C^2}\right] A^2$$

Where: E_A = Error in A

E_B = Error in B

E_C = Error in C

Substituting:

$$E^2_{\frac{P-VP}{T}} = \left[\frac{E^2_{P-VP}}{(P-VP)^2} + \frac{E_T^2}{T^2}\right]\left(\frac{P-VP}{T}\right)^2$$

Where: E^2_{P-VP} = Error for V-VP calculated in Section 2.1

E_T = Error in Temperature (°R) Measurement

NOTE: The following error analysis shall use actual values from the Unit No. 2 Pre-operational ILRT for Pressure (P), Vapor Pressure (VP), and Temperature (T). Run 40 has been used with associated data listed in Appendix 'B'.

2.2.1 $E_{\frac{P-VB}{T}}$ for Upper Volume

$$E^2_{\frac{P-VP}{T}} = \left[\frac{2.5 \times 10^{-5}}{(26.5193)^2} + \frac{(0.11)^2}{(539.90)^2}\right] \times \left(\frac{26.5193}{539.90}\right)^2$$

$$E^2_{\frac{P-VP}{T}} = \boxed{1.86 \times 10^{-10} = E^2_{UPPER}}$$

2.2.2 $E_{\frac{P-VP}{T}}$ for Lower Volume

$$E^2_{\frac{P-VP}{T}} = \left[\frac{2.5 \times 10^{-5}}{(26.4814)^2} + \frac{(0.11)^2}{(539.82)^2}\right] \times \left(\frac{26.4814}{539.82}\right)^2$$

$$E^2_{\frac{P-VP}{T}} = \boxed{1.86 \times 10^{-10} = E^2_{LOWER}}$$

2.2.3 $E_{\frac{P-VP}{T}}$ for Ice Condenser Volume

$$E^2_{\frac{P-VP}{T}} = \left[\frac{2.0 \times 10^{-5}}{(26.5958)^2} + \frac{(0.11)^2}{(480.09)^2}\right] \times \left(\frac{26.5958}{480.09}\right)^2$$

$$E^2_{\frac{P-VP}{T}} = \boxed{2.47 \times 10^{-10} = E^2_{ICE}}$$

2.2.4 Calculation Summary for Section 2.2

Containment Compartment	Error (E^2)
Upper Volume	1.86×10^{-10}
Lower Volume	1.86×10^{-10}
Ice Condenser	2.47×10^{-10}

2.3 ERROR FOR W_i

If: $A = B + C + D$

And: $B = k_1 b$, $C = k_2 c$, $D = k_3 d$

Then: $E_B{}^2 = k_1{}^2 b^2$, $E_C{}^2 = k_2{}^1 c^2$, $E_D{}^2 = k_3{}^2 d^2$

Thus: $E_A{}^2 = k_1{}^2 b^2 + k_2{}^2 c^2 + k_3{}^2 d^2$

Where: E_A = Error for W_i

W_i is the total fractional weight of air in the Containment at Run "i".

k_1 = Volume Weighting Factor - Upper Volume (VWFU)

b^2 = Error E^2_{UPPER} from Section 2.2.4

k_2 = Volume Weighting Factor - Lower Volume (VWFL)

c^2 = Error E^2_{LOWER} from Section 2.2.4

k_3 = Volume Weighting Factor - Ice Condenser (VWFI)

d^2 = Error E^2_{ICE} from Section 2.2.4

Substituting:

$$E^2_{W_i} = \left[(VWFU)^2(E^2_{UPPER})\right] + \left[(VWFL)^2(E^2_{LOWER})\right] + \left[(VWFI)^2(E^2_{ICE})\right]$$

$$E^2_{W_i} = \left[(2.0144)^2(1.86 \times 10^{-10})\right] + \left[(1.0000)^2(1.86 \times 10^{-10})\right] + \left[(0.3671)^2(2.47 \times 10^{-10})\right]$$

$$\boxed{E^2_{W_i} = 1.03 \times 10^{-9}}$$

2.4 ERROR FOR W_n

If: $A = B/C$

Then: $$E_A^2 = \left[\frac{E_B^2}{B^2} + \frac{E_C^2}{C^2}\right] \times A^2$$

Where: E_A = Error in A; A = the normalized weight of containment air; W_n

E_B = Error in B; B = the weight of air within the containment ar Run "i"; W_i

E_C = Error in C; C = the original weight of air within the containment; W_o

Substituting:

$$W_n = W_i/W_o$$

$$E^2_{W_n} = \left[\frac{E^2_{W_i}}{W_i^2} + \frac{E^2_{W_o}}{W_o^2}\right] \times \left(\frac{W_i}{W_o}\right)^2$$

It can be assumed that W_i/W_o is essentially = / thus:

$$E^2_{W_n} = \left[\frac{E^2_{W_i}}{W_i^2} + \frac{E^2_{W_i}}{W_i^2}\right]$$

$$E^2_{W_n} = 2\left[\frac{E^2_{W_i}}{W_i^2}\right]$$

The ILRT Leak Rate Computer Program calculates W_i from:

$$W_i = (VMFU)\left(\frac{P-VP}{T}\right)_u + (VMFL)\left(\frac{P-VP}{T}\right)_L + (VMFI)\left(\frac{P-VP}{T}\right)_I$$

$$W_i = (2.0144)\left[\frac{26.6717 - 0.1524}{539.90}\right] + (1.000)\left[\frac{26.6481 - 0.1667}{539.82}\right] + (0.3671)\left[\frac{26.6513 - 0.0555}{480.09}\right]$$

$W_i = 0.1683$ and $W_i^2 = 0.0283 = 2.83 \times 10^{-2}$

$E^2_{W_i} = 1.03 \times 10^{-9}$ as per Section 2.3

Then:

$$E^2 W_n = 2\left[\frac{1.03 \times 10^{-9}}{2.83 \times 10^{-2}}\right]$$

$$\boxed{E^2 W_n = 7.28 \times 10^{-8}}$$

2.5 ERROR IN LEAKAGE RATE

If the leakage rate is given by:

$$LR = \frac{2400}{t}\left[1 - W_n\right]$$

Where:

LR = Leakage Rate; % wt./24 hrs.

t = Test Duration; hrs.

W_n = Normalized weight of containment air at time t.

If $t = 24$ hrs. then:

$$LR = 100 - 100\, W_n$$

The error in LR may be expressed as:

$$E^2_{LR} = 100^2\, E^2_{W_n}$$

$$E_{LR} = 100\sqrt{E^2_{W_n}}$$

Where: E_{LR} = Error in leakage rate; % wt./24 hrs.

$E^2_{W_n}$ = Error[2] in normalized weight of containment air from Section 2.4

Substituting:

$$E_{LR} = 100\sqrt{7.28 \times 10^{-8}}$$

$$\boxed{E_{LR} = \pm 0.027\%\ \text{wt./24 hrs.}}$$

Since $1L_A = 0.25\%$ wt./24 hrs.

$$\boxed{E_{LR} = \pm 0.108\, L_A}$$

APPENDIX A

UPPER VOLUME - Δ DEW POINT TO Δ PSIA

VPU-1	DEW POINT	PRESSURE PSIA
High	51	0.18473
Low	44	0.14194
	Δ PSIA/°F	0.0061

VPU-2		
High	50	0.17799
Low	44	0.14194
	Δ PSIA/°F	0.0060

LOWER VOLUME - Δ DEW POINT TO Δ PSIA

VPL-1	DEW POINT	PRESSURE PSIA
High	50	0.17799
Low	46	0.15317
	Δ PSIA/°F	0.0062

VPL-2		
High	53	0.19880
Low	48	0.16517
	Δ PSIA/°F	0.0067

ICE CONDENSER - Δ DEW POINT TO Δ PSIA

VPI-1 & VPI-2	DEW POINT	PRESSURE PSIA
High	30	0.08168
Low	18	0.04363
	Δ PSIA/°F	0.0032

APPENDIX B

Data From Pre-Operational ILRT - Unit No. 2 Run

Containment Pressure*	PSIA
UPPER VOLUME	26.6717
LOWER VOLUME	26.6481
ICE CONDENSER	26.6513

*Values are averages of redundant pressure sensors/volume

Containment Temperature**	°R
UPPER VOLUME	539.90
LOWER VOLUME	539.82
ICE CONDENSER	480.09

**Values are weighted averages/volume

Containment Vapor Pressure	PSIA
UPPER VOLUME	0.1524
LOWER VOLUME	0.1667
ICE CONDENSER	0.0555

Containment Volume Weighting Factors	VWF
UPPER VOLUME	2.0144
LOWER VOLUME	1.0000
ICE CONDENSER	0.3671

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 outside the containment where the air line can be isolated and vented.

6.0 Containment Model and Leak Rate Calculation

The containment leak calculations 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:

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

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

R = gas constant for dry air = 53.34 $\frac{ft\text{-}lbs}{lbm\text{-}°R}$ (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 presence of the volume of ice in the Ice Condenser as determined by the Ice Basket Weighing Program and the ice loading procedure between June 1, 1981 and July 8, 1981. The total ice weight was 2.612 x 10^6 pounds. The standard density of ice, 56 lbs/ft^3 is assumed to calculate the volume displaced, 46,620 ft^3. This reduces the net free volume in the Ice Condenser to 128,285.5 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 1 ILRT

Compartment	Free Volume (ft^3)
Upper	703,966
Lower	349,467
Ice Condenser	128,285.5
Total	1,181,718.5

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	$\frac{V_I}{V_L}$	0.3671

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:

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

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 (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.

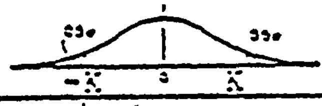
Referring to Table 6.5.1, the value K of the t-distribution, as determined from the point at which the cumulative distribution of the t-distribution has the normalized value $\alpha/2$, defines a two sided interval about the mean of ν(nu) independent measurements the entire population of measurements 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 ν of degrees of freedom available for the estimation of error. For a one-sided test the confidence limits are obtained for α/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 $1 - \alpha/2$ 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:

$$b-K(n-2, 0.1) \quad S_b$$

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:

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

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),H(99),TIME(99),HRA(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
*       WDEN = 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
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*      *   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 ,30X,        ** 02/02/78
*      *   'PU-2'/1H ,9(F7.4,1X),F7.4//1H ,30X,'PL-1'/1H ,9(F7.4,1X),         ** 10/24/77
*      *   F7.4//1H ,30X,'PL-2'/1H ,9(F7.4,1X),F7.4//1H ,30X,'PI-1'/          ** 10/24/77
*      *   1H ,9(F7.4,1X),F7.4//1H ,30X,'PI-2'/1H ,9(F7.4,1X),F7.4//          ** 10/24/77
*      *   1H ,30X,'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 IR = 0                                                               ** 02/02/78
*         LICP1 = LIC + 1                                                    ** 01/27/78
*         LUCP1 = LUC + 1                                                    ** 01/27/78
*C        IR 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 (IR.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
*         IR = IR + 1                                                        ** 02/02/78
*        TIME(IR) = TIMER - TIMEST                                           ** 01/27/78
*        NRA(IR) = 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
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*      THSHUC = 0.0                                                        ** 01/27/78
*      VHAC   = 1.0                                                        ** 01/27/78
*      DO 400 JAH1=1,LUC                                                   ** 01/27/78
*       A = TEMPUC(JAH1)                                                   ** 01/27/78
*      IF (A.LE.0.0) GO TO 801                                             ** 01/27/78
*       A = C1*A + C2                                                      ** 01/27/78
*      THSHUC = THSHUC + A*WTUP(JAH1)                                      ** 01/27/78
*      GO TO 400                                                           ** 01/27/78
*  801 VHAC = VHAC - WTUP(JAH1)                                            ** 01/27/78
*      WRITE (10,902) HRD,HDUP,JAH1                                        ** 01/27/78
*  902 FORMAT (1H0,5X,'TEMPERATURE MISSING',2X,I3,2X,A8,I2)       02/22/78** 02/22/78
*  400 TEMPU(JAH1) = A                                                     ** 01/27/78
*C      ADJUSTMENT FOR MISSING TEMPERATURE                                 ** 01/27/78
*      IF (VHAC.EQ.1.0) GO TO 709                                          ** 01/27/78
*       THSHUC = THSHUC/VHAC                                               ** 01/27/78
*      VHAC   = 1.0                                                        ** 01/27/78
*  709 THSHLC = 0.0                                                        ** 01/27/78
*      DO 401 JAH2=1,LLC                                                   ** 01/27/78
*       A = TEMPLC(JAH2)                                                   ** 01/27/78
*      IF (A.LE.0.0) GO TO 803                                             ** 01/27/78
*       A = C3*A + C4                                                      ** 01/27/78
*      THSHLC = THSHLC + A*WTLOW(JAH2)                                     ** 01/27/78
*      GO TO 401                                                           ** 01/27/78
*  803  VHAC = VHAC - WTLOW(JAH2)                                          ** 01/27/78
*      WRITE (10,902) HRD,HDLO,JAH2                                        ** 01/27/78
*  401 TEMPL(JAH2) = A                                                     ** 01/27/78
*      IF (VHAC.EQ.1.0) GO TO 711                                          ** 01/27/78
*      THSHLC = THSHLC/VHAC                                                ** 01/27/78
*      VHAC   = 1.0                                                        ** 01/27/78
*  711 THSHIC = 0.0                                                        ** 01/27/78
*      DO 402 JAH3=1,LIC                                                   ** 01/27/78
*       A = TEMPIC(JAH3)                                                   ** 01/27/78
*      IF (A.LE.0.0) GO TO 805                                             ** 01/27/78
*       A = C5*A + C6                                                      ** 01/27/78
*      THSHIC = THSHIC + A*WTICE(JAH3)                                     ** 01/27/78
*      GO TO 402                                                           ** 01/27/78
*  805 VHAC = VHAC - WTICE(JAH3)                                           ** 01/27/78
*      WRITE (10,902) HRD,HDIC,JAH3                                        ** 01/27/78
*  402 TEMPI(JAH3) = A                                                     ** 01/27/78
*      IF (VHAC.NE.1.0) THSHIC = THSHIC/VHAC                               ** 01/27/78
*C      CONVERT TO ABSOLUTE                                                ** 01/27/78
*      THSHUR = THSHUC + 459.7                                             ** 01/27/78
*      THSHLR = THSHLC + 459.7                                             ** 01/27/78
*      THSHIR = THSHIC + 459.7                                             ** 01/27/78
*C      PRINT CONTROL IPR  0=LAST ONLY, N=N THRU LAST                      ** 01/27/78
*       IF (IPR.EQ.0.OR.IPR.GT.HRD) GO TO 45                               ** 01/27/78
*   55 WRITE (6,200) HRD,TIMER                                             ** 01/27/78
*      DO 500 IHRT=1,LIC                                                   ** 01/27/78
*  500 WRITE (6,501) RIDL1(IHRT),TEMPUC(IHRT),TEMPU(IHRT),                 ** 01/27/78
*     -                  RIDL2(IHRT),TEMPLC(IHRT),TEMPL(IHRT),             ** 01/27/78
*     -                  RIDL3(IHRT),TEMPIC(IHRT),TEMPI(IHRT)              ** 01/27/78
*  501 FORMAT (1H ,A8,2X,2(F6.2,5X),A8,2X,2(F6.2,5X),A8,2X,F6.2,5X,F6.2)   ** 01/27/78
*      DO 502 IHRT=LICP1,LUC                                               ** 01/27/78
*  502 WRITE (6,503) RIDL1(IHRT),TEMPUC(IHRT),TEMPU(IHRT),                 ** 01/27/78
*     -                  RIDL2(IHRT),TEMPLC(IHRT),TEMPL(IHRT)              ** 01/27/78
*  503 FORMAT (1H ,A8,2X,2(F6.2,5X),A8,2X,F6.2,5X,F6.2)                    ** 01/27/78
*      DO 504 IHRT=LUCP1,LLC                                               ** 01/27/78
*  504 WRITE (6,505) RIDL2(IHRT),TEMPLC(IHRT),TEMPL(IHRT)                  ** 01/27/78
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 505 FORMAT (1H ,32X,A8,2X,F6.2,5X,F6.2)                                   ** 01/27/78
     WRITE (6,507) THSHUC,THSHLC,THSHIC,THSHUR,THSHLR,THSHIR               ** 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 (IPR.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
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*  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 N=1,70,10                                                        ** 01/27/78
*       N1=N+1                                                                 ** 10/20/77
*       N2=N+9                                                                 ** 10/20/77
*       NY=((N-1)/10)+1                                                        ** 10/20/77
*        PRDG = PRES(NY)                                                       ** 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(NY)=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,NY,PRDG                                     02/22/78** 02/22/78
*  407 FORMAT(I2,'***MANOMETER READING OFF CALIBRATION***',2X,I3,2X,  02/22/78** 02/22/78
*     - I2,F9.4)                                                      02/22/78** 02/22/78
*  408  PRESC(NY) = 0.0                                                        ** 02/09/78
*       GO TO 405                                                              ** 01/27/78
*  731 PRESC(NY) = 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.NOD) GO TO 747                                  ** 01/27/78
*   35 WRITE (6,500) 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 (IPR.EQ.99) GO TO 40                                                 ** 01/27/78
*C         CALCULATE NORMALIZED HEIGHT FRACTIONS; STORE WITH PRESSURES.         ** 01/27/78
*    747 HUCNUM = (PRESCU - VPAUC)/THSHUR                                        ** 01/27/78
*        HLCNUM = (PRESCL - VPALC)/THSHLR                                        ** 01/27/78
*        HICNUM = (PRESCI - VPAIC)/THSHIR                                        ** 01/27/78
*        HNUM = VHF1*HUCNUM + VHF2*HLCNUM + VHF3*HICNUM                          ** 01/27/78
*         IF (HDEN.GT.0.0) GO TO 749                                             ** 02/22/78
*        HUCDEN = HUCNUM                                                         ** 01/27/78
*        HLCDEN = HLCNUM                                                         ** 01/27/78
*        HICDEN = HICNUM                                                         ** 01/27/78
*        HDEN   = HNUM                                                           ** 01/27/78
*    749 HUC(NR) = HUCNUM/HUCDEN                                                 ** 01/27/78
*        HLC(NR)=HLCNUM/HLCDEN                                                   **
*        HIC(NR)=HICNUM/HICDEN                                                   **
*        H(NR)=HNUM/HDEN                                                         **
*         ATUC(NR) = THSHUC                                                      ** 02/02/78
*         ATLC(NR) = THSHLC                                                      ** 02/02/78
*         ATIC(NR) = THSHIC                                                      ** 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
*         T2SH = TIME(1)*H(1) + TIME(2)*H(2)                                     ** 01/27/78
```

```
*        WS = W(1) + W(2)                                                   ** 01/27/78
*       WRITE (9,201)                                                       ** 01/27/78
*   201 FORMAT(1H1,46X,'SUMMARY OF AVERAGES'///1H ,2X,'RUN #',2X,'ELAPSED   ** 01/27/78
*      -',2X,3(34HAVG TEMP  AVG FRESS  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) WRA(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
*       ADEN = XNRR*TSS - TS*TS                                             ** 01/27/78
*        A = ANUM/ADEN                                                      ** 01/27/78
*        BNUM = XNRR*T2SW - TS*WS                                           ** 01/27/78
*       B = BNUM/ADEN                                                       ** 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 N=2,II                                                        ** 01/27/78
*    48 TOT = TOT + (TIME(N)-AT)*(TIME(N)-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) WRA(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

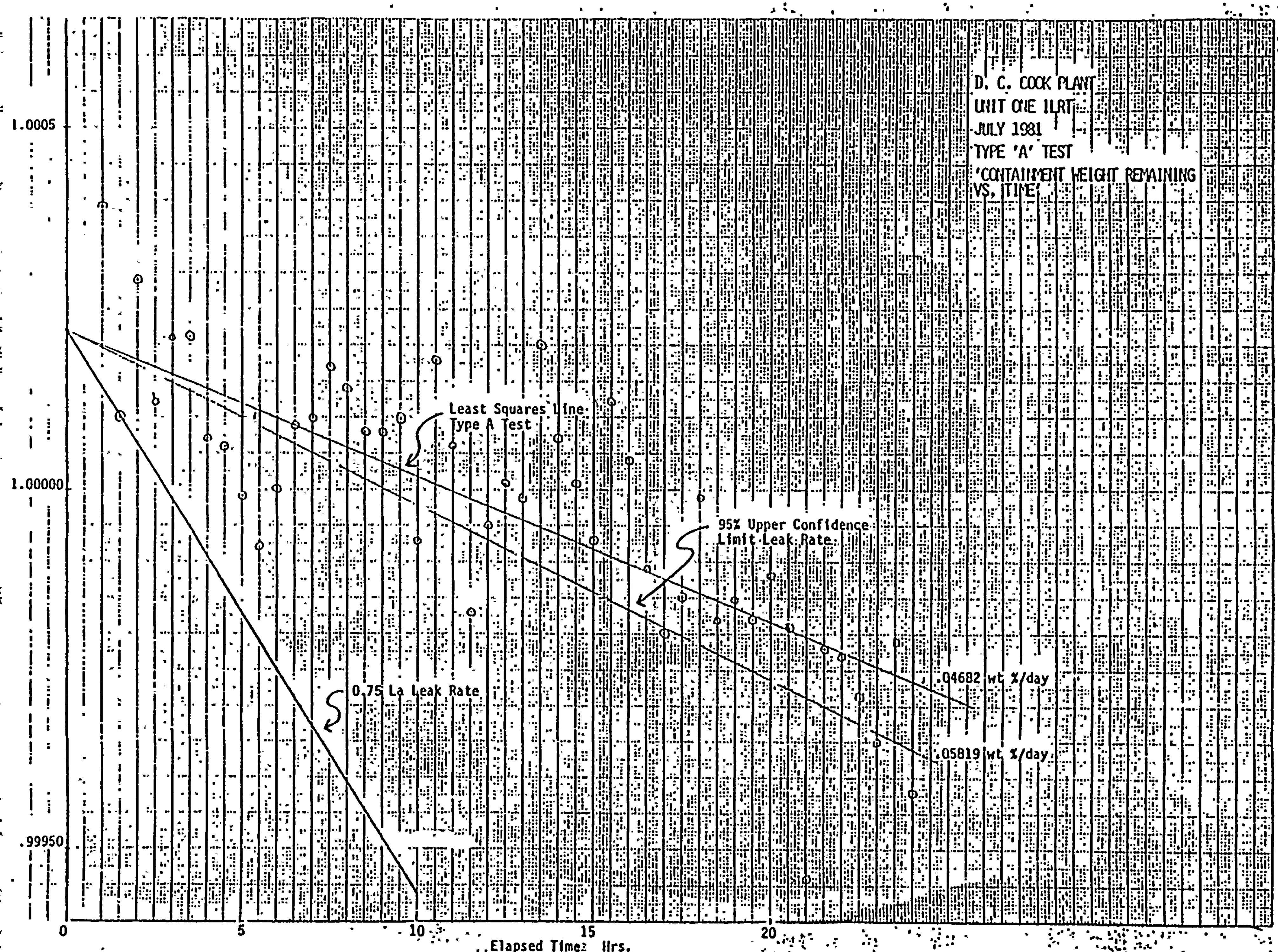
This section of the report contains graphical analysis of data obtained during the conduct of the ILRT. The 'ILRTEST' program summaries of average containment temperatures, pressures, and vapor pressures, and leak rate calculations appear in Section 8.2 of this report.

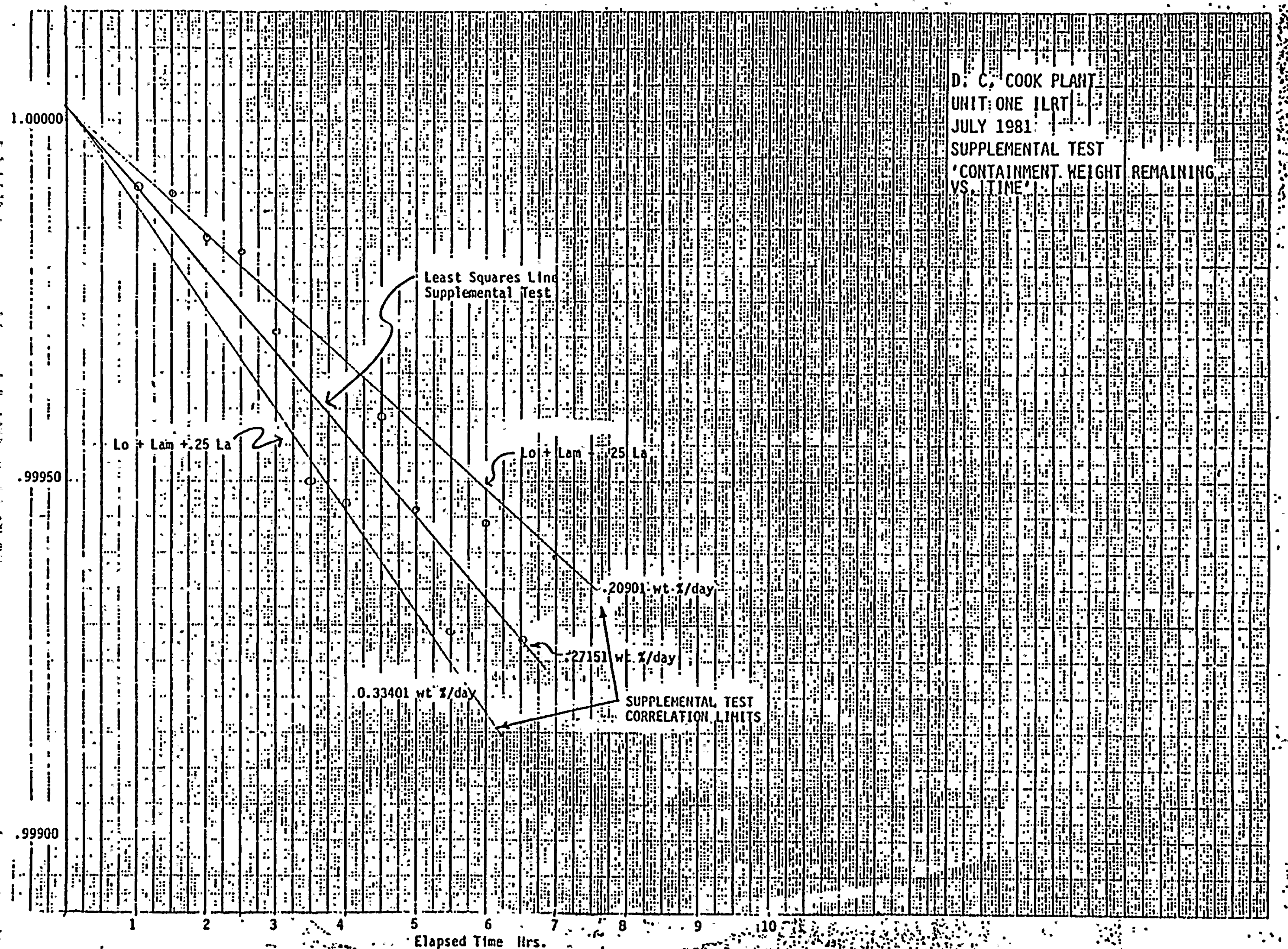
Past test experience has shown that the instrumentation package used for this test is quite capable of measuring the leak rate accurately, as evidenced by the rapid convergence of the 95% upper confidence limit of the leak rate and the excellent correlation of results between the 'Type A' and the Supplemental Test. The error analysis for the instrument system predicted an error of ± 0.027% wt/day which agreed well with the Supplemental Test correlation of 0.03027% wt/day.

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.


D. C. COOK PLANT
UNIT ONE ILRT
JULY 1981
TYPE 'A' TEST
'CONTAINMENT WEIGHT REMAINING
VS. TIME'
1.0005
1.00000
.99950
Least Squares Line
Type A Test
95% Upper Confidence
Limit Leak Rate
0.75 La Leak Rate
.04682 wt %/day
.05819 wt %/day
0
5
10
15
20
Elapsed Time: Hrs.


D. C. COOK PLANT
UNIT ONE ILRT
JULY 1981
SUPPLEMENTAL TEST
'CONTAINMENT WEIGHT REMAINING VS. TIME'
1.00000
.99950
.99900
Least Squares Line Supplemental Test
Lo + Lam + .25 La
Lo + Lam - .25 La
.20901 wt %/day
.27151 wt %/day
0.33401 wt %/day
SUPPLEMENTAL TEST CORRELATION LIMITS
1
2
3
4
5
6
7
8
9
10
Elapsed Time Hrs.

8.2 'ILRTEST' Program Summaries

D. C. Cook Unit 1, Integrated Leak Rate
Test July 15 - July 19, 1981

RESULTS OF THE LINEAR REGRESSION ANALYSIS

RUN #	W EXPERIMENTAL	LEAKAGE RATE UPPER LIMIT	LEAKAGE RATE	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
14	0.99989	-0.56859	-0.26943	1.00004	1.00005	0.99877
15	1.00000	-0.44469	-0.02052	1.00006	1.00032	0.99891
16	1.00000	-0.17425	0.03903	1.00003	1.00025	0.99929
17	0.99993	-0.13966	-0.00299	0.99996	1.00021	0.99910
18	0.99992	-0.11313	-0.01974	0.99992	1.00016	0.99935
19	1.00001	-0.06430	0.01134	1.00001	1.00039	0.99911
20	1.00032	-0.01186	0.12390	1.00064	1.00042	0.99857
21	1.00012	0.01457	0.12091	1.00016	1.00072	0.99849
22	0.99999	-0.00693	0.08619	1.00001	1.00036	0.99901
23	1.00001	-0.01287	0.06646	1.00006	1.00048	0.99863
24	1.00000	-0.01852	0.05008	1.00002	1.00035	0.99905
25	0.99991	-0.03640	0.02666	1.00004	1.00046	0.99798
26	0.99982	-0.06137	-0.00043	0.99992	1.00037	0.99800
27	1.00003	-0.04965	0.00349	1.00011	1.00063	0.99816
28	0.99990	-0.05334	-0.00576	0.99990	1.00050	0.99844
29	0.99993	-0.05219	-0.00988	0.99996	1.00053	0.99834
30	1.00011	-0.03819	0.00110	1.00019	1.00061	0.99850
31	1.00022	-0.02171	0.01692	1.00035	1.00065	0.99859
32	1.00022	-0.00828	0.02839	1.00045	1.00062	0.99820
33	1.00011	-0.00318	0.03012	1.00027	1.00071	0.99790
34	0.99998	-0.00614	0.02467	1.00006	1.00058	0.99816
35	1.00002	-0.00652	0.02180	1.00012	1.00066	0.99795
36	0.99996	-0.00939	0.01704	0.99998	1.00056	0.99846
37	0.99996	-0.01158	0.01308	0.99999	1.00059	0.99834
38	1.00000	-0.01172	0.01115	1.00016	1.00083	0.99724
39	0.99988	-0.01675	0.00524	0.99992	1.00088	0.99729
40	0.99999	-0.01630	0.00416	1.00009	1.00097	0.99714
41	1.00004	-0.01433	0.00475	1.00017	1.00106	0.99694
42	1.00027	-0.00719	0.01200	1.00041	1.00104	0.99778
43	1.00039	0.00111	0.02123	1.00071	1.00105	0.99729
44	1.00013	0.00311	0.02200	1.00027	1.00101	0.99737
45	1.00015	0.00521	0.02300	1.00021	1.00135	0.99699
46	1.00015	0.00707	0.02385	1.00032	1.00118	0.99688
47	1.00011	0.00771	0.02355	1.00026	1.00113	0.99697
48	1.00002	0.00609	0.02123	1.00015	1.00110	0.99677
49	1.00000	0.00434	0.01885	1.00016	1.00107	0.99664
50	0.99997	0.00213	0.01614	1.00005	1.00106	0.99692

FINAL LEAKAGE RATE (% PER DAY) = 0.01614 INTERCEPT= 0.99997

UPPER CONFIDENCE LIMIT FOR THE RATE IS 0.00213

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
12	0.0	82.3985	26.8123	0.2115	83.3963	26.7862	0.2239	20.8531	26.7947	0.0810
13	0.50	82.3530	26.8093	0.2094	83.3384	26.7831	0.2223	20.9437	26.7902	0.0973
14	1.00	82.3191	26.8059	0.2081	83.3159	26.7806	0.2208	20.9907	26.7821	0.0936
15	1.50	82.2819	26.8042	0.2074	83.2310	26.7781	0.2154	21.0212	26.7821	0.0883
16	2.00	82.2453	26.7994	0.2053	83.1270	26.7731	0.2173	20.9488	26.7783	0.0781
17	2.50	82.2020	26.7947	0.2047	83.1143	26.7696	0.2155	20.9206	26.7768	0.0834
18	3.00	82.1753	26.7904	0.2026	83.0657	26.7641	0.2136	20.8209	26.7718	0.0772
19	3.50	82.1960	26.7926	0.2013	83.0036	26.7666	0.2131	20.8522	26.7733	0.0834
20	4.00	82.1414	26.7899	0.1848	82.9670	26.7636	0.2112	20.9842	26.7703	0.0875
21	4.50	82.0750	26.7839	0.1948	82.9321	26.7586	0.2000	21.0447	26.7659	0.0818
22	5.00	82.0422	26.7797	0.1960	82.8690	26.7545	0.2084	20.8658	26.7629	0.0749
23	5.50	82.0136	26.7797	0.1961	82.8064	26.7535	0.2073	20.8422	26.7614	0.0848
24	6.00	81.9488	26.7740	0.1948	82.7936	26.7480	0.2060	20.8175	26.7565	0.0702
25	6.50	81.9522	26.7740	0.1941	82.7326	26.7475	0.2054	20.9681	26.7565	0.0904
26	7.00	81.9200	26.7680	0.1928	82.6948	26.7420	0.2041	20.9719	26.7495	0.0826
27	7.50	81.8917	26.7705	0.1916	82.6224	26.7440	0.2029	20.9920	26.7500	0.0777
28	8.00	81.8655	26.7637	0.1916	82.6021	26.7380	0.2011	20.9898	26.7446	0.0650
29	8.50	81.8550	26.7633	0.1903	82.5769	26.7365	0.2002	20.8934	26.7436	0.0719
30	9.00	81.7482	26.7624	0.1884	82.5312	26.7355	0.1993	20.8322	26.7411	0.0685
31	9.50	81.7274	26.7589	0.1817	82.4702	26.7324	0.1983	20.8382	26.7401	0.0648
32	10.00	81.7128	26.7559	0.1769	82.4276	26.7284	0.1971	20.9183	26.7367	0.0675
33	10.50	81.6979	26.7545	0.1810	82.3689	26.7269	0.1961	20.9162	26.7352	0.0740
34	11.00	81.6680	26.7489	0.1822	82.3476	26.7219	0.1954	20.8847	26.7272	0.0609
35	11.50	81.6358	26.7489	0.1822	82.3160	26.7214	0.1943	20.7896	26.7272	0.0718
36	12.00	81.6226	26.7433	0.1810	82.2824	26.7159	0.1933	20.7877	26.7233	0.0543
37	12.50	81.5842	26.7403	0.1798	82.2137	26.7129	0.1927	20.7754	26.7187	0.0536
38	13.00	81.5764	26.7420	0.1774	82.1611	26.7149	0.1910	20.8464	26.7192	0.0798
39	13.50	81.5470	26.7360	0.1792	82.1197	26.7099	0.1868	20.9132	26.7163	0.0716
40	14.00	81.5312	26.7399	0.1792	82.0835	26.7129	0.1890	20.9917	26.7187	0.0737
41	14.50	81.4958	26.7390	0.1780	82.0500	26.7129	0.1883	21.0178	26.7187	0.0775
42	15.00	81.4612	26.7356	0.1700	81.9989	26.7094	0.1879	20.8949	26.7142	0.0574
43	15.50	81.4273	26.7323	0.1602	81.9534	26.7063	0.1869	20.9399	26.7118	0.0657
44	16.00	81.4074	26.7291	0.1698	81.9178	26.7033	0.1867	20.9281	26.7088	0.0613
45	16.50	81.3801	26.7291	0.1727	81.9280	26.7028	0.1767	20.9823	26.7083	0.0679
46	17.00	81.3573	26.7304	0.1721	81.8839	26.7038	0.1842	20.9848	26.7093	0.0716
47	17.50	81.3074	26.7269	0.1727	81.8371	26.7003	0.1844	20.9988	26.7054	0.0646
48	18.00	81.3004	26.7230	0.1721	81.8133	26.6973	0.1832	21.0315	26.7019	0.0645
49	18.50	81.2674	26.7218	0.1721	81.7869	26.6953	0.1833	21.0067	26.7019	0.0693
50	19.00	81.2410	26.7170	0.1715	81.7442	26.6913	0.1816	21.0533	26.6980	0.0554

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	81.2480	26.7149	0.1710	81.7247	26.6888	0.1810	20.9629	26.6949	0.0508
2	0.50	81.2268	26.7161	0.1710	81.7115	26.6898	0.1806	20.9608	26.6954	0.0534
3	1.00	81.1806	26.7140	0.1536	81.6883	26.6878	0.1804	20.9623	26.6940	0.0643
4	1.50	81.1732	26.7119	0.1664	81.6717	26.6888	0.1801	20.9933	26.6930	0.0590
5	2.00	81.1936	26.7145	0.1578	81.6504	26.6883	0.1797	21.0247	26.6940	0.0683
6	2.50	81.1489	26.7106	0.1636	81.6192	26.6848	0.1793	21.0958	26.6925	0.0613
7	3.00	81.1195	26.7184	0.1653	81.6146	26.6923	0.1791	21.3800	26.6959	0.0738
8	3.50	81.1064	26.7154	0.1659	81.5617	26.6938	0.1783	21.3689	26.6944	0.0690
9	4.00	81.1001	26.7119	0.1659	81.5416	26.6863	0.1779	21.3919	26.6925	0.0770
10	4.50	81.0772	26.7101	0.1659	81.5505	26.6832	0.1770	21.3636	26.6885	0.0685
11	5.00	81.0698	26.7071	0.1647	81.5176	26.6843	0.1773	21.3978	26.6870	0.0797
12	5.50	81.0517	26.7033	0.1642	81.5008	26.6777	0.1766	21.2642	26.6835	0.0738
13	6.00	81.0711	26.7050	0.1647	81.4965	26.6787	0.1720	21.2502	26.6835	0.0721
14	6.50	81.0521	26.7046	0.1631	81.4622	26.6787	0.1751	21.2942	26.6830	0.0570
15	7.00	81.0457	26.6995	0.1587	81.4587	26.6772	0.1748	21.2041	26.6816	0.0542
16	7.50	81.0088	26.6965	0.1598	81.2358	26.6747	0.1748	21.0675	26.6771	0.0514
17	8.00	81.0179	26.6977	0.1551	81.4451	26.6717	0.1743	21.0222	26.6776	0.0567
18	8.50	81.0048	26.6947	0.1587	81.3477	26.6697	0.1737	20.9957	26.6771	0.0503
19	9.00	80.9779	26.6956	0.1603	81.3626	26.6702	0.1666	21.0769	26.6766	0.0636
20	9.50	80.8778	26.6913	0.1598	81.3063	26.6667	0.1724	21.0104	26.6722	0.0476
21	10.00	80.9647	26.6900	0.1598	81.2719	26.6657	0.1722	20.9852	26.6712	0.0603
22	10.50	80.7982	26.6896	0.1592	81.2871	26.6652	0.1720	20.9197	26.6697	0.0472
23	11.00	80.7598	26.6878	0.1587	81.2476	26.6632	0.1716	21.0306	26.6692	0.0700
24	11.50	80.9055	26.6848	0.1587	81.2499	26.6597	0.1715	20.9498	26.6662	0.0639
25	12.00	80.9502	26.6887	0.1582	81.2088	26.6632	0.1706	20.9531	26.6671	0.0640
26	12.50	80.9223	26.6845	0.1534	81.1441	26.6597	0.1708	21.0228	26.6652	0.0539
27	13.00	80.9426	26.6848	0.1545	81.1654	26.6597	0.1700	20.9737	26.6642	0.0512
28	13.50	80.9283	26.6810	0.1419	81.1165	26.6561	0.1700	20.9401	26.6632	0.0486
30	14.25	80.8952	26.6818	0.1509	81.0783	26.6566	0.1690	20.9716	26.6622	0.0522
31	14.50	80.9056	26.6802	0.1524	81.0568	26.6556	0.1697	20.9288	26.6618	0.0476
32	15.00	80.8890	26.6776	0.1524	81.0855	26.6531	0.1689	20.9575	26.6583	0.0439
33	15.50	80.8186	26.6802	0.1519	80.9934	26.6556	0.1683	20.9638	26.6587	0.0524
34	16.00	80.7922	26.6806	0.1524	80.9672	26.6556	0.1689	21.1056	26.6567	0.0677
35	16.50	80.8027	26.6758	0.1550	80.9616	26.6511	0.1684	21.1490	26.6543	0.0477
36	17.00	80.8609	26.6776	0.1555	80.9456	26.6526	0.1677	21.1327	26.6547	0.0693
37	17.50	80.8471	26.6789	0.1550	80.9170	26.6536	0.1675	21.2766	26.6552	0.0682
38	18.00	80.8296	26.6763	0.1519	80.8782	26.6516	0.1635	21.2505	26.6542	0.0540
39	18.50	80.8104	26.6712	0.1534	80.8746	26.6466	0.1672	21.0878	26.6508	0.0485
40	19.00	80.8324	26.6717	0.1524	80.8206	26.6481	0.1667	21.0866	26.6513	0.0555
41	19.50	80.8097	26.6694	0.1524	80.8386	26.6451	0.1663	21.0191	26.6482	0.0497
42	20.00	80.7805	26.6712	0.1524	80.7990	26.6466	0.1664	21.0717	26.6497	0.0577
43	20.50	80.7684	26.6672	0.1524	80.7768	26.6436	0.1662	21.0910	26.6473	0.0488
44	21.00	80.7751	26.6659	0.1524	80.7501	26.6426	0.1913	21.0337	26.6478	0.0615
45	21.50	80.8012	26.6681	0.1518	80.7730	26.6441	0.1654	20.9263	26.6473	0.0688
46	22.00	80.7486	26.6642	0.1524	80.7206	26.6406	0.1653	20.8062	26.6453	0.0630
47	22.50	80.7416	26.6608	0.1529	80.7179	26.6366	0.1653	20.7048	26.6429	0.0539
48	23.00	80.7435	26.6573	0.1518	80.7184	26.6330	0.1637	20.5812	26.6404	0.0544
49	23.50	80.7340	26.6548	0.1447	80.6398	26.6300	0.1641	20.4662	26.6379	0.0537
50	24.00	80.7277	26.6518	0.1519	80.6567	26.6260	0.1633	20.3275	26.6364	0.0499

RUN #	W EXPERIMENTAL	LEAKAGE RATE UPPER LIMIT	LEAKAGE RATE	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	1.00039	-1.32053	0.92972	1.00074	1.00005	0.99946
4	1.00010	-0.86147	0.29909	1.00020	1.00013	0.99955
5	1.00029	-0.24441	0.29556	1.00058	1.00017	0.99918
6	1.00012	-0.24599	0.13219	1.00030	1.00011	0.99924
7	1.00026	-0.12033	0.13241	1.00058	1.00041	0.99831
8	1.00026	-0.05742	0.12445	1.00047	1.00059	0.99846
9	1.00007	-0.10686	0.05185	1.00035	1.00036	0.99803
10	1.00006	-0.12422	0.00848	1.00033	1.00027	0.99826
11	0.99999	-0.14671	-0.03175	1.00027	1.00035	0.99772
12	0.99992	-0.16673	-0.06572	1.00018	1.00016	0.99808
13	1.00000	-0.15618	-0.07136	1.00019	1.00038	0.99817
14	1.00009	-0.13361	-0.06072	1.00027	1.00033	0.99863
15	1.00010	-0.11482	-0.05136	1.00026	1.00029	0.99887
16	1.00017	-0.09389	-0.03674	1.00017	1.00061	0.99909
17	1.00014	-0.07942	-0.02857	1.00038	1.00013	0.99901
18	1.00008	-0.07268	-0.02767	1.00015	1.00025	0.99928
19	1.00008	-0.06632	-0.02617	1.00017	1.00051	0.99859
20	1.00010	-0.05924	-0.02311	1.00022	1.00026	0.99917
21	0.99993	-0.06475	-0.03118	1.00001	1.00030	0.99870
22	1.00018	-0.05461	-0.02313	1.00032	1.00026	0.99927
23	1.00006	-0.05142	-0.02275	1.00035	1.00027	0.99817
24	0.99983	-0.06139	-0.03320	0.99996	1.00014	0.99846
25	0.99995	-0.06158	-0.03558	1.00005	1.00038	0.99848
26	1.00001	-0.05886	-0.03490	1.00012	1.00036	0.99864
27	0.99999	-0.05696	-0.03482	1.00005	1.00035	0.99881
28	1.00020	-0.04893	-0.02700	1.00041	1.00031	0.99894
30	1.00007	-0.04526	-0.02485	1.00016	1.00044	0.99870
31	1.00001	-0.04394	-0.02490	1.00003	1.00041	0.99894
32	0.99993	-0.04503	-0.02711	0.99996	1.00029	0.99889
33	1.00012	-0.04073	-0.02359	1.00021	1.00058	0.99858
34	1.00004	-0.03871	-0.02259	1.00025	1.00061	0.99763
35	0.99989	-0.04055	-0.02518	0.99995	1.00047	0.99820
36	0.99980	-0.04447	-0.02941	0.99989	1.00058	0.99744
37	0.99985	-0.04599	-0.03161	0.99999	1.00068	0.99720
38	0.99999	-0.04414	-0.03051	1.00004	1.00082	0.99775
39	0.99982	-0.04584	-0.03275	0.99982	1.00050	0.99817
40	0.99985	-0.04642	-0.03395	0.99984	1.00068	0.99793
41	0.99982	-0.04739	-0.03546	0.99980	1.00054	0.99817
42	0.99988	-0.04689	-0.03555	0.99992	1.00067	0.99782
43	0.99981	-0.04746	-0.03661	0.99979	1.00061	0.99802
44	0.99946	-0.05466	-0.04273	0.99973	0.99967	0.99768
45	0.99978	-0.05481	-0.04341	0.99978	1.00066	0.99761
46	0.99977	-0.05479	-0.04389	0.99971	1.00063	0.99800
47	0.99971	-0.05556	-0.04508	0.99958	1.00048	0.99846
48	0.99965	-0.05693	-0.04677	0.99948	1.00041	0.99861
49	0.99979	-0.05620	-0.04646	0.99967	1.00043	0.99878
50	0.99957	-0.05819	-0.04862	0.99930	1.00027	0.99916

FINAL LEAKAGE RATE (% PER DAY) = -0.04862 INTERCEPT= 1.00022

UPPER CONFIDENCE LIMIT FOR THE RATE IS -0.05819

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

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RTO 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  0.00063   1.97455  -0.06833  0.00072  1.96506  -0.02149

                 UPPER-2                         LOWER-2                                 ICE-2
   .0.0     18.00000  32.00000  0.00062   1.96880   0.02522  0.0[illegible]  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  9.8880

RTD WEIGHTING FACTORS
                              UPPER
.0628 .1161 .0831 .0831 .0960 .0960 .0960 .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 .0170 .0249 .0219 .0240 .0423 0

                              ICE
.0728 .0728 .0704 .0704 .2240 .2800 .2100

VOLUME WEIGHTING FACTORS
 UPPER  LOWER   ICE
 2.0144 1.0000 0.3671
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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
12	0.0	80.6625	26.6328	0.1452	80.3830	26.6099	0.1588	20.2135	26.6151	0.0606
13	0.50	80.6537	26.6272	0.1452	80.3930	26.6049	0.1580	20.0716	26.6112	0.0397
14	1.00	80.6441	26.6277	0.1452	80.3446	26.6049	0.1594	19.9987	26.6102	0.0584
15	1.50	80.6612	26.6264	0.1452	80.3201	26.6039	0.1592	19.9337	26.6067	0.0511
16	2.00	80.6152	26.6234	0.1452	80.2950	26.6019	0.1589	19.9158	26.6067	0.0611
17	2.50	80.5754	26.6200	0.1452	80.2443	26.5984	0.1580	19.8897	26.6047	0.0557
18	3.00	80.6504	26.6204	0.1452	80.2818	26.5979	0.1532	19.9589	26.6032	0.0647
19	3.50	80.6504	26.6139	0.1452	80.2352	26.5929	0.1576	20.0427	26.5988	0.0524
20	4.00	80.6428	26.6105	0.1452	80.1944	26.5894	0.1572	19.8822	26.5953	0.0472
21	4.75	80.6670	26.6144	0.1394	80.1642	26.5924	0.1567	19.8961	26.5947	0.0735
22	5.00	80.6559	26.6114	0.1413	80.1530	26.5904	0.1568	19.9553	26.5943	0.0741
23	5.50	80.6437	26.6049	0.1423	80.1390	26.5843	0.1567	19.8528	26.5903	0.0668
24	6.00	80.6435	26.6091	0.1423	80.1015	26.5879	0.1569	19.9475	26.5913	0.0632
25	6.50	80.6338	26.6027	0.1432	80.0658	26.5818	0.1560	19.8796	26.5884	0.0574

What was induced leak rate → 0.2 % wt per day
volume

[illegible]! see log

RUN #	W EXPERIMENTAL	LEAKAGE RATE UPPER LIMIT	LEAKAGE RATE	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
14	0.99991	-0.52047	-0.22314	0.99984	0.99986	1.00035
15	0.99990	-0.28281	-0.16027	0.99976	0.99987	1.00062
16	0.99984	-0.23693	-0.17603	0.99973	0.99986	1.00029
17	0.99982	-0.20298	-0.16388	0.99968	0.99985	1.00047
18	0.99971	-0.24636	-0.19842	0.99955	0.99994	0.99993
19	0.99950	-0.37763	-0.27993	0.99931	0.99967	1.00005
20	0.99947	-0.38950	-0.30909	0.99919	0.99963	1.00045
21	0.99959	-0.34013	-0.26564	0.99952	0.99982	0.99941
22	0.99946	-0.32801	-0.26749	0.99935	0.99976	0.99924
23	0.99929	-0.34391	-0.28883	0.99909	0.99956	0.99958
24	0.99944	-0.32031	-0.26981	0.99925	0.99976	0.99956
25	0.99928	-0.31458	-0.27151	0.99899	0.99963	0.99981

FINAL LEAKAGE RATE (% PER DAY) = -0.27151   INTERCEPT= 1.00002

UPPER CONFIDENCE LIMIT FOR THE RATE IS -0.31458

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9.0 Local Leak Test Program

9.1 Past Test Results Summary

Local leak tests were conducted periodically on Unit 1 in accordance with guidelines specified in 10 CFR 50 Appendix J, the FSAR, and the Plant Technical Specifications. Testing was 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 1 lists all the valves that exhibited a high leak rate during testing as well as the leak rate of the valves after they were repaired prior to the most recent Type A test.

The leakage detection instrumentation used in the conduct of the 'Type B and C' tests was 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.

The volumes where as found leakage exceeded the guideline leakage is shown in Table 2, a copy of our computer output program. Table 3, also a computer output, shows volumes where as left leakage has exceeded the guideline leakage. It should be noted that the 'guideline leakage' is not defined as an acceptance criteria, but as a status figure. If all the valves tested were to have a leakage equal to the guideline leakage, the total leakage would be 0.6 La, the maximum leakage allowable.

The corrective action taken on the valves prior to this Type A test are shown in Table 4. Typical corrective action performed included cleaning, lapping and replacing gaskets along with replacement of worn parts and some machining. Strokes were reset on all air operated valves after repairs.

Table 1 shows the main source of leakage to be from non-essential service water valves. The NESW containment isolation check valves in particular have shown a high rate of failure and in this year's test 13 of 14 check valves failed. The reason for failure in one or a combination of the following: 1) hard sandy deposits had collected on the sealing surfaces on valve flapper and/or the seats, preventing complete closure, 2) pitted seats and/or flappers.

The NESW System uses lake water after it is filtered through strainers, however the strainers are not capable of removing fine particles of sand from the water and it is this sand that embeds itself in the sealing surfaces of the valves or causes excessive erosion of the sealing parts. The 'WCR' valves in the NESW System were also prone to leak test failures. Twenty of the 42 WCR valves have failed in the last B & C Program. Eight of the 20 have failed 2 consecutive times and one of 20 has failed six consecutive times (WCR-922). The reason for the WCR-922 repeated failure is not known.

The existing carbon steel bodied NESW valves will be replaced with valves with 304 stainless steel bodies and elastomer diaphragms. This should prevent corrosion and assure tight closure on shutoff.

Table 1

Unit #1 - Leak Rate Test Failures

Valve	4-76	1-77	4-78	4-79	8-80	6-81	
						As Found	As Left
NSW-415-1	X	X		X	X	25349.1	1394.3
NSW-415-2	X	X		X	X	27145.2	1242.5
NSW-415-3	X	X		X	X	29933.8	2603.7
NSW-415-4	X	X		X		29524.1	0.0
NSW-417-3	X	X	X			796.0	0.0
NSW-417-4	X	X	X	X		11928.9	0.0
NSW-419-1		X		X	X	11431.9	2188.1
NSW-419-2			X	X	X		
NSW-419-3		X	X	X	X	29989.4	0.0
NSW-419-4						2993.4	0.0
NSW-244-1	X	X		X	X	30049.8	75.0
NSW-244-2	X	X		X	X	4194.2	0.0
NSW-244-3	X	X		X	X	29933.8	30.0
NSW-244-4	X	X		X	X	19938.0	0.0
WCR-902			X				
WCR-905	X	X	X				
WCR-906		X		X	X	Tested Against NSW-415-2	
WCR-907				X	X		
WCR-909				X		11962.8	1486.8
WCR-910				X		Tested Against WCR-909	
WCR-911				X		Tested Against NSW-415-3	
WCR-913				X	X	23383.4	309.0
WCR-914			X	X	X	Tested Against WCR-914	
WCR-915					X	Tested Against NSW-415-4	
WCR-921	X				X	13420.1	994.1
WCR-922	X	X	X	X	X	Tested Against NSW-419-1	
WCR-923						Tested Against WCR-921	
WCR-925					X		
WCR-926				X	X		
WCR-929						8980.1	0.0
WCR-930				X			
WCR-931						Tested Against WCR-929	
WCR-933						2993.6	521.9
WCR-934				X		Tested Against NSW-419-4	
WCR-935						Tested Against WCR-933	

Valve	4-76	1-77	4-78	4-79	8-80	6-81 As Found	6-81 As Left
WCR-945					X		
WCR-946			X	X	X	Tested Against NSW-244-2	
WCR-947					X	Tested Against NSW-244-3	
WCR-958	X					24105.7	0.0
WCR-965		X				696.5	0.0
WCR-966						Tested Against WCR-965	
VCR-103					X	27648.4	0.0
VCR-103					X	Tested Against VCR-103	
VCR-104		X	X	X			
VCR-204		X	X	X			
VCR-105		X	X		X		
VCR-205		X	X		X		
VCR-106	X	X	X				
VCR-206	X	X	X				
ECR-15	X		X				
SM-1	X			X			
N-102	X			X			
N-159		X		X	X		
DW-275				X			
CS-321				X			
VCR-10				X			
VCR-11				X			
VCR-20				X			
VCR-21				X			
N-160						47272.6	545.2
SI-189	X			X			
DCR-620		X		X		47227.2	744.1
DCR-621	X	X		X	X	Tested Against DCR-620	
DCR-205				X			
DCR-206				X			
NCR-105	X						
NCR-106	X						
ECR-33				X			
ICM-260		X					
ICM-265						1189.5	0.0
ECR-31		X	X	X			
ECR-32		X		X			

Valve	4-76	1-77	4-78	4-79	8-80	6-81 As Found	6-81 As Left
XCR-100		X	X		X		
XCR-101		X	X				
SM-2					X		
XCR-102					X		
GCR-314	X						
GCR-301						1785.9	0.0
NCR-252						1694.8	0.0
CCR-460						6168.9	0.0
CCR-462						Tested Against CCR-460	
CCW-135					X		
CCR-440					X		
CCR-441					X		
CCW-243-72					X		
CCW-244-72					X		
CA-181-N						28580.9	0.0
R-156				X			
R-159				X			
R-157				X			
R-158				X			
CTS-131-W					X	55.5	2.3
CTS-131-E						19.0	0.4

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)
UPPER PURGE EXH. VCR-106,206 CPN-60	2880.00	3052.32	3052.32
N-2 AND VENT HDR FOR PCDT N160,DCR-201	120.00	47272.61	545.17
CLV AND CDV DRAIN HDR DCR-620,621 CPN-31	120.00	47227.22	744.13
REFUELING H2O RX CAV SF151(1,2),153(154)	300.00	502.46	502.46
AIR PART/RAD GAS MONITOR ECR-33 CPN-31	60.00	272.58	272.58
'S' SI PP DISCH. ICR-265 CPN-68(43)	240.00	1189.46	0.0
AIR PART/RAD GAS MON ECR-31,32 CPN-32	120.00	169.16	169.16
CON AIR TO CONT. XCR-102,103 CPN-29	120.00	787.50	787.50
N-2 TO PRT GCR-301 CPN-74	45.00	1705.90	0.0
PW TO PRT WCR-252 CPN-33	180.00	1694.84	0.0
CCW FOR EXCESS LD HX CCW-460,462 CPN-75	360.00	6168.87	0.0
GRAB SAMPLE SM-4,6 CPN-92.	60.00	60.05	60.05
CONT PRESS & H ISOL PPP-102 CPN-91	0.0	39.84	39.84
WELD CHANNEL PRESS CA-1415 CPN-13	30.00	64.06	64.06
WELD CHANNEL PRESS CA-1814 CPN-83	30.00	26580.92	0.0
CCW TO CFU COILS 2,5 CCW-243-25 CPN-25	60.00	129.80	129.80
CCW TO CFU COILS 2,5 CCW-244-25 CPN-25	60.00	238.29	238.29
GLYCOL SUPPLY EXP. P-156,159 CPN-86	60.00	72.17	72.17
GLYCOL RETURN EXP. P-157,158 CPN-56	60.00	79.07	79.07

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 1 NSW-415-1 AND WCR-903 CPN-17,21	720.00	25349.00	1394.31
CLV 4 NSW-415-4 AND WCR-915 CPN-20,24	720.00	29524.12	0.0
CLV 4 WCR-913 AND WCR-914 5 CPN-20,24	720.00	23383.37	309.02
CUV 1 NSW-419-1 AND WCR-922 CPN-26	480.00	11431.90	2188.83
CUV 1 WCR-921 AND WCR-923 CPN-26	480.00	13420.05	994.08
CUV 4 NSW-419-4 AND WCR-934 CPN-64	480.00	2993.38	0.0
CUV 4 WCR-933 AND WCR-935 CPN-84	480.00	2993.59	521.86
RCP 1 NSW-244-1 AND WCR-945 CPN-26	360.00	30049.84	74.97
RCP 4 NSW-244-4 AND WCR-948 CPN-86	360.00	19937.98	0.0
RCP 4 WCR-954 AND WCR-958 CPN-84	360.00	24105.67	0.0
CLV 2 NSW-415-2 AND WCR-906 CPN-22	720.00	27145.20	1242.46
CLV 2 WCR-905 AND WCR-907 CPN-22	720.00	1789.24	1039.78
CLV 3 NSW-415-3 AND WCR-911 CPN-23	720.00	29933.83	2603.68
CLV 3 WCR-909 AND WCR-910 CPN-23	720.00	11962.79	1486.83
CUV 2 WCR-925 AND WCR-927 CPN-27	480.00	649.77	649.77
CUV 3 NSW-419-3 AND WCR-930 CPN-65	480.00	29969.42	0.0
CUV 3 WCR-929 AND WCR-931 CPN-85	480.00	6980.15	0.0
RCP 2 NSW-244-2 AND WCR-946 CPN-27	360.00	4194.18	0.0
RCP 3 NSW-244-3 AND WCR-947 CPN-85	360.00	29933.83	30.02
INSTR. RM. EAST NSW-417-4,WCR-963 CPN-71	240.00	11928.94	0.0
INSTR. RM. WEST NSW-417-3,WCR-967 CPN-71	240.00	756.03	0.0
INSTR. RM. WEST WCR-965,WCR-966 CPN-71	240.00	695.51	0.0

Table 3

********** D. C. COOK NUCLEAR PLANT, UNIT NO. 1 **********
TYPE "B" AND "C" LEAK RATE TEST OF CONTAINMENT ISOLATION VALVES DURING JUNE 1981 OUTAGE

TYPE "C" DATA INFORMATION

VOLUMES WHERE GUIDLINE LEAKAGE HAS BEEN EXCEEDED

TEST STEP	DESCRIPTION	GUIDLINE LEAKAGE	CORRECTED LEAKAGE	
1	CLV 1 MSR-415-1 AND WCR-903 (CPN-17,21	720.0	1394.3	COMPLETE****
5	CHV 1 MSR-419-1 AND WCR-922 CPN-26	480.0	2188.8	COMPLETE****
6	CHV 1 WCR-921 AND WCR-923 CPN-26	480.0	994.1	COMPLETE****
8	CHV 4 WCR-933 AND WCR-935 CPN-84	480.0	521.9	COMPLETE****
13	CLV 2 MSR-415-2 AND WCR-906 CPN-22	720.0	1242.5	COMPLETE****
14	CLV 2 WCR-905 AND WCR-907 CPN-22	720.0	1039.8	COMPLETE****
15	CLV 3 MSR-415-3 AND WCR-911 CPN-23	720.0	2603.7	COMPLETE****
16	CLV 3 WCR-909 AND WCR-910 CPN-23	720.0	1486.8	COMPLETE****
18	CHV 2 WCR-925 AND WCR-927 CPN-27	480.0	649.8	COMPLETE****
34	UPPER PURGE EXH. VCR-106,206 CPN-60	2880.0	3052.3	COMPLETE****
60	N-2 AND VENT HDR FOR RCDT N160,NCR-201	120.0	545.2	COMPLETE****
62	CLV AND CHV DRAIN HDR DCR-620,621 CPN-31	120.0	744.1	COMPLETE****
70	REFUELING H2O RX CAV SF151(152),153(154)	300.0	502.5	COMPLETE****
78	AIR PART/RAD GAS MONITOR ECR-33 CPN-31	60.0	272.6	COMPLETE****
81	AIR PART/RAD GAS MON ECR-31,32 CPN-32	120.0	169.2	COMPLETE****
83	CON AIR TO CONT. XCR-102,103 CPN-29	120.0	787.5	COMPLETE****
91	GRAB SAMPLE SN-4,6 CPN-92.	60.0	60.0	COMPLETE****
96	CONT PRESS A-B ISOL PPP-302 CPN-91	0.0	39.8	COMPLETE****
102	WELD CHANNEL PRESS CA-181S CPN-83	30.0	64.1	COMPLETE****
105	CCW TO CPN COILS 2,5 CCW-243-25 CPN-25	60.0	129.8	COMPLETE****
106	CCW TO CPN COILS 2,5 CCW-244-25 CPN-25	60.0	238.3	COMPLETE****
115	GLYCOL SUPPLY EXP. R-156,159 CPN-86	60.0	72.2	COMPLETE****
116	GLYCOL RETURN EXP. R-157,158 CPN-56	60.0	79.1	COMPLETE****
119	POST ACCIDENT SAMPLING R-11/12 CPN-32	60.0	545.1	COMPLETE****

Table 4

Valves Showing Excess Leakage and Corrective Action Taken

Valve	Supplemental Job Order #	Corrective Action
NSW-415-1	54847-1	Cleaned valve and replaced flappers
	54847-56	Installed new S.S. check flapper
NSW-415-2	54847-14	Installed new flapper
	54847-71	New valve and new S.S. flapper
NSW-415-3	54847-16	Cleaned valve and replaced
NSW-415-4	54847-48	Replaced flappers
	54847-61	Replaced flappers
	54847-73	Cleaned and lapped
	54847-75	Installed new valve and new flappers
NSW-417-3	54847-27	Cleaned valve
NSW-417-4	54847-26	Cleaned seats, body. Installed new bonnet gasket
	54847-47	Lapped disc to seat
NSW-419-1	54847-03	Cleaned valve
	54847-69	Cleaned valve
NSW-419-3	54847-2	Cleaned and lapped, new gaskets
NSW-419-4	54847-07	Cleaned, lapped, new spring, new gaksets
NSW-244-1	54847-11	Cleaned valve
NSW-244-2	54847-22	Cleaned valve
NSW-244-3	54847-24	Cleaned valve
NSW-244-4	54847-12	Cleaned, lapped, new gaskets
WCR-906	54847-15	Cleaned and lapped, set stroke
WCR-909	54847-18	Cleaned, lapped, new gaskets, set stroke
	54847-68	Cleaned, lapped, set stroke
	54847-76	Replaced plug seat ring, set stroke
	54847-77	New plug and cage, stem, stem pin, seal
	54847-78	Ring and gaksets, remachined seat on plug
WCR-910	54847-19	Cleaned and lapped, new gaskets, set stoke
	54847-67	Lapped seat, set stroke
WCR-911	54847-17	Lapped and cleaned, set stroke
	54847-66	Lapped seat, set stroke
WCR-913	54847-51	Cleaned, new gaskets and seal ring, set stroke
WCR-914	54847-50	Cleaned, new gaskets and seal ring, set stroke
	54847-62	Lapped, set stroke
	54847-74	Adjusted packing, set stroke

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 1)

10.1.4 Local Leak Rate (Type B and C) Testing
Question 022.15, AppendQ (Unit 1)

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 1 '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'

10.7 NRC Correspondence

10.7.1 AEP:NRC:0615

Table 4

Valves Showing Excess Leakage and Corrective Action Taken

Valve	Supplemental Job Order #	Corrective Action
WCR-915	54847-49	Lapped seat, set stroke
WCR-921	54847-5	Cleaned and replaced gaskets
WCR-922	54847-4	Cleaned and replaced gaskets
	54847-70	Replaced gaskets, cage, plug, set stroke
WCR-923	54847-6	Remachined plug, repacked new gaskets, set stroke
	54847-55	New plug, stem, cage, gaskets, set stroke
WCR-929	54847-20	Cleaned and lapped, set stroke
WCR-931	54847-21	Cleaned and lapped, set stroke
WCR-933	54847-9	Cleaned, replaced gaskets, set stroke
WCR-934	54847-8	Cleaned, remachined seat, new gaskets, set stroke relanded cables
WCR-935	54847-10	Cleaned and replaced gaskets, set stroke
WCR-946	54847-23	Cleaned, new gaskets
WCR-947	54847-25	Cleaned, lapped
WCR-958	54847-13	Remachined seat surface, new gaskets, cleaned, set stroke
WCR-965	54847-28	Cleaned, lapped, new gasket, set stroke
WCR-966	54847-29	Cleaned and lapped
VCR-103	54847-37	Greased rubber sest
VCR-203	54847-38	Looked good to Maintenance
N-160	54847-32	lapped
	54847-45	lapped
	54847-57	Duplicate of 54847-45
DCR-620	54847-33	Cleaned, set stroke
DCR-621	54847-34	Cleaned valve
ICM-265	54847-44	No work done
GCR-301	54847-30	Replaced diaphram, pin, and compressor
NCR-252	54847-31	Replaced diaphram, set stroke
CCR-460	54847-40	SV-64 was replaced on the volume
CCR-462	54847-41	SV-64 was replaced on the volume
CA-181-N	54847-39	Cleaned valve
CCW-243-25	54847-35	Cleaned valve
CCW-244-25	54847-36	Cleaned valve
CTS-131-W	54847-53	Lapped
CTS-131-E	54847-54	Lapped