25

DONALD C. COOK NUCLEAR PLANT UNIT 2

INDIANA & MICHIGAN POWER COMPANY

REACTOR CONTAINMENT BUILDING INTEGRATED LEAK RATE TEST (PRE-OPERATIONAL)

AMERICAN ELECTRIC
AEP
POWER SYSTEM

D. C. COOK NUCLEAR PLANT - UNIT NO. 2
REACTOR CONTAINMENT BUILDING
INTEGRATED LEAK RATE TEST
(PRE-OPERATIONAL)

TABLE OF CONTENTS

SECTION		PAGE
1.0	Introduction	1
2.0	Integrated Leak Rate (Type 'A') Test Acceptance Criteria	2
3.0	ILRT (Type 'A') Test Results	
	3.1 Leakage Rate Summary	3
	3.2 Discussion of Type 'A' Results	3
	3.3 Discussion of Type 'C' Leak Rate Penalty	5
4.0	Conduct of Test	
	4.1 Organization of Test	[illegible]
	4.2 Log of Time and Events	10
5.0	Test Instrumentation and Equipment	
	5.1 Test Instrumentation Specifications	15
	5.2 Sensor Locations	19
	5.3 Pressurization Apparatus	23
6.0	Containment Model and Leak Rate Calculations	
	6.1 Discussion of Containment Free Volume	26
	6.2 Containment Volume Weighting Factors	29
	6.3 Temperature Sensor (RTD) Weighting Factors	31
	6.4 Containment Leak Rate Equations	32
	6.5 Statistical Treatment of Data	35
	6.6 Discussion of Computer Program	[illegible]

AEP:NPC:00020

Errata and Additions to the Report on the Reactor Containment Building Integrated Leak Rate Test (Pre-Operational, for Donald C. Cook Nuclear Plant Unit 2 Operated by the Indiana and Michigan Power Company.

Page	Comment
1	To be consistent with rest of report, 0.25 in 2nd paragraph should be preceded by minus(-) sign.
2	LAM should be L_{am}. LA should be La and L'AM should be L'_{am}
3	Same comment on subscripts am as above. Item E. -0.0011, is Item D-A, not A-D.
4	Subscript am, as per comment above.
5	Subscripts am, as per comment above.
8	Person, not man in 1st line under Containment Inspection Group.
16	Hygrometer, not Hydrometer.
18	PSIA, not PSIG in Pressure/Accuracy box.
22	On Fig. 5.1, the number "51" appears twice in the section J-9 view. The "51" in the triangle with "53" at H-7 should be "55".
23	Stage, not state in 4th line.
24	Was, not has be, in 6th line.
35	Axes, not axis in 4th line of Section 6.5. Run-on sentence in 2nd to last line.
37	Additional information: the confidence interval used is two-sided.
57	Effect, not affect in 7th to last line. Periodic, not pericdic in last line.
63	Effect that, not affect in 4th line. Delete "so" in 2nd line of 3rd paragraph.

1.0 INTRODUCTION

The Pre-Operational Integrated Leakage Rate Test (ILRT) for the Donald C. Cook Nuclear Plant - Unit 2 Reactor Containment was successfully completed on October 2, 1977 by members of the Indiana and Michigan Power Company and the American Electric Power Service Corporation.

As per FSAR and Technical Specifications the containment allowable leakage rate L_a is limited to 0.25 percent by weight of the containment air per twenty-four hours at a pressure P_a of 12.0 PSIG. In conformance with the criteria specified in Appendix 'J' of 10CFR 50 this allowable leakage is reduced to 0.75 L_a which is equivalent to -0.1875 percent by weight per day.

The ILRT was performed as specified in the I&M approved Pre-Operational Test Procedure 2 PO-033-334 written by AEPSC. The American National Standard - ANSI N45.4-1972-Leakage Rate Testing of Containment Structures for Nuclear Reactors and 10CFR 50; Appendix 'J' were used as guidelines for the procedure as well as for the associated leak rate calculations. The absolute test method was used to calculate the leakage rate using data taken every thirty minutes for thirty-one and one-half hours. The normalized weight of original air remaining in the containment determined from these calculations was plotted against time and a statistically averaged leakage rate in per cent by weight per day was obtained by a linear least-squares fit to the resulting graph. Following the thirty-one and one-half hour test, a Supplemental Test was performed by imposing a known leak on the containment to verify the validity of the original measurements.

2.0 INTEGRATED LEAK RATE (TYPE 'A') TEST ACCEPTANCE CRITERIA

2.1 As specified in Section 6.0 of D. C. Cook Nuclear Plant Pre-Operational Test Procedure 2 PO-033-334 and in accordance with 10CFR 50; Appendix 'J' requirements for Type 'A' leak tests, the test was considered acceptable when the following had been verified:

2.1.1 The measured leakage rate (LAM), as determined by a linear least-squares fit to a graph of calculated points, proves to be less than 0.75LA as specified in the D. C. Cook Nuclear Plant - Unit No. 2 Technical Specifications.

2.1.2 The accuracy of this test has been verified by performance of the Supplemental Test. The measured leakage rate (LAM) is validated when the difference between the leakage rate L'AM, determined from the Supplemental Test, and the leakage rate LAM, determined from the linear least-squares fit to the graph of calculated points, is within ± 0.25 L_A.

3.0 ILRT (TYPE 'A') TEST R...S

3.1 Leakage Rate Summary

	Measured Leakage* (% wt./24 hrs.)	Allowable Leakage (% wt./24 hrs.)
A. ILRT Type 'A' Leak Rate LAM	-0.00428	-0.1875
B. Supplemental Test Composite Leak	-0.19028	N/A
C. Imposed Leak	-0.1779	N/A
D. Leak Rate L'AM (Item B-C)	-0.01238	N/A
E. Supplemental Test Correlation (Item A-D)	-0.0081	= 0.0625

* Negative sign denotes leakage out of containment.

N/A Not Applicable.

3.2 Discussion of Type 'A' Test Results

As indicated in the Leakage Rate Summary above, the ILRT Type 'A' leak rate LAM and the results of the Supplemental Test are well within the maximum allowable limits for acceptance established in the D. C. Cook Nuclear Plant FSAR and Technical Specifications.

The containment integrated leakage rate reported here was determined from data recorded during the September 30

3.2 Discussion of Type 'A' Test Results (Cont'd)

through October 2, 1977 performance of I&M Pre-Operational Test Procedure 2 PO-033-334. A discussion of the mathematical and statistical treatment of this data to yield the containment leakage rate may be found in Section 6.0 of this report.

Item 'A' of the Leakage Rate Summary is the measured containment leakage determined after thirty-one and one-half (31.5) hours of data taking, recorded at thirty minute intervals. The measured containment leakage rate was calculated using the "Absolute Method" on a "Total Time" basis as described in American National Standard N45.4 - 1972.

In accordance with 10CFR 50; Appendix 'J' the accuracy of the Type 'A' leak test was verified by the performance of a Supplemental Test. The Supplemental Test was conducted for eight (8) hours while a metered leakage of 2.77 SCFM (0.1779 % wt./24 hrs. equivalent) was imposed on the containment. Thus, Item 'B' of the Leakage Rate Summary represents the composite leakage measured for the containment, that is, containment leakage plus the imposed leak.

When the known value of the imposed leak is deducted from the measured composite leak the resultant is the containment leak rate L'AM measured during the Supplemental Test.

3.2 Discussion of Type 'A' Test Results (Cont'd)

This is represented as Item 'D' on the Leakage Rate Summary.

The results of the Supplemental Test, that is, the correlation between ILRT Type 'A' leak rate (LAM) and the resultant containment leak rate (L'AM) is indicated as Item 'E' on the Leakage Rate Summary. Here the difference between the containment leak rate measured during the Type 'A' test and during the Supplemental Test is shown to be -0.0081 % wt./24 hrs. As stated in Section 2.0 "ILRT Acceptance Criteria", the maximum allowable difference between these measurements shall be within ± 0.25 L_a which is equivalent to ± 0.0625 % wt./24 hrs. As can be seen from the Leakage Rate Summary, excellent correlation has been achieved.

3.3 Discussion of Type 'C' Leak Rate Penalty

Prior to the performance of the Unit 2 Pre-Operational ILRT, the NRC imposed a prerequisite that required the draining and venting of additional systems or portions of systems not specified in the test procedure. In the event this could not be implemented, the results of the isolation valve local (Type 'C') leak tests for these systems would have to be added to the measured containment (Type 'A') leak rate.

A review of the affected services revealed that it was not practical, due to the existing piping configurations.

3.3 Discussion of Type 'C' Leak Rate Penalty (Cont'd)

to comply with this prerequisite for all cases. Where possible, the test procedure was revised to implement the aforementioned prerequisite. For the remaining services, the associated containment isolation valve local leak rate test data was taken from Pre-Operational Test Procedure 2 PO-C33-332.

As a result of the measurements made during the local valve leak rate tests, the total Type 'C' leak rate penalty was calculated to be -0.0294 % wt./24 hrs.

Thus, the total reportable containment leak rate is increased to (-0.00428) + (-0.0294) or -0.03368 % wt./ 24 hrs. (0.14 L_a) which is still well below the acceptance criteria of -0.1875 % wt./24 hrs. (0.75 L_a).

4.0 CONDUCT OF TEST

4.1 Organization of Test

The D. C. Cook Plant Performance Engineering Section was responsible for the Integrated Leak Rate Test. The functions performed by persons involved in the test could be subdivided between pre-test activities and test activities. Figures 4.1 and 4.2 illustrate the organization of pre-test and test activities, respectively.

Pre-Test Responsibilities

Test Supervisor

Organized efforts to ensure the readiness of the Unit 2 containment systems and test instrumentation for the conduct of this test. Responsible for the proper documentation of the test, and instrument calibration.

Operations Interface

Arranged for operations manpower to perform containment isolation valve line-up and system venting as required by the test procedure.

Startup Interface

Coordinated construction work required to place the containment in the final state of readiness for the test, and coordinated the test schedule with the construction schedule.

Instrumentation Coordination Group

Four performance engineers, each responsible for the proper operation and set-up of some portion of the test instrumentation required for this test.

Technicians

Performed work required to place test instrumentation in proper operation for the test.

Containment Inspection Coordinator

Coordinated Containment Inspection Group. Responsible for evaluating the containment inspection results and coordinating efforts for resolving any discrepancies in the containment systems that would jeopardize the success of the ILRT.

Containment Inspection Group

Four two-man teams dispatched to inspect the containment, containment electrical and piping penetrations, and containment system piping for any deficiencies. Reported to Inspection Coordinator.

4.1 Organization of Test

Test Responsibilities

Test Supervisor
(1 per 12 hour shift)

Responsible for maintenance of test documentation, data inspection, and the general conduct of the test.

Computer Operator/AEPSC Cognizant Engineer and Support
(1 per 12 hour shift)

Responsible for the on-site processing of raw data and results analysis.

Time Keeper/Data Coordinator
(1 per 12 hour shift)

Coordinated data collection and transfer of data to the computer input format.

Data Takers
(4 per 12 hour shift)

Responsible for the recording of specific test instrument readings.

Technical Support Coordinator
(1 per 12 hour shift)

Responsible for dispatching of manpower for support in the area of test instrument maintenance, repair work, installation and removal of the pressurization line spool piece and flanges, and the emergency support of the regular test crew.

Technicians
(2 per 12 hour shift)

Responsible for maintaining all test instrumentation in a proper operating condition.

Startup and Maintenance (On Call)

Responsible to assist and coordinate any repair work that may be required during the test.

Containment Inspection and General Support Group (On Call)

Provide manpower from the pre-test Containment

Inspection Group for troubleshooting containment leakage and support to the regular test crew.

4.2 Log of Times and Events

Prior to the commencement of this test, an inspection of all accessible interior and exterior surfaces of the containment structure, containment electrical penetrations, piping penetrations, associated piping, vent valves, and penetration and weld channel pressurization piping was performed. This was a visual inspection intended to uncover any evidence of deterioration or system deficiencies that would violate the integrity of the containment pressure boundary. The inspection did not uncover any adverse conditions. Therefore, after having verified the completion of the valve line-up and all of the other test prerequisites and initial conditions, containment pressurization was initiated.

Pressurization of the Unit 2 reactor containment began at 0114 hours on September 30, 1977. Data collection for this period consisted of an hourly log of containment average temperatures, pressures, vapor pressures, and ambient temperature and pressure. At 1200 on September 30, a pressure of 12.5 PSIG was achieved and pressurization was terminated.

This marked the beginning of the stabilization period.

4.2 Log of Times and Events (Cont'd)

All test parameters were recorded in half hour intervals for a preliminary determination of the containment leak rate and the establishment of stability criteria. The stabilization period was terminated at 0600 on October 1, when stability criteria had been demonstrated. The pressurization spool piece was removed, a blank flange installed and bubble tested for leak tightness.

The Integrated Leak Rate Test data collection began at 0600 on October 1. Data was collected in half hour intervals for 31.5 hours, 7.5 hours in excess of the 24 hour requirement. At 1330, October 2, the test period was declared over and a leakage of 2.77 scfm was established as the "imposed leakage" for the Supplemental Test period.

The "imposed leakage" was allowed to stabilize for a half hour and data collection for the Supplemental Test began at 1400 on October 2. The test data was collected in half hour intervals for 8 hours, 2 hours in excess of the 6 hour requirement. The test was declared complete at 2200 on October 2. The containment was subsequently depressurized and systems were restored to normal as required by plant Operations.

During the performance of ILRT, repeated problems with the on-site method of processing raw data proved to be too overwhelming, due to the large volume of data, to calculate up to the minute leakage rates. Moreover, because of the ever increasing backlog of data, the continued use of the on-site programmable calculators was eventually abandoned. The collection of data continued, however, based upon the trend of leak rate calculations performed early in the test which indicated a leak-tight containment. Thus, the final hours of data collection for the Type 'A' Test and all eight hours for the Supplemental Test were conducted without the benefit of on-site knowledge of the final measured leakage rate. It was for these reasons that the Type 'A' Test and Supplemental Test were extended beyond the original twenty-four hour and six hour test periods, respectively, to provide additional data for subsequent analysis.

Upon termination of the Supplemental Test, a second attempt was made to present on-site leakage rate calculations to the NRC inspector for his review. In place of the programmable calculators, the original computer programs used for the Unit 1 Pre-Operational ILRT were accessed from the American Electric Power Service Corporation's computer disc storage. A computer punch card deck was assembled from the Unit 2 ILRT data and transmitted to the New York computer facility via microwave. A complete review of New York computer printout

4.2 Log of Times and Events (Cont'd)

revealed that the data format and the containment model represented in the existing program would not be acceptable for this test and in effect on-site leak rate calculations were not possible.

On September 21 and 22, 1977 members of the American Electric Power Service Corporation, Indiana and Michigan Power Company and the Nuclear Regulatory Commission met to discuss all unresolved items concerning the ILRT. A presentation was made to the NRC inspector describing the revisions to the original ILRT computer program and the basis for the revised containment model represented therein. After the presentation was concluded, a thorough review of the data and final leakage calculations was made by the NRC inspector. The results of the NRC inspection were that no items of noncompliance or deviations were identified and that the Unit 2 Pre-Operational Containment Integrated Leak Rate Test was indeed acceptable.

PRETEST ACTIVITIES

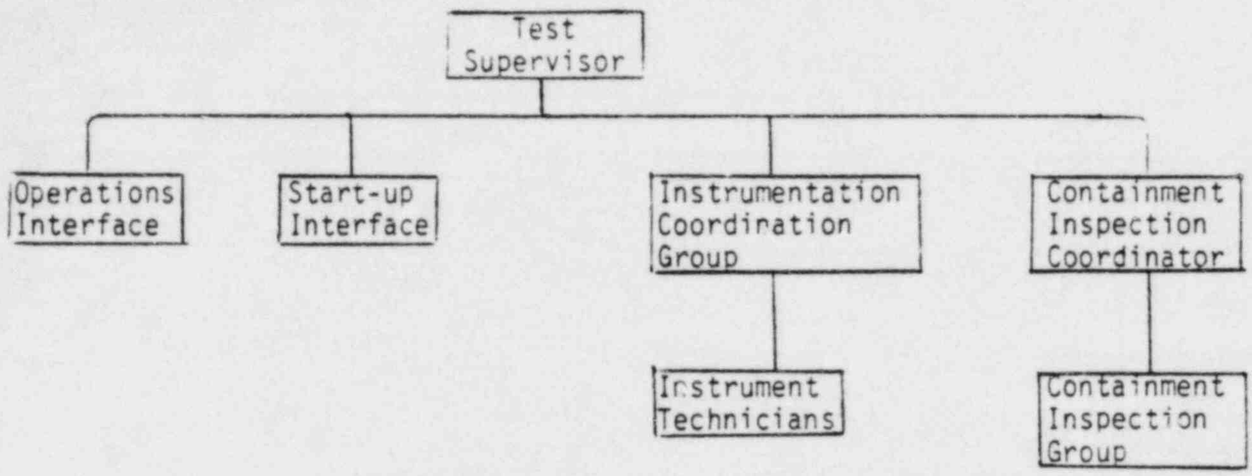


Fig. 4.1

TEST ACTIVITIES

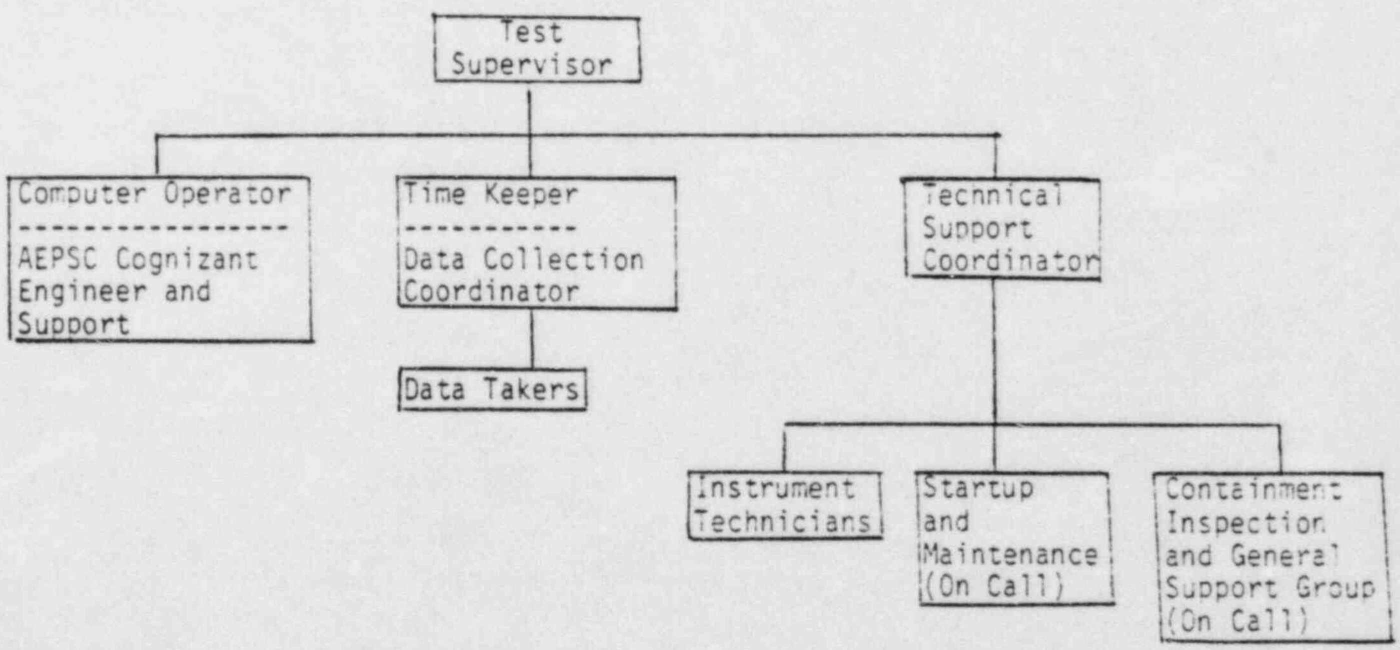


Fig. 4.2

5.0 TEST INSTRUMENTATION AND EQUIPMENT

5.1 Test Instrumentation Specifications

The best state of the art pressure, temperature, and vapor pressure instrumentation was employed during the ILRT test. The ice condenser reactor containment is unique in the fact that containment design pressure is limited to 12 PSIG. This low pressure requires more accurate instrumentation to detect leakage to the same degree as for conventional containments with design pressures of 50-60 PSIG.

Six precision Mensor Quartz Manometers were used to measure containment absolute pressure. Two sensed lower volume pressure, two upper volume, and two ice condenser pressure. A seventh Manometer measured ambient pressure during the test. Each instrument was supplied with an NBS certified standard calibration correction chart. These instrument corrections were pre-programmed into the leak rate computer program to allow direct input of the manometer readings. When the aforementioned instrument corrections are applied the manometer accuracy is specified as ± 0.01% full scale with manometer resolution specified as 0.0001 PSIA.

The three containment compartments were instrumented with a total of forty-six (46) precision RTD sensors. The number of sensors for the Upper, Lower and Ice Condenser compartments was sixteen (16), twenty-three (23) and

5.1 Test Instrumentation Specifications (Cont'd)

seven (7) respectively.

Unlike the Unit 1 Pre-Operational ILRT, platinum RTD's with stainless steel probe bodies were selected. The sensors temperature coefficient was specified as 0.00385 ohms/ohm/°C with a resistance of 100 Ω ± 0.2% at 0°C. The 100 Ω platinum RTD's were found to be much more durable and as accurate as the 2330 Ω copper sensors used during the Unit 1 ILRT. Each platinum sensor was calibrated with a linearized bridge amplifier as a matched set. Both the sensor and its associated bridge amplifier carried the same serial number so that matched calibration would be maintained. All RTD sensor/bridge calibrations are certified traceable to NBS. The 0-50 mV bridge output was connected to a digital printout device programmed to accept a linear 0-50 mV output for an output of 0-100°F. Overall temperature monitoring system accuracy is ± 0.078°F.

Four Cambridge Dew Point Hydrometers were used to sense containment humidity during the test. Two units sensed lower volume dew point, one Ice Condenser and one in the upper volume. Each unit is complete with its own sample pump which draws the sample through the mirror surface sensor. The sensor is cooled until vapor is formed on the mirror surface and electronic circuitry is used to maintain an equilibrium condition on the sensor. The

5.1 Test Instrumentation Specifications (Cont'd)

sensor temperature is measured by the use of a platinum RTD. Each RTD had certification to NBS. The overall dew-point temperature sensing accuracy is ± .5°F.

A rotameter was used during the Supplemental Test to measure and maintain a constant flow rate for the imposed leak. The rotameter has a calibrated range of 0.58 to 5.86 SCFM air at one atmosphere and 70°F and an accuracy of ± 1.0% of full scale. As all test instrumentation associated with the leak rate test, the rotameter has its calibration traceable to N.B.S.

The chart shown in Table 5.1.1 lists the specifications of test instrumentation used during the test in tabular form.

TABLE 5.1.1

INSTRUMENT SPECIFICATIONS

Item	Manufacturer	Type	Model	Range	Accuracy
Pressure	Mensor	Quartz Manometer	10100-001	0-30 PSIA	± 0.01 % f.s. .0001 PSIG Resolution
Temperature Sensors/Bridge	Hy-Cal Eng'g.	100 Platinum Linearized Bridge	RTS-4233-B ESD-9050-A	0-100°F	± 0.06 °F
Temperature Readout	Fluke	Linear Readout/ Printer	2240	0-50 MV (0-100 °F)	± 0.05 °F
Temperature (Overall System)	Fluke, Bridge & Sensors	--	--	0-100°F	± 0.078 °F
Dew Point Temperature	Cambridge	Mirror Surface	992-C1	-100°- +200°	± .5°F
Supplemental Leak	Brooks Instr.	Rotometer	R-8M-25-4	0.58-5.86 SCFM	± 1% f.s.
Pressure Gage	Heise	Bordon Tube	CCM	0-30 PSIG	0.1% f.s.

5.2 Sensor Locations

The Test Instrumentation, which included forty-six RTD's, six absolute pressure reading quartz Manometers, and six vapor pressure sensing points, was located throughout the containment to give an accurate accounting of the containment environmental conditions during the test. The actual location of each sensor can be seen on the elevation and plan views of the containment found on Figure 5.1 of this report.

The breakdown of sensor locations as per containment volume are as follows:

5.2.1 UPPER VOLUME

a) Sixteen Resistance Temperature detectors

1.	ETR-101	9.	ETR-109
2.	ETR-102	10.	ETR-110
3.	ETR-103	11.	ETR-111
4.	ETR-104	12.	ETR-112
5.	ETR-105	13.	ETR-114
6.	ETR-106	14.	ETR-128
7.	ETR-107	15.	ETR-133
8.	ETR-108	16.	ETR-113*

b) Two absolute pressure reading Quartz Manometers.

c) One vapor pressure sensing point (one Hygrometer).

* With the reactor missile shield removed, this RTD is considered to be in the Upper Volume.

5.2 Sensor Locations (Cont'd)

5.2.2 LOWER VOLUME

a) Twenty-three resistance temperature detectors

1. ETR-122	12. ETR-135
2. ETR-123	13. ETR-136
3. ETR-124	14. ETR-137
4. ETR-125	15. ETR-138
5. ETR-126	16. ETR-139
6. ETR-127	17. ETR-140
7. ETR-129	18. ETR-141
8. ETR-130	19. ETR-142
9. ETR-131	20. ETR-143
10. ETR-132	21. ETR-144
11. ETR-134	22. ETR-145
	23. ETR-146

b) Two absolute pressure reading Quartz Manometers.

c) Four vapor pressure sensing points (two Hygrometers).

5.2.3 ICE CONDENSER VOLUME

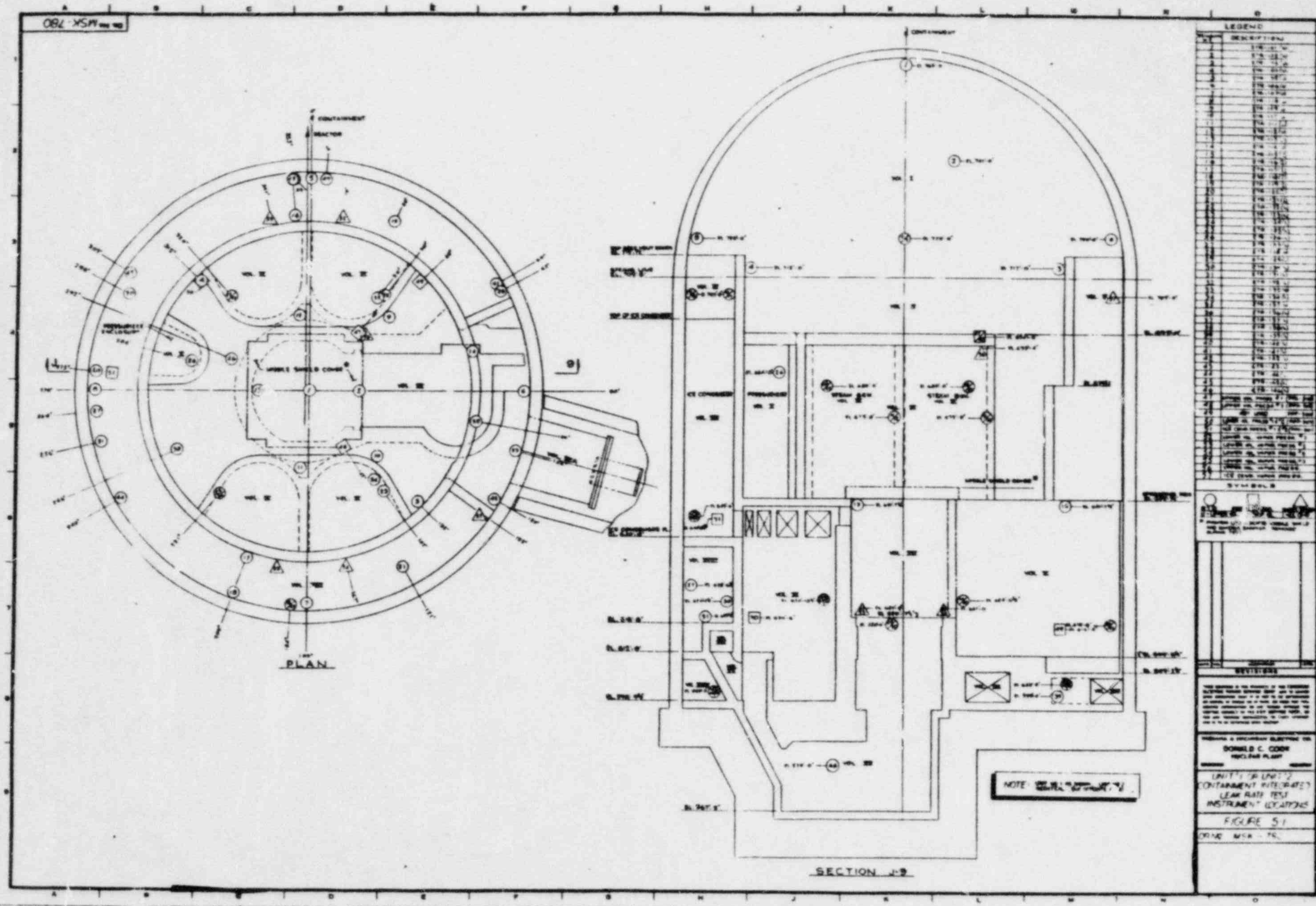
a) Seven resistance temperature detectors

1. ETR-115	5. ETR-119
2. ETR-116	6. ETR-120
3. ETR-117	7. ETR-121
4. ETR-118	

5.2.3 ICE CONDENSER VOLUME (Cont'd)

b) Two absolute pressure reading Quartz Manometers.

c) One vapor pressure sensing point (one Hygrometer).

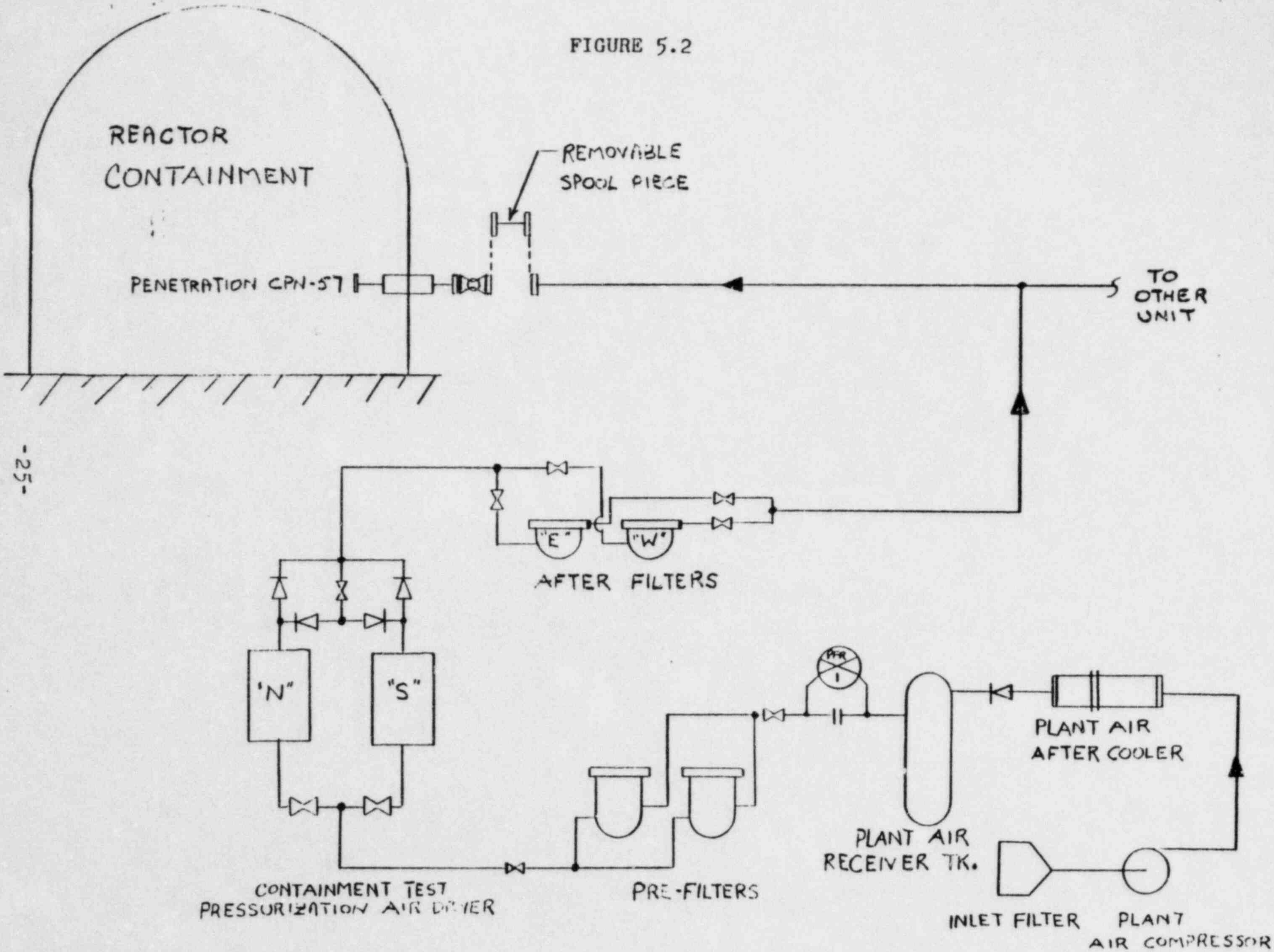

CONTAINMENT
REACTOR
PLAN
SECTION
LEGEND
DESCRIPTION
SYMBOLS
REVISIONS
DONALD C. COOK
NUCLEAR PLANT
UNIT 1 OR UNIT 2
CONTAINMENT INTEGRATED
LEAK RATE TEST
INSTRUMENT LOCATIONS
FIGURE 5.1
NOTE:

5.3 Pressurization Apparatus (Cont'd)

The valve was used to isolate the containment volume from the pressurization system after pressurization to the test pressure was complete.

The spool piece was removed after stabilization of the containment had be achieved. A blank flange was installed and leak tested to prevent out leakage from the penetration. See Figure 5.2 for sketch of pressurization apparatus.

FIGURE 5.2


REACTOR
CONTAINMENT
REMOVABLE
SPOOL PIECE
PENETRATION CPN-57
TO
OTHER
UNIT
"E"
"W"
AFTER FILTERS
'N"
"S"
PLANT AIR
AFTER COOLER
PLANT AIR
RECEIVER TK.
CONTAINMENT TEST
PRESSURIZATION AIR DRYER
PRE-FILTERS
INLET FILTER
PLANT
AIR COMPRESSOR

6.0 CONTAINMENT MODEL AND LEAK RATE CALCULATIONS

6.1 Discussion of Containment Free Volume

The reactor containment is designed to insure that acceptable limits for leakage to the environment of radioactive materials are not exceeded under conditions resulting from the Design Basis Accident for doses dictated by the 10CFR 100 criteria. The steel-lined, reinforced concrete containment structure, including foundations, access hatches, and penetrations is designed and constructed to maintain full containment integrity when subjected to accident forces. The containment design pressure is twelve (12) PSIG.

The reactor containment is divided into three compartments; a lower compartment which houses the reactor and Reactor Coolant System, an intermediate compartment housing the energy absorbing ice bed and an upper compartment which accommodates the air displaced from the other two volumes during the unlikely event of a loss-of-coolant accident.

A detailed tabularization of the individual free volumes which comprise the three containment compartments is listed on Table Q.P.1-1 of the D. C. Cook Nuclear Plant FSAR. The free volume study was originally compiled in response to Question Q.P.-1 concerning the input parameters used in the ECCS evaluation model and may be found in FSAR Appendix 'P' (Amendment 60).

6.1 Discussion of Containment Free Volume (Cont'd)

The following is a summary of FSAR Table Q.P.1-1 on a compartmental basis:

TABLE 6.1.1

COMPARTMENT	FREE VOLUME (FT.^{3})
Upper Volume	734,829
Lower Volume	365,614
Ice Condenser	163,713
Total Free Volume	1,264,156

As was previously mentioned, the free volume study was originated for ECCS model evaluation and therefore, while the total free volume figure is correct, the compartment breakdown does not reflect the true containment configuration during the Integrated Leak Rate Test.

Structural barriers within the containment result in a normal operating containment configuration with the following free volume distribution:

TABLE 6.1.2

COMPARTMENT	FREE VOLUME (FT.^{3})
Upper Volume	687,819
Lower Volume	365,614
Ice Condenser	210,723
Total Free Volume	1,264,156

The differences between Table 6.1.1 and Table 6.1.2 lie in the fact that in Table 6.1.1 the upper volume includes the free volume (47,010 $Ft.^3$) of the ice condenser upper plenum which, under normal circumstances, is physically separated from the upper volume. It is also important to note at this time that the ice condenser free volume in both Table 6.1.1 and Table 6.1.2 include the free volume that would normally be displaced after ice basket loading. Thus, to obtain the actual free volume for this compartment the volume of ice resident in the ice baskets must be deducted.

Prior to the performance of the Unit 2 Pre-Operational ILRT, ice basket weighing data was collected from which the average weight per basket and the total volume of ice was calculated. These values were found to be 1481 lbs./basket and 51,412 $Ft.^3$ total ice volume based upon an ice density of 56 $lbs./Ft.^3$.

During the performance of the Unit 2 Pre-Operational ILRT, the missile shield normally located directly above the reactor cavity was removed. The reactor cavity, which is identified as Volume XIV in FSAR Table Q.P.1-1, has a free volume of 16,147 $Ft.^3$ and is normally associated as part of the lower volume. With the missile shield removed, however, direct communication with the upper volume is established.

When Table 6.1.2 is adjusted to reflect the reduction in

6.1 Discussion of Containment Free Volume (Cont'd)

ice condenser free volume due to the displacement of ice and the re-distribution of Volume No. XIV, the following free volume distribution thus represents the actual ILRT values:

TABLE 6.1.3

COMPARTMENT	FREE VOLUME (FT.^{3})
Upper Volume	703,966
Lower Volume	349,467
Ice Condenser	159,311
Total Free Volume	1,212,744

6.2 Volume Weighting Factors

Volume weighting factors (VWF) are used in the compartmental calculation of the containment air fraction. The definition of a volume weighting factor is the ratio of the free volume for a given containment compartment, ie, Upper Volume, Lower Volume or Ice Condenser, with respect to a "Base Volume".

For purposes of the Unit 2 Pre-Operational ILRT the Lower Volume was selected as the "base volume". Thus, for the containment free volume distribution of Table 6.1.3 the free volume ratio for each containment compartment using the Lower Volume as a "base volume" results in the following volume weighting factors:

6.2 Volume Weighting Factors (Cont'd)

TABLE 6.2.1

CONTAINMENT COMPARTMENT	VWF
Upper Volume	2.0144
Lower Volume	1.0000
Ice Condenser	0.4559

A discussion of how the volume weighting factors (VWF) are applied in the leak rate calculations is presented in Section 6.4 of this report.

6.3 Temperature Sensor (RTD) Weighting Factors

A parameter of importance concerning the determination of containment leak rate is the containment air temperature. Assuming an isovolumic relation exists within the containment pressure boundary, by definition of the perfect gas law the pressure of a gas varies directly with temperature. Therefore, it is necessary to temperature compensate the pressure measurement(s) made for each compartment with its associated average air temperature.

Due to large free volumes of air under consideration, it would require an infinite number of sensors per compartment to determine the average air temperature by the simple arithmetic average of all associated measurements. Being a finite number of sensors must be used, a "weighted average" is computed for each of the three

6.3 Temperature Sensor (RTD) Weighting Factors (Cont'd)

containment compartments.

The weighted average temperature for each compartment is computed by summing the products of sensor reading and its associated temperature sensor (RTD) weighting factor for all sensors located in that particular containment compartment. This may be expressed mathematically by:

$$Tavg. = \sum_{i=1}^{i=n} K_i T_i$$

Where: T_i = the measured temperature for sensor i.

K_i = the associated sensor weighting factor.

The temperature sensor (RTD) weighting factors are derived by a volumetric analysis of each compartment to determine each sensor's "representative volume". Representative volumes are constructed by imaginary and/or physical boundaries separating the various temperature sensors within a particular containment compartment. The volume contained within these boundaries is calculated using approved scale drawings for the D. C. Cook Nuclear Plant. Once all the representative volumes have been determined, the individual temperature sensor (RTD) weighting factors are computed on a compartmental basis using the formula:

6.3 Temperature Sensor (RTD) Weighting Factors (Cont'd)

$$\text{Weighting Factor} = \frac{\text{Representative Volume (Ft.}^3\text{)}}{\sum \text{Representative Volumes (Ft.}^3\text{)}}$$

The total of all temperature sensor (RTD) weighting factors for each containment compartment is equal to one.

6.4 Containment Leak Rate Equations

As indicated earlier in this report, the American National Standard - ANSI N45.4 - 1972; Leakage Rate Testing of Containment Structures for Nuclear Reactors was used as a guideline for leak rate calculations.

The following is the deriviation of the equations used in the calculation of containment leak rate.

From the ideal gas law:

$$P_oV = W_oRT_o \quad \text{and} \quad P_iV = W_iRT_i$$

Where:

P_o = total absolute pressure in containment at the first test interval.

P_i = total absolute pressure in containment at the end of test interval i.

T_o = weighted average absolute temperature at start of test (°F + 459.7).

T_i = weighted average absolute temperature at the end of the test interval i.

V = internal volume of containment assumed to remain constant.

W_o = original weight of air in containment at first test interval.

6.4 Containment Leak Rate Equations (Cont'd)

W_i = weight of air in containment at the end of test interval i.

R = gas constant for a perfect gas; applicable to air for ILRT test conditions.

Therefore,

$$W_o = \frac{P_o V}{R\ T_o} \quad \text{and} \quad W_i = \frac{P_i V}{R\ T_i}$$

If W_n is the normalized weight of air remaining in the containment at the end of test interval i, Then:

$$W_n = \frac{W_i}{W_o}$$

Substituting,

$$W_n = \frac{P_i V}{R\ T_i} \times \frac{RT_o}{P_o V}$$

Since V and R are constants,

$$W_n = \frac{P_i T_o}{P_o T_i}$$

Compensating for condensation or evaporation of moisture within the air,

$$W_n = \frac{(P_i - VP_i)\ T_o}{(P_o - VP_o)\ T_i}$$

<u>Equation 6.4.1</u>

Where,

VP_o = water vapor pressure at the start of the test.

VP_i = water vapor pressure at the end of test interval i.

Thus, equation 6.4.1 may be used to compute the normalized weight of air within a containment, of total volume V, at the end of any time interval (i) during the test.

Due to the physical separations between containment compartments and the distinct differences in their associated environmental conditions, inherent in an ice condenser containment, the calculation for the normalized weight of air is best determined on a compartmental basis. Thus it is assumed the total mass of air in the entire containment is equal to the sum of the individual air masses for the three containment compartments.

On this basis equation 6.4.1 is revised as,

$$W_n = \frac{\left[VWF\left(\frac{P-VP}{T}\right)\right]_{Ui} + \left[VWF\left(\frac{P-VP}{T}\right)\right]_{Li} + \left[VWF\left(\frac{P-VP}{T}\right)\right]_{Ii}}{\left[VWF\left(\frac{P-VP}{T}\right)\right]_{Uo} + \left[VWF\left(\frac{P-VP}{T}\right)\right]_{Lo} + \left[VWF\left(\frac{P-VP}{T}\right)\right]_{Io}}$$

<u>Equation 6.4.2</u>

6.4 Containment Leak Rate Equations (Cont'd)

Where: VWF = Volume Weighting Factor

U = In subscript indicates Upper Volume parameters.

L = In subscript indicates Lower Volume parameters.

I = In subscript indicates Ice Condenser parameters.

O = In subscript indicates parameters at start of test.

i = In subscript indicates parameters at end of test interval i.

As can be seen above, equation 6.4.2 is actually the normalized weight equation 6.4.1 calculated three times, once for each containment compartment. The fractional amount of air for the three compartments are proportionately combined by the volume weighting factors (VWF) which are computed as described in Section 6.2 of this report.

6.5 Statistical Treatment of Data

The resulting values of the normalized weight of air W_n, calculated as described in Section 6.4 of this report, are plotted on a graph whose axis are W_n versus time. A least-squares analysis of the resulting graph yields a straight line.

The slope of the regression line represents the change in the normalized weight of air per unit of time, thus it is the fractional leakage per hour. This is converted to leakage rate expressed in per cent per day by multiplying by 2400.

The slope (b) of the regression line is computed by,

$$b = \frac{(2t + 1) \sum W_n t - \sum W_n \sum t}{(2t + 1) \sum t^2 - (\sum t)^2}$$

Where t is the time in hours.

In order to determine the confidence limits on the leak rate analysis, the following calculations are performed:

The vertical intercept (a) of the regression line is given by,

$$a = \frac{\sum t^2 \sum W_n - \sum t \sum W_n t}{(2t + 1) \sum t^2 - (\sum t)^2}$$

The mean square deviation or variance of W_n is given by,

$$S_{Wn}^2 = \frac{\sum (W_n - a - bt)^2}{(2t - 1)}$$

The variance of the slope (b) is given by,

$$S_b^2 = \frac{S_{Wn}^2}{\sum (t - \bar{t})^2}$$

Where $\bar{t}$ is the average value of time t.

6.5 Statistical Treatment of Data (Cont'd)

From the above prerequisite calculations, the confidence limits on leakage rate (slope b) are expressed as $B \pm KS_b$, where the value of 'K' is dependent upon the desired level of significance and the appropriate number of degrees of freedom. The value of 'K' is taken from Table 6.5.1 of this report showing the distribution of 'K' with respect to the level of significance and the number of degrees of freedom.

The level of significance (α) is the term used to describe degree of possible error associated with all points on the regression line. For a ninety-five (95) per cent confidence level the level of significance is five (5) per cent. Thus, those values of 'K' listed under a level of significance (α) of 0.05 are applicable, depending upon the existing degree of freedom.

Two constraints determine the regression line; the centroidal point ($\bar{t}$, $\bar{W}_n$) and either the slope (b) or intercept (a). Therefore, if n is the number of readings for W_n, the number of degrees of freedom (ν) is given by,

$$\nu = n - 2$$

During the ILRT, readings are taken at time intervals of one half hour with time t equal to zero for the first reading. Thus, the number of degrees of freedom (ν) is also given by,

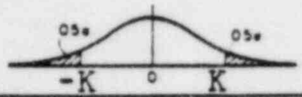


TABLE 6.5.1
DISTRIBUTION OF K

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

This table gives the values of *t* corresponding to various values of the probability α (level of significance) of a random variable falling inside the shaded areas in the figure, for a given number of degrees of freedom ν available for the estimation of error. For a one-sided test the confidence limits are obtained for 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 Basic Statistical Methods For Engineers and Scientists.

6.5 Statistical Treatment of Data (Cont'd)

$$\nu = (2t - 1)$$

The text "Basic Statistical Methods for Engineers and Scientists" by A. M. Neville and J. B. Kennedy was used as a reference for the statistical analysis.

6.6 Discussion of Computer Program

The computer calculations performed for the containment leak rate analysis is implemented by two separate programs.

The first program creates a data file from which the second program for linear regression and confidence limits draws its information. The data file is established by first constructing a deck of computer punch cards containing the run number, elapsed time, and the corresponding temperatures, pressures and dew points as recorded at the end of each time interval during the test. All calculations and printout formats for each of the measured parameters are executed on a compartmental basis.

The data file program takes the millivolt values representing air temperature and, from the instrument calibration data, converts them to the corresponding °F temperature. Each °F air temperature is then multiplied by its corresponding RTD weighting factor and summed to

6.6 Discussion of Computer Program (Cont'd)

provide the weighted average temperature in °F. To express the weighted average temperature in absolute units, 459.7 is added. Finally the data file program prints out the individual millivolt input values, the corresponding unweighted temperatures and a "Summary of Weighted Average Temperatures" expressed in both °F and °R.

The data file program determines the dew point, and hence vapor pressure, by taking the hygrometer millivolt output and, from the instrument calibration data, converts this initially to dew point expressed in °F. The resulting dew point is then converted to vapor pressure (PSIA) based on the Goff-Gratch formulas for saturation vapor pressure over water or over ice. The data file program prints out the individual millivolt input values, the corresponding dew point, resultant vapor pressure and summarizes these parameters for each compartment.

The portion of the data file program dedicated to containment pressure reads a total of seven input values of uncorrected absolute pressure, two per containment compartment and one for the prevailing ambient condition. The program corrects the input values from instrument calibration data and averages the two associated pressures for each compartment. An average of all three containment compartments is taken thus representing the mean containment absolute pressure. The ambient reading is subtracted

6.6 Discussion of Computer Program (Cont'd)

from the mean containment absolute pressure to yield the mean containment gage pressure. The program then prints each uncorrected and corrected pressure as well as a "Summary of Corrected Average Pressures".

The establishment of a data file serves several useful functions. As mentioned before, its primary function is to provide weighted and/or corrected information to the linear regression and confidence limits program for ultimate leak rate computations. As can be seen in the accompanying Table 6.6.1 it also provides a comprehensive and highly organized hard copy of measured parameters for documentation purposes, from which test personnel may easily perform an input error check of the data. Moreover, through the convenience of the parameter summaries, on the spot confirmatory calculations may be easily performed by the site NRC Inspector as well as the test supervisor.

Once the data file is complete and verified to be free of input error, the second program for linear regression and confidence limits is executed.

The program calculates the amount of air in each compartment, using the equations presented in Section 6.4 of this report, as based on the original amount of air in each compartment at the start of the test

6.6 Discussion of Computer Program (Cont'd)

(Computer Run #1). The fractional amounts of air in each compartment are then combined to yield the fractional amount of air for the entire reactor containment. The program computes the leak rate at a given time from input values of pressure, temperature and vapor pressure stored in the data file. The leak rate, on a per cent per 24 hour basis, is determined by the least-squares method as described in Section 6.5 of this report.

The program is designed to allow evaluation of test results every half hour after the first 3 sets of data. A print out for all sets of data up to and including the data just submitted is provided in the form of a tabulated summary. Included are fractional air reports for each compartment, for the containment as a whole, as well as the 24 hour leak rate at the time the last set of data was taken. In addition, the upper and lower leakage bounds associated with the 95% confidence limits are printed out.

Reproductions of the aforementioned tabulated summary for the Integrated Leak Rate Test and Supplemental Test may be found in Section 8.0 of this report.

RUN NUMBER 64
ELAPSED TIME 31.50

TABLE 6.6.1

CONTAINMENT TEMPERATURES DATA CHECK

UPPER VOLUME

RTD	MILLI-VOLTS	DEG. F.
ETR-101	37.19	74.38
ETR-102	37.14	74.28
ETR-103	37.14	74.28
ETR-104	37.45	74.90
ETR-105	36.68	73.36
ETR-106	37.09	74.18
ETR-107	36.95	73.90
ETR-108	37.10	74.20
ETR-109	37.41	74.82
ETR-110	37.43	74.86
ETR-111	37.32	74.64
ETR-112	37.78	75.56
ETR-114	37.20	74.40
ETR-128	35.72	71.44
ETR-133	36.70	73.40
ETR-113	38.48	76.96

LOWER VOLUME

RTD	MILLI-VOLTS	DEG. F.
ETR-122	45.96	91.92
ETR-123	45.35	90.70
ETR-124	45.56	91.12
ETR-125	45.59	91.18
ETR-126	39.87	79.74
ETR-127	38.60	77.20
ETR-129	37.63	75.26
ETR-130	39.97	79.94
ETR-131	38.67	77.34
ETR-132	37.20	74.40
ETR-134	38.76	77.52
ETR-135	39.00	78.00
ETR-136	37.65	75.30
ETR-137	39.26	78.52
ETR-138	38.24	76.48
ETR-139	37.32	74.64
ETR-140	33.77	67.54
ETR-141	36.79	73.58
ETR-142	36.45	72.90
ETR-143	34.69	69.38
ETR-144	37.19	74.38
ETR-145	38.26	76.52
ETR-146	36.44	72.88

ICE CONDENSER

RTD	MILLI-VOLTS	DEG. F.
ETR-115	11.28	22.56
ETR-116	10.48	20.96
ETR-117	13.74	27.48
ETR-118	12.67	25.34
ETR-119	10.26	20.52
ETR-120	10.47	20.94
ETR-121	11.44	22.88

SUMMARY OF WEIGHTED AVERAGE TEMPERATURES

UPPER VOLUME (DEG. F.)	74.39	LOWER VOLUME (DEG. F.)	78.48	ICE CONDENSER (DEG. F.)	22.16
UPPER VOLUME (DEG. R.)	534.08	LOWER VOLUME (DEG. R.)	538.18	ICE CONDENSER (DEG. R.)	481.86

CONTAINMENT VAPOR PRESSURE DATA CHECK

HYGROMETER	MILLI-VOLTS	DEW POINT (DEG. F.)	VAPOR PRESSURE (PSIA)
VPU-1	33.00	30.91	0.0848
VPL-1	36.00	43.09	0.1371
VPL-2	39.55	57.33	0.2328
VPI-1	29.13	15.38	0.0403

SUMMARY OF VAPOR PRESSURES

UPPER CONTAINMENT (PSIA)	0.0848
AVERAGE LOWER CONTAINMENT (PSIA)	0.1849
ICE CONDENSER (PSIA)	0.0403

CONTAINMENT PRESSURES DATA CHECK

MANOMETER	UNCORRECTED READING (PSIA)	CORRECTED READING (PSIA)
PU-1	26.6110	26.6327
PU-2	26.0910	26.6247
PL-1	26.4804	26.6273
PL-2	26.7292	26.6498
PI-1	26.6323	26.6294
PI-2	25.9353	26.6366
AMBIENT	14.1760	14.4963

SUMMARY OF CORRECTED AVERAGE PRESSURES

AVERAGE UPPER PRESSURE (PSIA)	26.6287
AVERAGE LOWER PRESSURE (PSIA)	26.6385
AVERAGE ICE CONDENSER PRESSURE (PSIA)	26.6330
AVERAGE CONTAINMENT PRESSURE (PSIA)	26.6334
AVERAGE CONTAINMENT PRESSURE (PSIG)	12.1471

RUN NUMBER 64
ELAPSED TIME 31.50

TABLE 6.6.1

CONTAINMENT TEMPERATURES DATA CHECK

UPPER VOLUME RTD	MILLI-VOLTS	DEG. F.	LOWER VOLUME RTD	MILLI-VOLTS	DEG. F.	ICE CONDENSER RTD	MILLI-VOLTS	DEG. F.
ETR-101	37.19	74.38	ETR-122	45.96	91.92	ETR-115	11.28	22.56
ETR-102	37.14	74.28	ETR-123	45.35	90.70	ETR-116	10.48	20.96
ETR-103	37.14	74.28	ETR-124	45.56	91.12	ETR-117	13.74	27.48
ETR-104	37.45	74.90	ETR-125	45.59	91.18	ETR-118	12.67	25.34
ETR-105	36.68	73.36	ETR-126	39.87	79.74	ETR-119	10.26	20.52
ETR-106	37.09	74.18	ETR-127	38.60	77.20	ETR-120	10.47	20.94
ETR-107	36.95	73.90	ETR-129	37.63	75.26	ETR-121	11.44	22.88
ETR-108	37.10	74.20	ETR-130	39.97	79.94			
ETR-109	37.41	74.82	ETR-131	38.67	77.34			
ETR-110	37.43	74.86	ETR-132	37.20	74.40			
ETR-111	37.32	74.64	ETR-134	38.76	77.52			
ETR-112	37.78	75.56	ETR-135	39.00	78.00			
ETR-114	37.20	74.40	ETR-136	37.65	75.30			
ETR-128	35.72	71.44	ETR-137	39.26	78.52			
ETR-133	36.70	73.40	ETR-138	38.24	76.48			
ETR-113	38.48	76.96	ETR-139	37.32	74.64			
			ETR-140	33.77	67.54			
			ETR-141	36.79	73.58			
			ETR-142	36.45	72.90			
			ETR-143	34.69	69.38			
			ETR-144	37.19	74.38			
			ETR-145	38.26	76.52			
			ETR-146	36.44	72.88			

SUMMARY OF WEIGHTED AVERAGE TEMPERATURES

UPPER VOLUME (DEG. F.)	74.39	LOWER VOLUME (DEG. F.)	78.48	ICE CONDENSER (DEG. F.)	22.16
UPPER VOLUME (DEG. R.)	534.08	LOWER VOLUME (DEG. R.)	538.18	ICE CONDENSER (DEG. R.)	481.86

CONTAINMENT VAPOR PRESSURE DATA CHECK

HYGROMETER	MILLI-VOLTS	DEW POINT (DEG. F.)	VAPOR PRESSURE (PSIA)
VPU-1	33.00	30.91	0.0848
VPL-1	36.00	43.09	0.1371
VPL-2	39.55	57.33	0.2328
VPI-1	29.13	15.38	0.0403

SUMMARY OF VAPOR PRESSURES

UPPER CONTAINMENT (PSIA)	0.0848
AVERAGE LOWER CONTAINMENT (PSIA)	0.1849
ICE CONDENSER (PSIA)	0.0403

CONTAINMENT PRESSURES DATA CHECK

MANOMETER	UNCORRECTED READING (PSIA)	CORRECTED READING (PSIA)
PU-1	26.6110	26.6327
PU-2	26.0910	26.6247
PL-1	26.4804	26.6273
PL-2	26.7292	26.6498
PI-1	26.6323	26.6294
PI-2	25.9353	26.6366
AMBIENT	14.1760	14.4963

SUMMARY OF CORRECTED AVERAGE PRESSURES

AVERAGE UPPER PRESSURE (PSIA)	26.6287
AVERAGE LOWER PRESSURE (PSIA)	26.6385
AVERAGE ICE CONDENSER PRESSURE (PSIA)	26.6330
AVERAGE CONTAINMENT PRESSURE (PSIA)	26.6334
AVERAGE CONTAINMENT PRESSURE (PSIG)	12.1471

D. C. COOK NUCLEAR PLANT - UNIT NO. 2

CONTAINMENT INTEGRATED LEAK RATE TEST

(PRE-OPERATIONAL)

COMPUTER PROGRAM "CCVDREP"

```
*C   ***********************************************          **
*C   *                                             *          **
*C   *    COOK CONTAINMENT VESSEL DATA PROGRAM     *          **
*C   *                                             *          **
*C   *      THIS PROGRAM ENTITLED CCVDREP:         *          **
*C   *                                             *          **
*C   *    1.READS RAW INPUT DATA FOR THE LINEAR    *          **
*C   *      REGRESSION ANALYSIS PROGRAM:CCVREPT    *          **
*C   *    2.WRITES THIS DATA AS A MEANS OF         *          **
*C   *      ERROR CHECKING                         *          **
*C   *    3.CALCULATES THE AVERAGE TEMPERATURE     *          **
*C   *      PRESSURE AND VAPOR PRESSURE FOR EACH   *          **
*C   *      CHAMBER AND OUTPUTS THESE RESULTS      *          **
*C   *      AS A CUMULATIVE SUMMARY.              *           ** 10/18/77
*C   *    4.CALCULATES A W FOR EACH CHAMBER AS     *          **
*C   *      WELL AS A TOTAL W.THESE CALCULATIONS   *          **
*C   *      ARE SAVED ON A DISK DATA SET TO BE     *          **
*C   *      USED AS THE DATA  FOR THE REGRESSION   *          **
*C   *      ANALYSIS PROGRAM                       *          **
*C   *    5.THE OUTPUT OF THIS PROGRAM SERVES      *          **
*C   *      AS THE FINAL FORMAT FOR PRESENTATION   *          **
*C   *      TO THE N.R.C.                          *          ** 10/18/77
*C   *                                             *          **
*C   ***********************************************          **
*       REAL*8 TEMPUC(16),TEMPLC(24)                          ** 10/27/77
*       REAL*8 TEMPIC(7),VPPE(4)                              ** 10/27/77
*       REAL*8 TEMPU(16),TEMPL(24),TEMPI(7)                   ** 10/27/77
*       INTEGER*2 NR,NRR,N2F                                  **
*       INTEGER*4 RTDL1(32) RTDL2(43),RTDL3(14)               ** 10/20/77
*       REAL*8 WUCDEM,WLCDEM,WICDEM,WDEM,WUC(99),WLC(99),WIC(99),W(99)   **
*       REAL*8 TIMS(98),PRES(7),PRESC(7)                      ** 10/25/77
*       REAL*8 VWF(3),C(6),K(12),SR(70)                       ** 10/20/77
*       REAL*8 WUCNUM,WLCNUM,WICNUM,WNUM,WTUP(16),WTLOW(24),WTICE(7)   ** 10/25/77
*       REAL*8 TMSMUC,TMSMLC,TMSMIC,VPLAVG                    ** 10/25/77
*       REAL*8 DP(4),TMSMUR,VPR(4),TMSMLR,TMSMIR,LVP(4),PRESCU,PRESCL,   ** 10/20/77
*      *        PRESCI,ACPA,ACPG                              ** 10/20/77
*       DATA  RTDL1(1),RTDL1(2),RTDL1(3),RTDL1(4),RTDL1(5),RTDL1(6),   ** 10/20/77
*      *      RTDL1(7),RTDL1(8),RTDL1(9),RTDL1(10),RTDL1(11),   ** 10/20/77
*      *      RTDL1(12),RTDL1(13),RTDL1(14),RTDL1(15),RTDL1(16),   ** 10/20/77
*      *      RTDL1(17),RTDL1(18),RTDL1(19),RTDL1(20),RTDL1(21),   ** 10/20/77
*      *      RTDL1(22),RTDL1(23),RTDL1(24),RTDL1(25),RTDL1(26),   ** 10/20/77
*      *      RTDL1(27),RTDL1(28),RTDL1(29),RTDL1(30),RTDL1(31),   ** 10/20/77
*      *      RTDL1(32)/'ETR-','101 ','ETR-','102 ','ETR-','103 ','ETR-',   ** 10/20/77
*      *  '104 ','ETR-','105 ','ETR-','106 ','ETR-','107 ','ETR-','108 ',   ** 10/20/77
*      *  'ETR-','109 ','ETR-','110 ','ETR-','111 ','ETR-','112 ','ETR-',   ** 10/20/77
*      *  '114 ','ETR-','128 ','ETR-','133 ','ETR-','113 '/   ** 10/20/77
*       DATA  RTDL3(1),RTDL3(2),RTDL3(3),RTDL3(4),RTDL3(5),RTDL3(6),   ** 10/20/77
*      *      RTDL3(7),RTDL3(8),RTDL3(9),RTDL3(10),RTDL3(11),   ** 10/20/77
*      *      RTDL3(12),RTDL3(13),RTDL3(14)/'ETR-','115 ','ETR-','116 ',   ** 10/20/77
*      *      'ETR-','117 ','ETR-','118 ','ETR-','119 ','ETR-','120 ',   ** 10/20/77
*      *      'ETR-','121 '/                                  ** 10/20/77
*       DATA  RTDL2(1),RTDL2(2),RTDL2(3),RTDL2(4),RTDL2(5),RTDL2(6),   ** 10/20/77
*      *      RTDL2(7),RTDL2(8),RTDL2(9),RTDL2(10),RTDL2(11),RTDL2(12),   ** 10/20/77
*      *      RTDL2(13),RTDL2(14),RTDL2(15),RTDL2(16),RTDL2(17),   ** 10/20/77
*      *      RTDL2(18),RTDL2(19),RTDL2(20),RTDL2(21),RTDL2(22),   ** 10/20/77
```

```
*    *     RTDL2(23),RTDL2(24),RTDL2(25),RTDL2(26),RTDL2(27),                    ** 10/20/77
*    *     RTDL2(28),RTDL2(29),RTDL2(30),RTDL2(31),RTDL2(32),                    ** 10/20/77
*    *     RTDL2(33),RTDL2(34),RTDL2(35),RTDL2(36),RTDL2(37),                    ** 10/20/77
*    *     RTDL2(38),RTDL2(39),RTDL2(40),RTDL2(41),RTDL2(42),                    ** 10/20/77
*    *     RTDL2(43),RTDL2(44),RTDL2(45),RTDL2(46),RTDL2(47),                    ** 10/20/77
*    *     RTDL2(48)/'ETR-','122 ','ETR-','123 ','ETR-','124 ','ETR-',           ** 10/20/77
*    *  '125 ','ETR-','126 ','ETR-','127 ','ETR-','129 ','ETR-','130 ',          ** 10/20/77
*    *  'ETR-','131 ','ETR-','132 ','ETR-','134 ','ETR-','135 ','ETR-',          ** 10/20/77
*    *  '136 ','ETR-','137 ','ETR-','138 ','ETR-','139 ','ETR-','140 ',          ** 10/20/77
*    *  'ETR-','141 ','ETR-','142 ','ETR-','143 ','ETR-','144 ','ETR-',          ** 10/20/77
*    *  '145 ','ETR-','146 ','ETR-','113 '/                                      ** 10/20/77
*      DEFINE FILE 4(99,146,L,ID)                                                **
*      READ(5,300,END=12)C                                                       ** 10/18/77
*300   FORMAT(6F6.3)                                                             ** 10/18/77
*      READ(5,301,END=12)K                                                       ** 10/18/77
*301   FORMAT(6F11.6/6F11.6)                                                     ** 10/18/77
*      READ(5,302,END=12)SR                                                      ** 10/18/77
*302   FORMAT(10F8.5/10F8.5/10F8.5/10F8.5/10F8.5/10F8.5/10F8.5)                  ** 10/24/77
*      READ(5,303,END=12)WTUP,WTLOW,WTICE                                        ** 10/18/77
*303   FORMAT(10F6.5/6F6.5/11F6.5/13F6.5/7F6.5)                                  ** 10/18/77
*      READ(5,304,END=12)VWF                                                     ** 10/18/77
*304   FORMAT(3F7.5)                                                             ** 10/18/77
*      WRITE(6,305)C,K,SR                                                        ** 10/18/77
*305   FORMAT(1H1,44X,'*** THIS IS A CHECK OF THE INPUT DATA ***'////1H ,        ** 10/18/77
*    *   'RTD MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS'/1H ,6X,          ** 10/18/77
*    *   'UPPER',12X,'LOWER',13X,'ICE'/1H ,F5.2,3X,F5.2,4X,F5.2,3X,              ** 10/18/77
*    *   F5.2,4X,F5.2,3X,F5.2////1H ,'HYGROMETER MILLI-VOLT TO ',                ** 10/18/77
*    *   'FAHRENHEIT CONVERSION COEFFICIENTS'/1H ,14X,'UPPER',27X,               ** 10/18/77
*    *   'LOWER-1'/1H ,5(F10.5,1X),F10.5//1H ,13X,'LOWER-2',28X,'ICE'            ** 10/18/77
*    *   /1H ,5(F10.5,1X),F10.5////1H ,'MANOMETER PRESSURE CORRECTION ',         ** 10/18/77
*    *   'COEFFICIENTS'/1H ,38X,'PU-1'/1H ,9(F7.4,1X),F7.4//1H ,38X,             ** 10/24/77
*    *   'PU-2'/1H ,9(F7.4,1X),F7.4//1H ,38X,'PL-1'/1H ,9(F7.4,1X),              ** 10/24/77
*    *   F7.4//1H ,38X,'PL-2'/1H ,9(F7.4,1X),F7.4//1H ,38X,'PI-1'/               ** 10/24/77
*    *   1H ,9(F7.4,1X),F7.4//1H ,38X,'PI-2'/1H ,9(F7.4,1X),F7.4//               ** 10/24/77
*    *   1H ,38X,'P-ATM'/1H ,9(F7.4,1X),F7.4)                                    ** 10/24/77
*      WRITE(6,306)WTUP,WTLOW,WTICE,VWF                                          ** 10/18/77
*306   FORMAT(1H1,'RTD WEIGHTING FACTORS'/1H ,27X,'UPPER'/1H ,9(F5.4,1X),        ** 10/18/77
*    *   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 FAC ORS'/1H ,1X,'UPPER',2X,'LOWER',3X,          ** 10/18/77
*    *   'ICE'/1H ,2(F6.4,1X),F6.4)                                              ** 10/18/77
*   13 READ(5,100,END=12)NR,TIME(NR)                                             **
*  100 FORMAT(I2,1X,F5.2)                                                        **
*      WRITE(6,200)NR,TIME(NR)                                                   **
*  200 FORMAT(1H1,'RUN NUMBER',4X,I2/1H ,'ELAPSED TIME',2X,F5.2///1H ,           ** 10/24/77
*    *   '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
*      READ(5,101)(TEMPUC(I),I=1,16)                                             ** 10/18/77
*  101 FORMAT(10(F5.2,1X)/6(F5.2,1X))                                            ** 10/18/77
*      READ(5,102)(TEMPLC(I),I=1,24)                                             ** 10/24/77
*  102 FORMAT(11(F5.2,1X)/13(F5.2,1X))                                           ** 10/24/77
*      READ(5,103)(TEMPIC(I),I=1,7)                                              ** 10/18/77
*  103 FORMAT(7(F5.2,1X))                                                        ** 10/18/77
*      DO 400 JAW1=1,16                                                          ** 10/20/77
*      IF(TEMPUC(JAW1).EQ.0.)TEMPU(JAW1)=0.                                      ** 10/24/77
*      IF(TEMPUC(JAW1).EQ.0.)GOTO 400                                            ** 10/24/77
```

```
*      TEMPU(JAW1)=(C(1)*TEMPUC(JAW1))+C(2)                              ** 10/24/77
*400   CONTINUE                                                          ** 10/24/77
*      DO 401 JAW2=1,24                                                  ** 10/24/77
*      IF(TEMPLC(JAW2).EQ.0.)TEMPL(JAW2)=0.                              ** 10/24/77
*      IF(TEMPLC(JAW2).EQ.0.)GOTO 401                                    ** 10/24/77
*      TEMPL(JAW2)=(C(3)*TEMPLC(JAW2))+C(4)                              ** 10/24/77
*401   CONTINUE                                                          ** 10/24/77
*      DO 402 JAW3=1,7                                                   ** 10/20/77
*402   TEMPI(JAW3)=(C(5)*TEMPIC(JAW3))+C(6)                              ** 10/20/77
*      TMSMUC=0.                                                         ** 10/20/77
*      DO 1 J=1,16                                                       ** 10/20/77
*1     TMSMUC=TMSMUC+(TEMPU(J)*WTUP(J))                                  ** 10/20/77
*      TMSMUR=TMSMUC+459.7                                               ** 10/20/77
*      TMSMLC=0.                                                         ** 10/20/77
*      DO 3 L=1,24                                                       ** 10/24/77
*3     TMSMLC=TMSMLC+(TEMPL(L)*WTLOW(L))                                 ** 10/20/77
*      TMSMLR=TMSMLC+459.7                                               ** 10/20/77
*      TMSMIC=0.                                                         ** 10/20/77
*      DO 6 IT=1,7                                                       ** 10/20/77
*6     TMSMIC=TMSMIC+(TEMPI(IT)*WTICE(IT))                               ** 10/20/77
*      TMSMIR=TMSMIC+459.7                                               ** 10/20/77
*      READ(5,509)VPRE,PRES                                              ** 10/21/77
*509   FORMAT(4F6.3/7F8.5)                                               ** 10/21/77
*      DP(1)=(K(1)*VPRE(1)*VPRE(1))+(K(2)*VPRE(1))+K(3)                  ** 10/20/77
*      DP(2)=(K(4)*VPRE(2)*VPRE(2))+(K(5)*VPRE(2))+K(6)                  ** 10/20/77
*      DP(3)=(K(7)*VPRE(3)*VPRE(3))+(K(8)*VPRE(3))+K(9)                  ** 10/20/77
*      DP(4)=(K(10)*VPRE(4)*VPRE(4))+(K(11)*VPRE(4))+K(12)               ** 10/24/77
*      DO 403 J=1,3                                                      ** 10/20/77
*      LVP(J)=(-7.90298*((373.16/(((5.*(DP(J)-32.))/9.)+273.16))-1))+    ** 10/20/77
*     * (5.02808*DLOG10(373.16/(((5.*(DP(J)-32.))/9.)+273.16)))+         ** 10/20/77
*     * (-1.3816*(10.**(-7.))*(10.**(11.344*(1-((((5.*(DP(J)-32.))/9.)+  ** 10/24/77
*     * 273.16)/373.16)))-1))+(8.1328*(10.**(-3.))*((10.**(-3.49149*     ** 10/24/77
*     * ((373.16/(((5.*(DP(J)-32.))/9.)+273.16))-1)))-1))+               ** 10/20/77
*     * DLOG10(1013.246D0)                                               ** 10/24/77
*403   CONTINUE                                                          ** 10/20/77
*      LVP(4)=(-9.09718*((273.16/(((5.*(DP(4)-32.))/9.)+273.16))-1))+    ** 10/20/77
*     * (-3.56654*DLOG10(273.16/(((5.*(DP(4)-32.))/9.)+273.16)))+        ** 10/20/77
*     * (0.876793*(1-((((5.*(DP(4)-32.))/9.)+273.16)/273.16)))+          ** 10/24/77
*     * DLOG10(6.1071D0)                                                 ** 10/24/77
*      DO 404 KAY=1,4                                                    ** 10/24/77
*404   VPR(KAY)=(10.**LVP(KAY))*.0145038                                 ** 10/25/77
*      VPLAVG=(VPR(2)+VPR(3))/2                                          ** 10/20/77
*      DO 405 M=1,70,10                                                  ** 10/20/77
*      N1=M+1                                                            ** 10/20/77
*      N2=M+9                                                            ** 10/20/77
*      MY=((M-1)/10)+1                                                   ** 10/20/77
*      DO 406 N=N1,N2,2                                                  ** 10/20/77
*      IF(PRES(MY).LT.SR(N))GOTO 406                                     ** 10/20/77
*      IF(N.EQ.N1.AND.PRES(MY).GT.SR(N))GOTO 444                         ** 10/24/77
*      PRESC(MY)=((PRES(MY)-SR(N))*((SR(N-3)-SR(N-1))/(SR(N-2)-SR(N))))  ** 10/28/77
*     *+SR(N-1)                                                          ** 10/28/77
*      GOTO 405                                                          ** 10/20/77
*406   CONTINUE                                                          ** 10/20/77
*444   WRITE(6,407)                                                      ** 10/24/77
*407   FORMAT(1H-,'*** MANOMETER READING OFF SCALE ***')                 ** 10/20/77
*405   CONTINUE                                                          ** 10/20/77
*      PRESCU=(PRESC(1)+PRESC(2))/2                                      ** 10/20/77
*      PRESCL=(PRESC(3)+PRESC(4))/2                                      ** 10/20/77
```

```
*       PRESCI=(PRESC(5)+PRESC(6))/2                                          ** 10/20/77
*       ACPA=(PRESCU+PRESCL+PRESCI)/3                                         ** 10/20/77
*       ACPG=ACPA-PRESC(7)                                                    ** 10/20/77
*       DO 500 IWRT=1,7                                                       ** 10/20/77
*       ME=(2*IWRT)-1                                                         ** 10/20/77
*       MO=ME+1                                                               ** 10/20/77
*       WRITE(6,501)RTDL1(ME),RTDL1(MO),TEMPUC(IWRT),TEMPU(IWRT),             ** 10/20/77
*      *            RTDL2(ME),RTDL2(MO),TEMPLC(IWRT),TEMPL(IWRT),             ** 10/20/77
*      *            RTDL3(ME),RTDL3(MO),TEMPIC(IWRT),TEMPI(IWRT)              ** 10/20/77
*501    FORMAT(1H ,2A4,2X,F6.2,5X,F6.2,5X,2A4,2X,F6.2,5X,F6.2,5X,2A4,         ** 10/26/77
*      *  2X,F6.2,5X,F6.2)                                                    ** 10/26/77
*500    CONTINUE                                                              ** 10/20/77
*       DO 502 IWRT2=8,16                                                     ** 10/20/77
*       ME2=(2*IWRT2)-1                                                       ** 10/20/77
*       MO2=ME2+1                                                             ** 10/20/77
*       IF(IWRT2.EQ.16.AND.TEMPUC(IWRT2).EQ.0.)WRITE(6,504)                   ** 10/24/77
*      *            RTDL2(ME2),RTDL2(MO2),TEMPLC(IWRT2),TEMPL(IWRT2)          ** 10/24/77
*       WRITE(6,503)RTDL1(ME2),RTDL1(MO2),TEMPUC(IWRT2),TEMPU(IWRT2),         ** 10/24/77
*      *            RTDL2(ME2),RTDL2(MO2),TEMPLC(IWRT2),TEMPL(IWRT2)          ** 10/20/77
*503    FORMAT(1H ,2A4,2X,F6.2,5X,F6.2,5X,2A4,2X,F6.2,5X,F6.2)                ** 10/27/77
*504    FORMAT(1H ,32X,2A4,2X,F6.2,5X,F6.2)                                   ** 10/27/77
*502    CONTINUE                                                              ** 10/20/77
*       DO 505 IWRT3=17,24                                                    ** 10/20/77
*       ME3=(2*IWRT3)-1                                                       ** 10/20/77
*       MO3=ME3+1                                                             ** 10/20/77
*       IF(IWRT3.EQ.24.AND.TEMPLC(IWRT3).EQ.0.)GOTO 505                       ** 10/24/77
*       WRITE(6,506)RTDL2(ME3),RTDL2(MO3),TEMPLC(IWRT3),TEMPL(IWRT3)          ** 10/20/77
*506    FORMAT(1H ,32X,2A4,2X,F6.2,5X,F6.2)                                   ** 10/27/77
*505    CONTINUE                                                              ** 10/20/77
*       WRITE(6,507)TMSMUC,TMSMLC,TMSMIC,TMSMUR,TMSMLR,TMSMIR                 ** 10/20/77
*507    FORMAT(1H-,17X,'SUMMARY OF WEIGHTED AVERAGE TEMPERATURES'//1H ,       ** 10/27/77
*      *'UPPER VOLUME (DEG. F.)     ',F5.2,4X,'LOWER VOLUME (DEG. F.)    ',   ** 10/27/77
*      *  F6.2,4X,'ICE CONDENSER (DEG. F.)      ',F5.2/1H ,                   ** 10/27/77
*      *  'UPPER VOLUME (DEG. R.)    ',F6.2,4X,'LOWER VOLUME (DEG. R.)   ',   ** 10/24/77
*      *  F7.2,4X,'ICE CONDENSER (DEG. R.)     ',F7.2)                        ** 10/24/77
*       WRITE(6,508)                                                          ** 10/21/77
*      *  VPRE(1),DP(1),VPR(1),PRES(1),PRESC(1),VPRE(2),DP(2),VPR(2),         ** 10/21/77
*      *  PRES(2),PRESC(2),VPRE(3),DP(3),VPR(3),PRES(3),PRESC(3),VPRE(4),     ** 10/21/77
*      *  DP(4),VPR(4),PRES(4),PRESC(4),PRES(5),PRESC(5),PRES(6),PRESC(6)     ** 10/21/77
*      *  ,PRES(7),PRESC(7),VPR(1),VPLAVG,VPR(4),PRESCU,PRESCL,PRESCI,        ** 10/21/77
*      *  ACPA,ACPG                                                           ** 10/21/77
*508    FORMAT(1H1,11X,'CONTAINMENT VAPOR PRESSURE DATA CHECK',25X,           ** 10/21/77
*      *  '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
*      *  10X,F7.4,8X,F7.4/1H ,5X,'VPL-1',10X,F5.2,10X,F5.2,9X,F7.4,          ** 10/24/77
*      *  25X,'PU-2',10X,F7.4,8X,F7.4/1H ,5X,'VPL-2',10X,F5.2,10X,F5.2,       ** 10/21/77
*      *  9X,F7.4,25X,'PL-1',10X,F7.4,8X,F7.4/1H ,5X,'VPI-1',10X,F5.2,        ** 10/24/77
*      *  10X,F5.2,9X,F7.4,25X,'PL-2',10X,F7.4,8X,F7.4/1H ,81X,'PI-1',        ** 10/26/77
*      *  10X,F7.4,8X,F7.4/1H ,81X,'PI-2',10X,F7.4,8X,F7.4/1H ,17X,           ** 10/26/77
*      *  'SUMMARY OF VAPOR PRESSURES',38X,'AMBIENT',7X,F7.4,8X,F7.4//        ** 10/26/77
*      *  1H ,15X,'UPPER CONTAINMENT (PSIA)',6X,F7.4/1H ,15X,'AVERAGE ',      ** 10/24/77
*      *  'LOWER CONTAINMENT (PSIA)',5X,F7.4,28X,'SUMMARY OF CORRECTED ',     ** 10/24/77
*      *  'AVERAGE PRESSURES'/1H ,15X,'ICE CONDENSER (PSIA)',5X,F7.4/1H ,     ** 10/24/77
*      *  80X,'AVERAGE UPPER PRESSURE (PSIA)',10X,F7.4/1H ,                   ** 10/21/77
*      *  80X,'AVERAGE LOWER PRESSURE (PSIA)',10X,F7.4/1H ,                   ** 10/21/77
```

```
      *  80X,'AVERAGE ICE CONDENSER PRESSURE (PSIA)',2X,F7.4/1H ,     ** 10/24/77
      *  80X,'AVERAGE CONTAINMENT PRESSURE (PSIA)',4X,F7.4/1H ,       ** 10/26/77
      *  80X,'AVERAGE CONTAINMENT PRESSURE (PSIG)',4X,F7.4)           ** 10/26/77
       IF(NR-1)8,8,9                                                  **
     8 WUCDEM=(PRESCU-VPR(1))/TMSMUR                                  ** 10/25/77
       WLCDEM=(PRESCL-VPLAVG)/TMSMLR                                  ** 10/25/77
       WICDEM=(PRESCI-VPR(4))/TMSMIR                                  ** 10/25/77
       WDEM=VWF(1)*WUCDEM+VWF(2)*WLCDEM+VWF(3)*WICDEM                 ** 10/29/77
       N2R=NR                                                         **
       WRITE(4'1)N2R,TIME(N2R),WUCDEM,WLCDEM,WICDEM,WDEM              **
       NRR=NR                                                         **
       WRITE(4'99)NRR                                                 **
     9 READ(4'1)N2R,TIME(N2R),WUCDEM,WLCDEM,WICDEM,WDEM               **
       WUCNUM=(PRESCU-VPR(1))/TMSMUR                                  ** 10/25/77
       WUC(NR)=WUCNUM/WUCDEM                                          **
       WLCNUM=(PRESCL-VPLAVG)/TMSMLR                                  ** 10/25/77
       WLC(NR)=WLCNUM/WLCDEM                                          **
       WICNUM=(PRESCI-VPR(4))/TMSMIR                                  ** 10/25/77
       WIC(NR)=WICNUM/WICDEM                                          **
       WNUM=VWF(1)*WUCNUM+VWF(2)*WLCNUM+VWF(3)*WICNUM                 ** 10/29/77
       W(NR)=WNUM/WDEM                                                **
       IF(NR-1)10,10,11                                               **
    10 N2R=NR                                                         **
       WRITE(4'1)N2R,TIME(N2R),WUCDEM,WLCDEM,WICDEM,WDEM,TMSMUR,PRESCU,  ** 10/25/77
      *   VPR(1),TMSMLR,PRESCL,VPLAVG,TMSMIR,PRESCI,VPR(4),           ** 10/25/77
      *WUC(N2R),WLC(N2R),WIC(N2R),W(N2R)                              ** 10/21/77
       GO TO 13                                                       **
    11 WRITE(4'NR)NR,TIME(NR),TMSMUR,PRESCU,VPR(1),TMSMLR,PRESCL,VPLAVG,  ** 10/25/77
      *   TMSMIR,PRESCI,VPR(4),                                       ** 10/25/77
      *WUC(NR),WLC(NR),WIC(NR),W(NR)                                  ** 10/21/77
       READ(4'99)NRR                                                  **
       IF(NR-NRR)13,13,14                                             **
    14 NRR=NR                                                         **
       WRITE(4'99)NRR                                                 **
       GO TO 13                                                       **
    12 STOP                                                           **
       END                                                            **
```

D. C. COOK NUCLEAR PLANT - UNIT NO. 2

CONTAINMENT INTEGRATED LEAK RATE TEST

(PRE-OPERATIONAL)

COMPUTER PROGRAM "CCVREPT"

```
C              ************************************************
C              *                                              *
C              *  COOK CONTAINMENT VESSEL REGRESSION PROGRAM  *
C              *                                              *
C              *     THIS PROGRAM ENTITLED CCVREPT:           *
C              *                                              *
C              *   1.READS THE DISK DATA SET THAT             *
C              *     WAS CREATED BY THE CCVDREP PROGRAM       *
C              *   2.PERFORMS A LINEAR REGRESSION             *
C              *     ANALYSIS TEST ON THESE DATA POINTS       *
C              *   3.THE ANALYSIS IS PERFORMED ON THE         *
C              *     CURRENT MAXIMUM NUMBER OF DATA POINTS.   *
C              *   4.THE W EXPERIMENTAL,THE W REGRESSION,     *
C              *     THE LEAKAGE RATE,CONFIDENCE LIMITS       *
C              *     FOR THE RATE,AS WELL AS THE INTERCEPT    *
C              *     ARE ALL OUTPUTED.                        *
C              *   5.THE OUTPUT OF THIS PROGRAM SERVES AS     *
C              *     THE FINAL FORMAT TO BE PRESENTED TO      *
C              *     THE N.R.C.                               *     10/17/77
C              *                                              *
C              ************************************************
      REAL*8 ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPIC
      REAL*3 WUC(99),WLC(99),WIC(99),W(99),TIME(98)
      REAL*8 WR(99),WLR(99),WUR(99),ATAB(99)
      INTEGER*2 NR,NRR,N2R
      DIMENSION TABLE(96)
      REAL*8 A,B,BL,BH
      REAL*8 WUCDEM,WLCDEM,WICDEM,WDEM
      DEFINE FILE 4(99,146,L,ID)
      REAL*8 TSS,TS,WS,TS2W,ANUM,ADEM,BNUM,EK,WSUM,SIGMAB,XNRR,SIGMA
      REAL*8 AT,ATTN,EKK,TOT,F2,F1,F,FF
      READ(4'99)NRR
      IF(NRR-3)1,2,2
    1 WRITE(6,200)
  200 FORMAT(1H1,10X,'INSUFFICIENT NUMBER OF DATA POINTS FOR A MEANINGFU
     *L ANALYSIS TO BE RUN.  MORE DATA POINTS ARE NEEDED.')         10/17/77
      GO TO 3
    2 NRR1=2
  847 NRR1=NRR1+1
      TSS=0.0
      TS=0.0
      DO 4 I=2,NRR1
      READ(4'I)NR,TIME(I),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPI
     *C,WUC(I),WLC(I),WIC(I),W(I)
      TSS=TSS+TIME(I)**2
    4 TS=TS+TIME(I)
      READ(4'1)N2R,TIME(N2R),WUCDEM,WLCDEM,WICDEM,WDEM,ATUC,APUC,AVPUC,A
     *TLC,APLC,AVPLC,ATIC,APIC,AVPIC,WUC(N2R),WLC(N2R),WIC(N2R),W(N2R)
      WS=W(N2R)
      DO 5 J=2,NRR1
      READ(4'J)NR,TIME(J),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPI
     *C,WUC(J),WLC(J),WIC(J),W(J)
    5 WS=WS+W(J)
      TS2W=0.0
      DO 6 K=2,NRR1
```

```
      READ(4'K)NR,TIME(K),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPI
     *C,WUC(K),WLC(K),WIC(K),W(K)
    6 TS2W=TS2W+TIME(K)*W(K)
      ANUM=TSS*WS-TS*TS2W
      XNRR=NRR1
      ADEM=XNRR*TSS-TS**2
      A=ANUM/ADEM
      BNUM=XNRR*TS2W-TS*WS
      B=BNUM/ADEM
      DATA TABLE/12.706,4.303,3.182,2.776,2.571,2.447,2.365,2.306,2.262,
     *2.228,2.201,2.179,2.160,2.145,2.131,2.120,2.110,2.101,2.093,2.086,
     *2.080,2.074,2.069,2.064,2.060,2.056,2.052,2.048,2.045,2.042,2.040,
     *2.038,2.036,2.034,2.032,2.030,2.027,2.025,2.023,2.021,2.020,2.019,
     *2.018,2.017,2.016,2.015,2.014,2.013,2.012,2.011,2.009,2.008,2.007,
     *2.006,2.005,2.004,2.003,2.002,2.001,2*2.000,3*1.999,3*1.998,3*1.99
     *7,3*1.996,3*1.995,3*1.994,3*1.993,3*1.992,3*1.991,3*1.990,3*1.989,
     *2*1.989/
      WR(1)=A
      READ(4'2)NR,TIME(2),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPI
     *C,WUC(2),WLC(2),WIC(2),W(2)
      WR(2)=A+B*TIME(2)
      DO 7 II=3,NRR1
      READ(4'II)NR,TIME(II),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AV
     *PIC,WUC(II),WLC(II),WIC(II),W(II)
      WR(II)=A+B*TIME(II)
      EK=TABLE(II-2)
      READ(4'1)N2R,TIME(N2R),WUCDEM,WLCDEM,WICDEM,WDEM,ATUC,APUC,AVPUC,A
     *TLC,APLC,AVPLC,ATIC,APIC,AVPIC,WUC(1),WLC(1),WIC(1),W(1)
      IF(DABS(W(1)-A).LT.1.D-39)W(1)=A
      WSUM=(W(1)-A)**2
      DO 8 L=2,NRR1
      READ(4'L)NR,TIME(L),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPI
     *C,WUC(L),WLC(L),WIC(L),W(L)
    8 WSUM=WSUM+(W(L)-A-B*TIME(L))**2
      SIGMA=DSQRT((1./XNRR)*WSUM)
      AT=TS/XNRR
      READ(4'II)NR,TIME(II),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AV
     *PIC,WUC(II),WLC(II),WIC(II),W(II)
      ATTN=(TIME(II)-AT)**2
      TOT=AT**2
      DO 9 M=2,NRR1
      READ(4'M)NR,TIME(M),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AVPI
     *C,WUC(M),WLC(M),WIC(M),W(M)
    9 TOT=TOT+(TIME(M)-AT)**2
      F2=ATTN/TOT
      F1=(XNRR+1.)/XNRR
      F=F1+F2
      FF=F*(XNRR/(XNRR-2.))
      ATAB(II)=DSQRT(FF)*SIGMA
      WLR(II)=WR(II)-EK*ATAB(II)
      WUR(II)=WR(II)+EK*ATAB(II)
    7 CONTINUE
      B=B*2400.
      SIGMAB=DSQRT(WSUM/((XNRR-2.)*TOT))
      EKK=TABLE(NRR1-2)
      BL=B-(EKK*SIGMAB)*2400.
      BH=B+(EKK*SIGMAB)*2400.
      READ(4'NRR1)NR,TIME(NR),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,
```

```
     *AVPIC,WUC(NR),WLC(NR),WIC(NR),W(NR)
      WRITE(4'NRR1)NR,TIME(NR),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC
     *,AVPIC,WUC(NR),WLC(NR),WIC(NR),W(NR),BL,B,BH,A
      WRITE(6,201)
  201 FORMAT(1H1,48X,'SUMMARY OF  AVERAGES'///1H ,2X,'RUN #',2X,'ELAPSED
     *',2X,3(34HAVG TEMP  AVG PRESS  AVG V PRESS  )/1H ,10X,'TIME',6X,'U
     *PPER',5X,'UPPER',7X,'UPPER',7X,'LOWER',5X,'LOWER',6X,'LOWER',8X,'I
     *CE',7X,'ICE',9X,'ICE'/)
      READ(4'1)N2R,TIME(N2R),WUCDEM,WLCDEM,WICDEM,WDEM,ATUC,APUC,AVPUC,A
     *TLC,APLC,AVPLC,ATIC,APIC,AVPIC
      ATUC=ATUC-459.7
      ATLC=ATLC-459.7
      ATIC=ATIC-459.7
      WRITE(6,202)N2R,TIME(N2R),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,API
     *C,AVPIC
  202 FORMAT(1H ,2X,I3,4X,F6.2,2X,3(F9.4,2X,F9.4,3X,F9.4,2X))
      DO 846 JG=2,NRR1
      READ(4'JG)NR,TIME(NR),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,AV
     *PIC
      ATUC=ATUC-459.7
      ATLC=ATLC-459.7
      ATIC=ATIC-459.7
  846 WRITE(6,202)NR,TIME(NR),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,
     *AVPIC
      WRITE(6,205)
  205 FORMAT(1H1,34X,'RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST'///
     *1H ,2X,'RUN #',8X,'W',11X,'LEAKAGE RATE',9X,'LEAKAGE',9X,'LEAKAGE
     *RATE',8X,'W UPPER',7X,'W LOWER',9X,'W ICE'/1H ,10X,'EXPERIMENTAL',
     *6X,'LOWER LIMIT',11X,'RATE',11X,'UPPER LIMIT',5X,'CONTAINMENT',3X,
     *'CONTAINMENT',5X,'CONDENSER'/)
      DO 845 JG2=3,NRR1
      READ(4'JG2)NR,TIME(JG2),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,
     *AVPIC,WUC(JG2),WLC(JG2),WIC(JG2),W(JG2),BL,B,BH,A
  845 WRITE(6,206)NR,W(JG2),BL,B,BH,WUC(JG2),WLC(JG2),WIC(JG2)
  206 FORMAT(1H ,3X,I3,4X,F9.5,9X,F9.5,9X,F9.5,10X,F9.5,8X,F9.5,5X,F9.5,
     *6X,F9.5)
      READ(4'99)NRR
      IF(NRR1-NRR)847,844,844
  844 READ(4'NRR1)NR,TIME(NR),ATUC,APUC,AVPUC,ATLC,APLC,AVPLC,ATIC,APIC,
     *AVPIC,WUC(NR),WLC(NR),WIC(NR),W(NR),BL,B,BH,A
      WRITE(6,203)B,A
  203 FORMAT(1H0,21X,'FINAL LEAKAGE RATE (% PER DAY) =',F9.5,5X,'INTERCE
     *PT=',F9.5)
      WRITE(6,204)BL,BH
  204 FORMAT(1H0,21X,'FINAL CONFIDENCE LIMITS FOR THE RATE ARE ',F9.5,'
     *TO ',F9.5)
    3 STOP
      END
```

7.0 ANALYSIS AND INTERPRETATION

The previous sections of this report described the method of measuring and computing the containment leakage rate. This section will be dedicated to a discussion of the observations and conclusions drawn from the performance and subsequent analysis of this containment ILRT. Also included in this section is a presentation on the error analysis related to the test instrumentation.

7.1 Discussion of Graphical Test Data

Figures 7.1.1 and 7.1.2 are the graphical representations of the Integrated Leak Rate Test and Supplemental Test data respectively. The axis of these graphs are the normalized weight of original air versus time. The slope of the regression line is the leakage rate.

Examination of Figure 7.1.1 reveals the dispersion of data points, representing the normalized weight (W_n) of containment air, results in exceptionally horizontal regression line. A regression line of this nature over the indicated 31.5 hour test period is indicative of an extremely leak-tight containment which is confirmed in the fact that the average change in W_n per un time, hence leak rate, is -0.00428 %/24 hrs. when expressed on a daily basis. The dispersion of data points yields a variance (mean square deviation) in the leak rate of ± 0.00422 % wt./24 hrs. The variance is computed on a 95% confidence level which results in a lower leakage limit of -0.00850 % wt./24 hrs. The 95% confidence level

7.1 Discussion of Graphical Test Data (Cont'd)

lower limit is still well within the specified allowable leak rate of -0.1875 % wt./24 hrs.

The graphical representation of the Supplemental Test may be found on Figure 7.1.2 of this report. As illustrated, with the supplemental leak rate imposed on the containment, the change in the normalized weight (W_n) of containment air per unit time is much more pronounced than in Figure 7.1.1 as would be expected. It is interesting to note, however, that because the measured containment leak rate was extremely low, the change in W_n per unit time as shown for the Supplemental Test is only 1.5 per cent greater than the Technical Specification limit for containment leak rate and, thus, may be viewed as a dramatic comparison with the measured containment leak rate shown in Figure 7.1.1 For ease of comparison the portion of the regression line from run 1 to 17 of Figure 7.1.1 has been superimposed on Figure 7.1.2.

Figure 7.1.3 is a plot of the average absolute pressure (PSIA) for each containment compartment. As indicated, each containment compartment generally exhibits the same steady decay in pressure during the 31.5 hours of the ILRT. A calculation on the measured change in the average absolute pressure over runs, 1 to 64 for the Upper, Lower and Ice Condenser Compartments results in a ΔP of 0.0868, 0.0887 and 0.0870 PSI respectively

7.1 Discussion of Graphical Test Data (Cont'd)

with an overall average change in absolute pressure of 0.0875 PSI. When the standard deviation is computed for the average absolute pressure measurements the standard error is found to be ± 0.00085 PSI. As can be seen in Section 7.3, the ILRT instrument error analysis uses the very conservative value for standard error of ± 0.003 PSI.

Figure 7.1.4 is the graphical representation of the average vapor pressure (PSIA) for each containment compartment as measured during the ILRT. This graph clearly demonstrates the contrasting environmental conditions experienced in the three containment compartments. As shown on Figure 7.1.4 the Upper and Ice Condenser compartments demonstrate relatively stable moisture content throughout the test while the Lower compartment experiences an appreciable "drying out". The steady decrease in the partial pressure of the water vapor present in the Lower compartment air is probably brought on by a migration of relatively colder drier air from the Ice Condenser compartment which, in turn, promotes condensation therein.

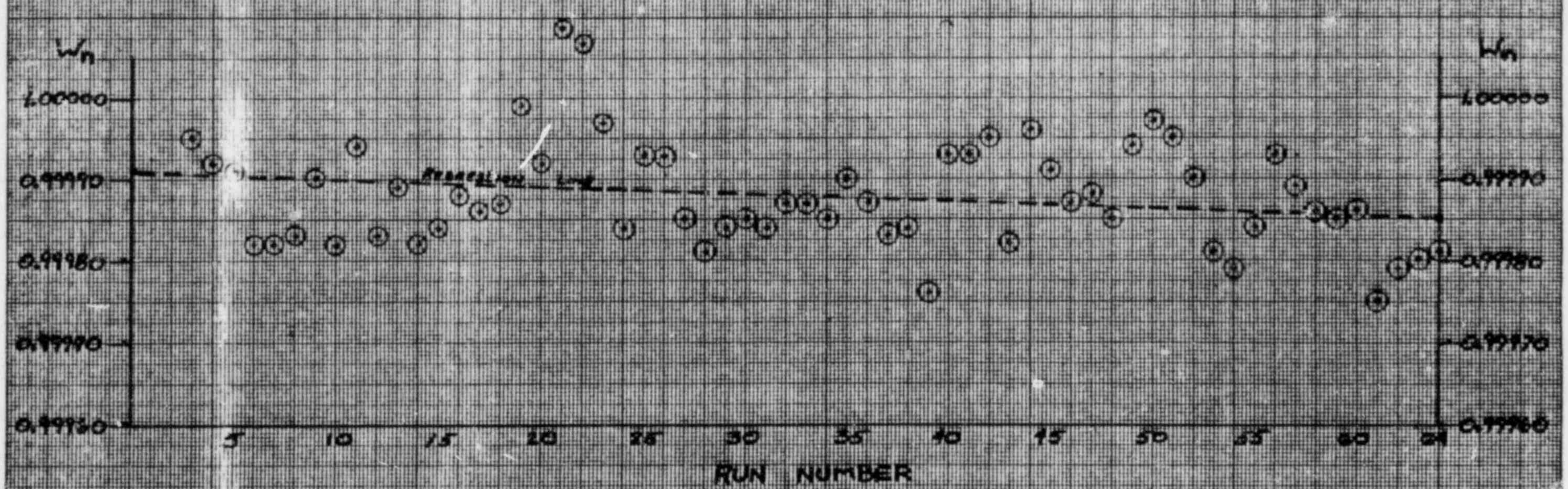
The weighted average temperatures for the three containment compartments have been plotted on the graph of Figure 7.1.5. The Lower and Upper containment volumes exhibit about the same steady decreasing trend in temperature. Both compartments experienced an approximate 1.5 °F drop

7.1 Discussion of Graphical Test Data (Cont'd)

in temperature over the 31.5 hours or 0.05 °F/hr. Thus, it may be concluded from this observation that the Upper and Lower containment compartments will stabilize in temperature and tend to maintain their stability throughout the course of the leak rate test.

The plot of Ice Condenser compartment average temperature, however, illustrates that stabilization here is quite another matter. While the overall change in temperature from Run 1 to Run 64 is an increase of only 0.68 °F for the 31.5 hours, much larger °F/hr. changes are experienced because, unlike the Upper and Lower compartments, the trend is not constant but rather tends to cycle. The cyclical variations in Ice Condenser average temperature, whose magnitude is typically 0.06 °F/hr. and as much as 0.23 °F/hr. are caused by the periodic defrosting of the Ice Condenser air handler cooling coils. This was also a problem on the Unit 1 Pre-Operational ILRT and steps were taken during this test to minimize this affect by manually actuating defrost on selected air handlers. While the defrost affect on average temperature was somewhat reduced by this effort, compared to the Unit 1 test, its affect on temperature stability makes compliance with the 0.1 °F/hr. stabilization criteria impracticable. A revised stabilization criteria for the Ice Condenser compartment is under consideration for use in future containment perodic re-tests.

FIGURE 7.1.1



NORMALIZED WEIGHT OF CONTAINMENT AIR VERSUS RUN NUMBER

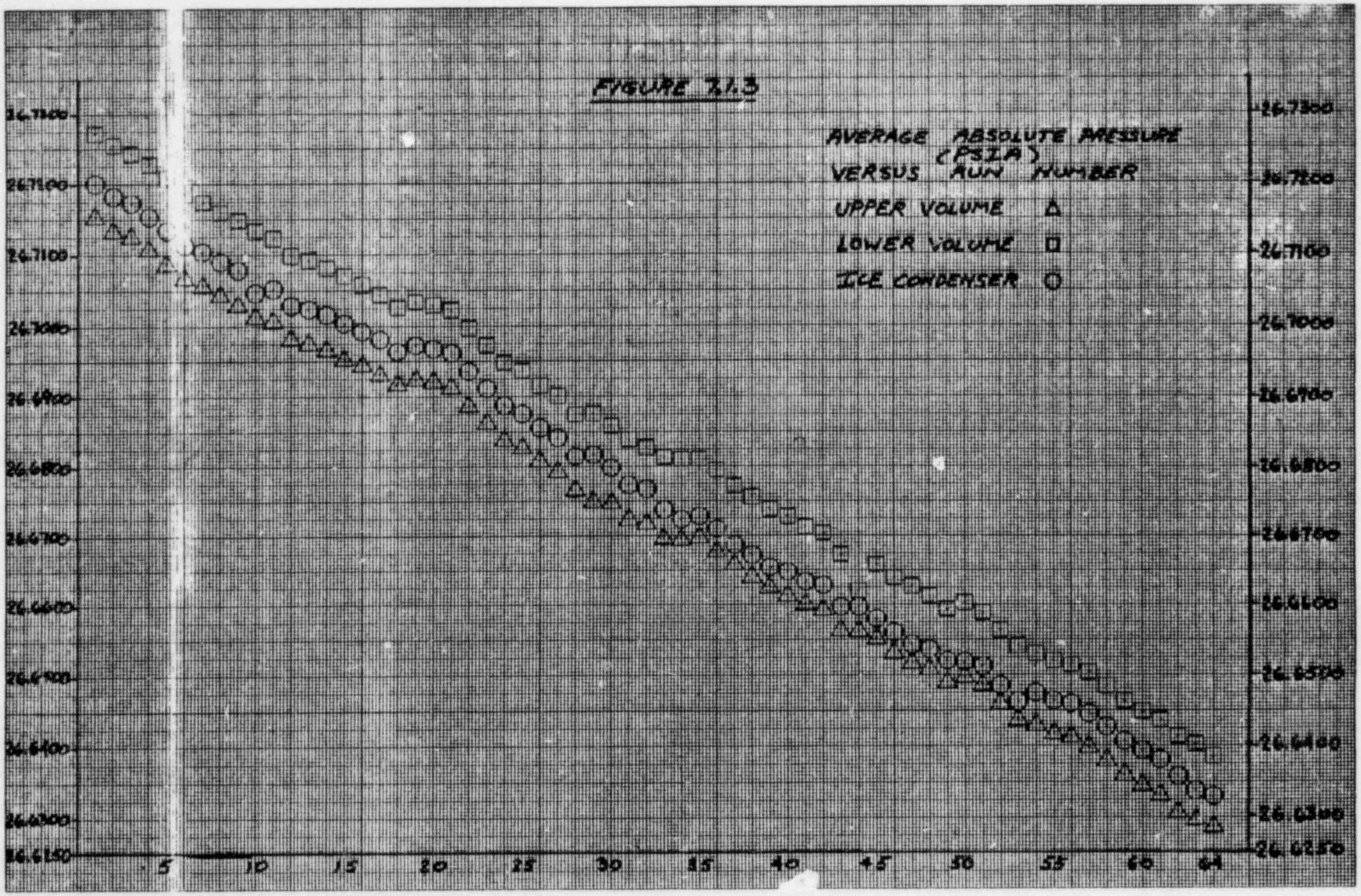


FIGURE 7.1.3
AVERAGE ABSOLUTE PRESSURE (PSIA)
VERSUS RUN NUMBER
UPPER VOLUME △
LOWER VOLUME □
ICE CONDENSER ○
26.7300
26.7200
26.7100
26.7000
26.6900
26.6800
26.6700
26.6600
26.6500
26.6400
26.6300
26.6250
26.6150
5
10
15
20
25
30
35
40
45
50
55
60
64

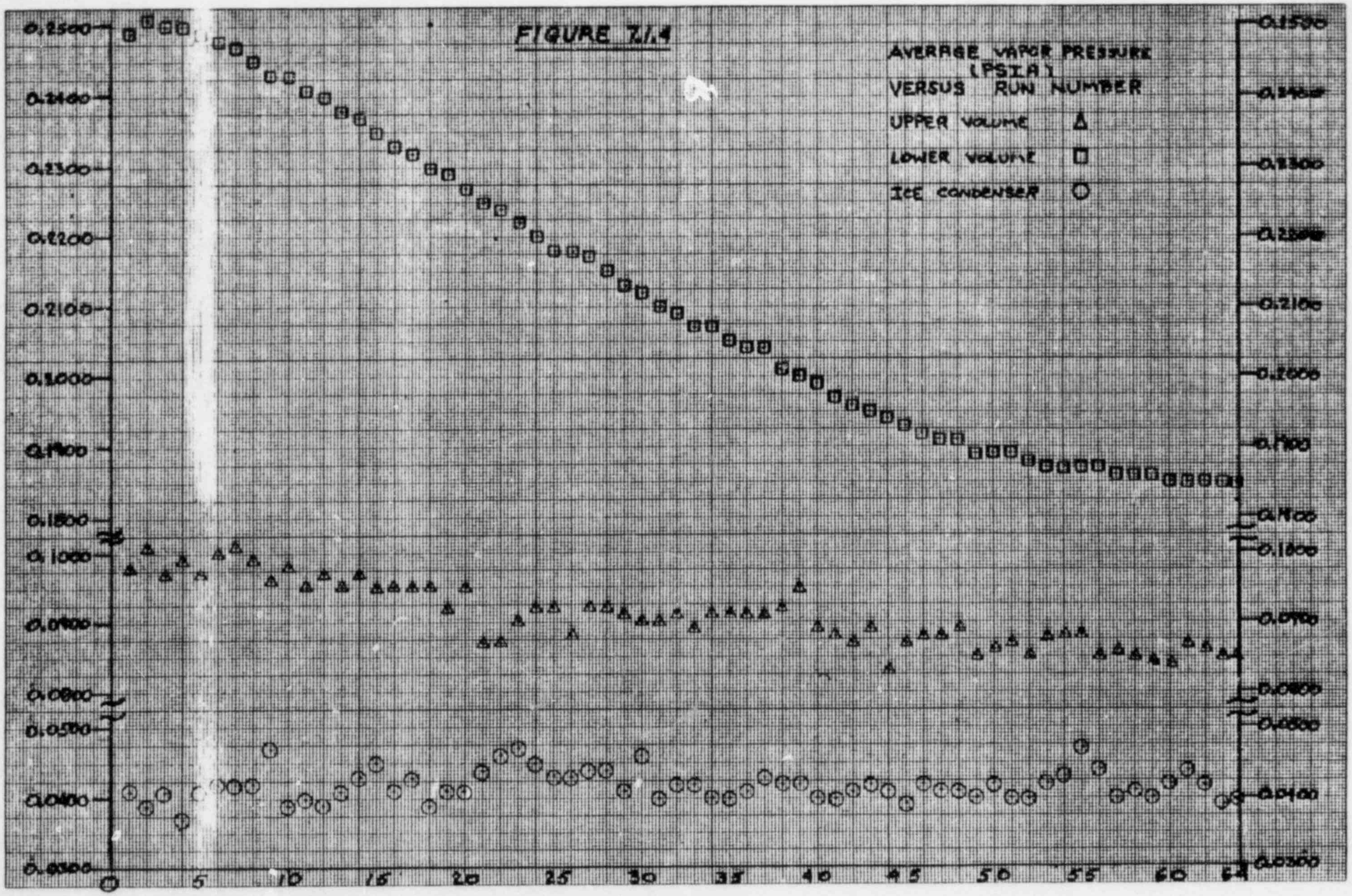


FIGURE 7.1.4
AVERAGE VAPOR PRESSURE (PSIA)
VERSUS RUN NUMBER
UPPER VOLUME △
LOWER VOLUME □
ICE CONDENSER ○
0.2500
0.2400
0.2300
0.2200
0.2100
0.2000
0.1900
0.1800
0.1000
0.0900
0.0800
0.0500
0.0400
0.0300
0
5
10
15
20
25
30
35
40
45
50
55
60
64

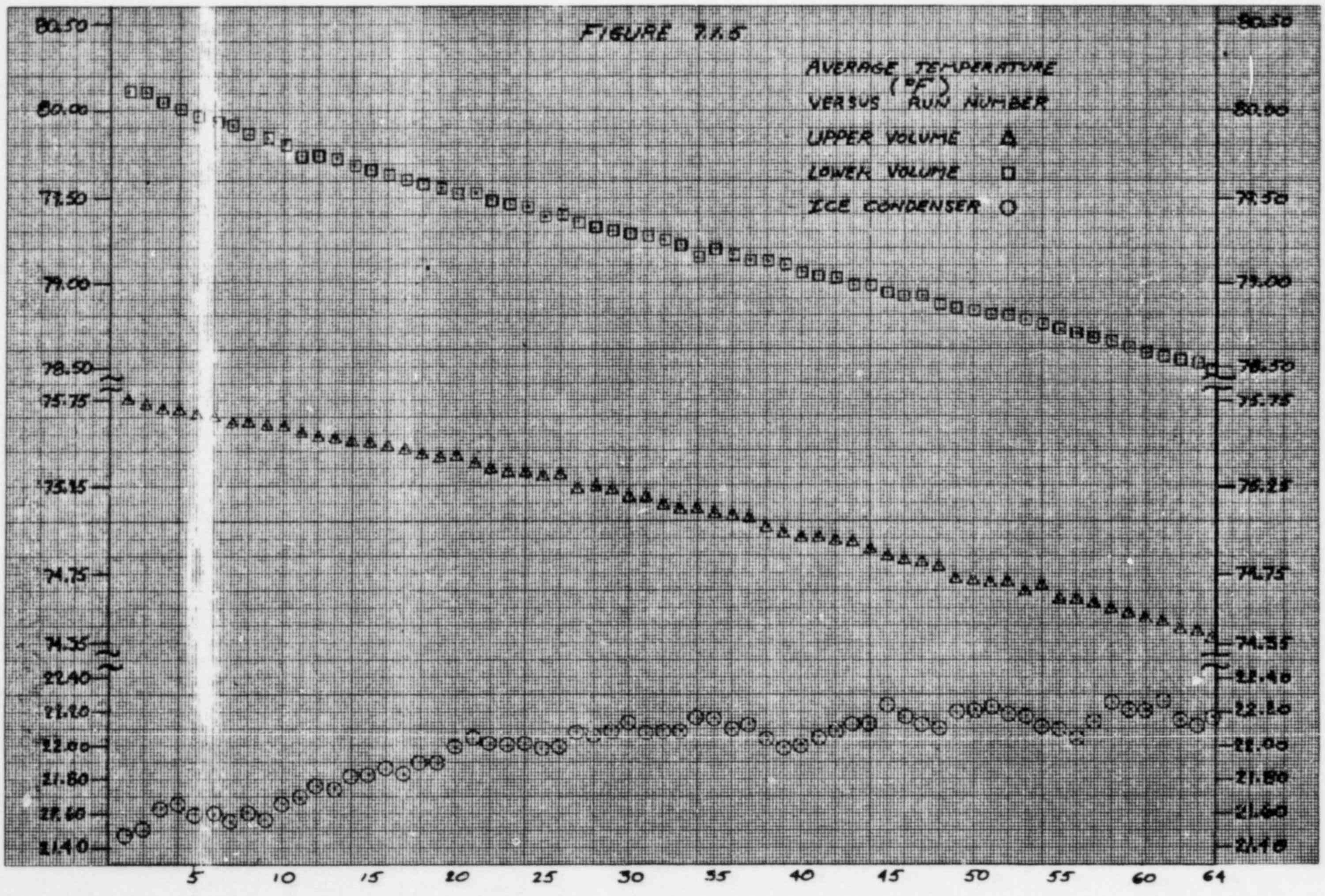


FIGURE 7.1.5
AVERAGE TEMPERATURE (°F) VERSUS RUN NUMBER
UPPER VOLUME △
LOWER VOLUME □
ICE CONDENSER ○
80.50
80.00
79.50
79.00
78.50
75.75
75.25
74.75
74.35
22.40
22.20
22.00
21.80
21.60
21.40
5
10
15
20
25
30
35
40
45
50
55
60
64

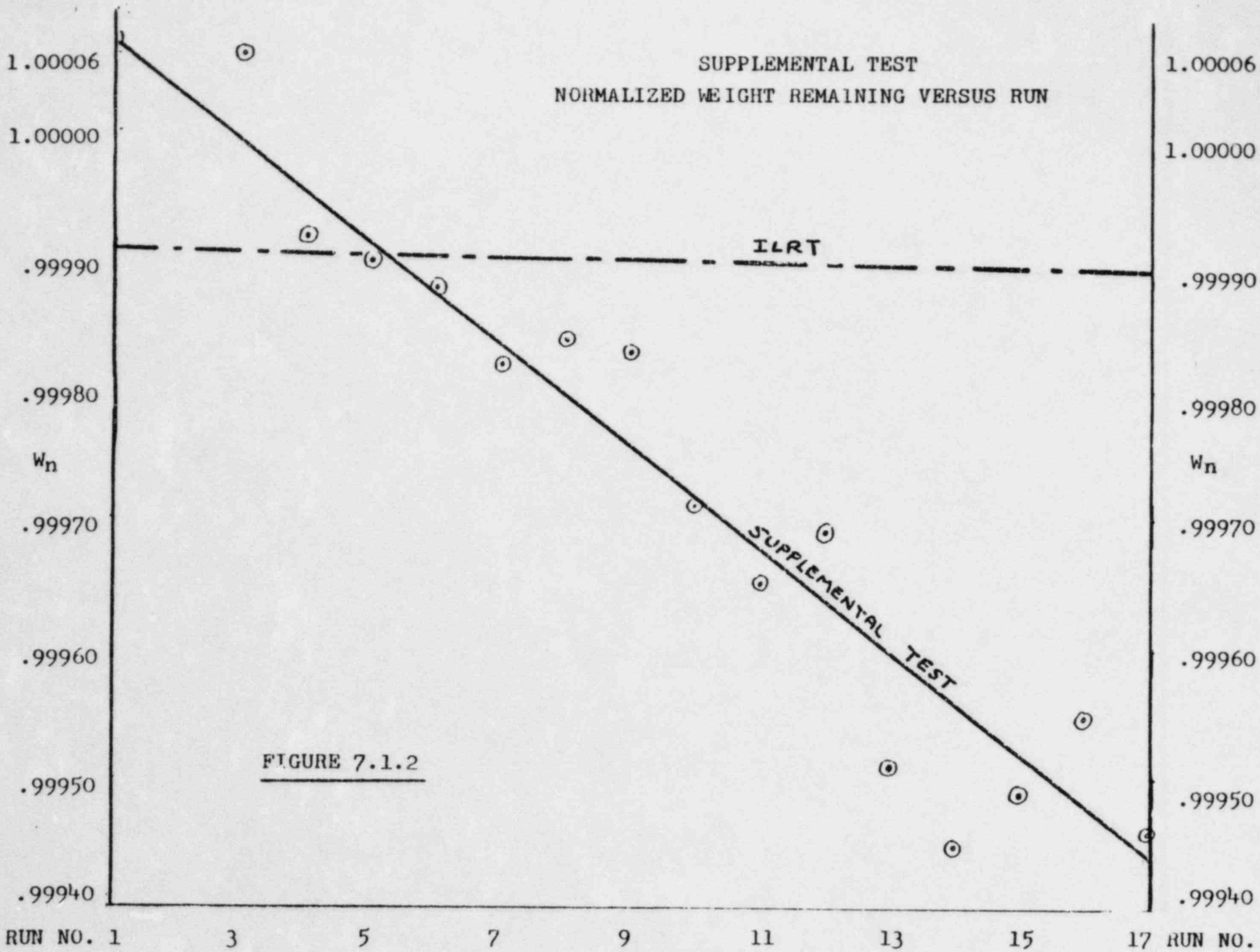

SUPPLEMENTAL TEST
NORMALIZED WEIGHT REMAINING VERSUS RUN
1.00006
1.00000
.99990
.99980
Wn
.99970
.99960
.99950
.99940
RUN NO.
1
3
5
7
9
11
13
15
17
ILRT
SUPPLEMENTAL TEST

FIGURE 7.1.2

5.3 Pressurization Apparatus

The Plant air system was used to pressurize the containment for the Integrated Leakage Rate Test. A three state centrifugal air compressor located in the turbine room supplies compressed air to the plant air system. The compressor is designed to provide 1500 cfm of oil free compressed air at a discharge pressure of 100 PSIG continuously. Air discharged from the plant air compressor retains the third stage heat of compression. An aftercooler installed in the discharge line, is designed to cool the air to within 10°F of its inlet cooling water temperature. The condensed moisture resulting from the cooling is removed by a cyclone-type separator installed immediately downstream of the aftercooler. The air discharged from the moisture separator is fed through the plant air system to the containment test pressurization filters and dryers. In order to avoid condensing water vapor during the test the plant air supplied is dried to a dew point that is below the coldest temperature anticipated in the ice condenser. Two parallel, 100 percent capacity strings of prefilters prevent contamination of the drying dessicants from mositure carryover or scale. Two afterfilters in parallel protect the containment from dessicant dusting.

The dried and filtered air is fed through a three inch test line, spool piece, and valve to penetration #CPN-57. This valve was used to throttle the air flow during pressurization and depressurization.

7.2 Discussion of Parametric Study

A parametric study was performed using the test data collected during the Unit 2 Pre-Operational ILRT to determine the affect varying the volume of ice resident in the Ice Condenser compartment would have on the leak rate calculations.

The parametric study was comprised of three conditions of ice basket loading, i.e., Case I maximum ice load, Case II minimum ice load allowed by current Technical Specification and Case III actual ice load. In the case of maximum ice load, the entire internal volume of each ice basket was assumed to be occupied by ice. The ice volumes for the actual and Technical Specification lower limit were calculated based on 1481 and 1220 lbs. per basket respectively.

By varying the volume of ice in the Ice Condenser the associated net free volume is so affected. The resultant Ice Condenser free volume for the three cases is reflected accordingly in the Volume Weighting Factors (VWF) used in the calculation of normalized weight of containment air. A detailed discussion on VWF is presented in Section 6.2 of this report.

The results of the parametric study has been tabularized

7.2 Discussion of Parametric Study (Cont'd)

in Table 7.2.1 below:

TABLE 7.2.1

Ice Basket Loading	Containment ILRT Measured Leak Rate*	Containment ILRT 95% Lower Confidence Limit*	Supplemental Test Leak Rate*
Maximum	+0.00270	-0.00166	-0.18199
Actual	-0.00428	-0.00850	-0.19028
Minimum	-0.00708	-0.01126	-0.19364

* Leak Rate expressed in % wt./24 hrs.; - denotes out leakage.

Using the actual weight of ice as a basis for comparison Table 7.2.2 illustrates the change in the calculated leak rate:

TABLE 7.2.2

Comparison Actual With:	Containment ILRT % wt./24 hrs.*	Containment ILRT % Δ	Supplemental Test % wt./24 hrs.*	Supplemental Test % Δ
Maximum Ice	+0.00698	163.1	+0.00829	4.36
Minimum Ice	-0.00280	65.4	-0.00336	1.77

* - Denotes increase in out leakage.

A review of the above Table 7.2.2 indicates the affect of varying the ice volume between the extreme conditions of maximum and minimum ice load conditions is not as significant, in terms of per cent difference in the overall leak rate,

7.2 Discussion of Parametric Study (Cont'd)

when the magnitude of leakage closely brackets the ILRT allowable limit of -0.1875 % wt./24 hrs. as it is for relatively smaller leak rates.

In the Supplemental Test, where the magnitude of leakage is approximately equal to the ILRT allowable limit, the difference in the leak rate between the actual leakage and the maximum and minimum ice load leak rates is 4.36 and 1.77 per cent respectively. The overall change in the leak rate for the two extreme ice load conditions is equal to 0.01165 % wt./24 hrs. or 6.2 per cent of the allowable leak rate. Leakage of this magnitude would be significant in the event the acceptance of an ILRT was a borderline case.

When the leak rate is small, as shown in Table 7.2.2 for the ILRT results, the affect on the magnitude of the measured leak rate is dramatic. There is, however, little significance at these levels of leakage, in that, even with a 65 per cent increase over the actual leak rate the resultant leakage (-0.00708 % wt./24 hrs.) is still only 3.8 per cent of the ILRT allowable.

It is interesting to note at this time that the difference between the maximum and minimum ice load conditions represents an ice volume of 30,936 cubic feet or 1.73×10^6 pounds of ice. To incur the 6.2 per cent

7.2 Discussion of Parametric Study (Cont'd)

error in the measured leak rate, as discussed above, due to inaccuracies in the ice basket weighing would require an error in measurement of approximately 890 pounds of ice per basket. The present method of weighing a representative sample of ice baskets and computing the statistical average weight per basket produced a standard deviation of only 35.45 pounds for the measurements taken prior to this ILRT.

Thus it may be concluded from the above results, that the variation in the calculated leak rate, as affected by the extreme conditions of maximum or minimum ice volume is small but would be significant in the acceptance of borderline ILRT's. It may also be concluded that the uncertainties involved in determining the quantity of ice within the ice baskets, and hence the net free volume of the Ice Condenser compartment, are well within the limits of required accuracy.

7.3 Instrument Error Analysis

The following calculation represents the instrument error analysis performed to substantiate the selection of the test instrumentation utilized to provide input to the computation of the containment leakage rate.

In summary, the instrument error analysis demonstrates the inaccuracies associated with the test instrumentation

7.2 Discussion of Parametric Study (Cont'd)

error in the measured leak rate, as discussed above, due to inaccuracies in the ice basket weighing would require an error in measurement of approximately 890 pounds of ice per basket. The present method of weighing a representative sample of ice baskets and computing the statistical average weight per basket produced a standard deviation of only 35.45 pounds for the measurements taken prior to this ILRT.

Thus it may be concluded from the above results, that the variation in the calculated leak rate, as affected by the extreme conditions of maximum or minimum ice volume is small but would be significant in the acceptance of borderline ILRT's. It may also be concluded that the uncertainties involved in determining the quantity of ice within the ice baskets, and hence the net free volume of the Ice Condenser compartment, are well within the limits of required accuracy.

7.3 Instrument Error Analysis

The following calculation represents the instrument error analysis performed to substantiate the selection of the test instrumentation utilized to provide input to the computation of the containment leakage rate.

In summary, the instrument error analysis demonstrates the inaccuracies associated with the test instrumentation

7.3 Instrument Error Analysis (Cont'd)

may contribute an error of = 0.076 L_a to the calculated containment leakage rate. This level of inaccuracy is more than tolerable in as much as the containment allowable leakage rate L_a is reduced for purposes of containment integrated leakage rate testing to a value of 0.75 L_a. Moreover, the required correlation between the ILRT and Supplemental Leak Test is established at = 0.25 L_a.

A.E.P.S.C. CALCULATION

MECHANICAL ENGINEERING DIVISION

INSTRUMENTATION AND CONTROLS SECTION

E.C.P. CALCULATION No. 2-PI-07	SHEET 1 OF 17
TYPE PRELIMINARY OR FINAL Final	PLANT D.C. Cook UNIT 2
SUBJECT ILRT Instrument Error Analysis	COMPANY I&M Power
	CALCULATED BY M. J. Trezza
	CHECKED BY E. D. Rounds
SUPERSEDES CALCULATION NO. N/A	APPROVED BY [signature]
FILE LOCATION	AND DATE 04?/??/78

PROBLEM DESCRIPTION: COMPUTE THE AFFECT OF ILRT INSTRUMENTATION ERROR ON THE CALCULATED CONTAINMENT LEAKAGE RATE.

DESIGN BASIS AND REFERENCES

1. Instrument Instruction Manuals.
   1.1 Mensor Quartz Manometers.
   1.2 Hy-Cal Engineering RTD and Bridge Amplifier System.
   1.3 Cambridge EG&G Dew Point Hygrometer.
   1.4 Fluke Recorders.
2. ILRT Computer Printouts for Data Check.
3. Smithsonian Meterological Tables.
4. Basic Statistical Methods for Engineers and Scientists.

E.C.P. REVISION			NO CALCULATION CHANGE		
NO.	DATE	CHANGE	CALCULATION BY/DATE	CHECKED BY/DATE	APPROVED BY/DATE
		RECORDED ON E.C.P. PACKAGE REVISION RECORD			

SUPERSEDED BY E.C.P. CALCULATION NO. ______ REASON ______

SUPERSEDED BY/DATE ______

A.I.D. E.C.P. 4
030877

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

THE FOLLOWING IS AN ERROR ANALYSIS FOR THE TEST INSTRUMENTATION USED FOR THE PRE-OPERATIONAL CONTAINMENT INTEGRATED LEAK RATE TEST PERFORMED AT THE D.C. COOK NUCLEAR PLANT - UNIT NO. 2.

THE INSTRUMENT ERROR ASSOCIATED WITH EACH MEASURED PARAMETER USED TO COMPUTE THE CONTAINMENT LEAKAGE RATE SHALL BE DETERMINED BASED UPON THE INSTRUMENT MANUFACTURERS SPECIFICATIONS FOR OVERALL ACCURACY. IN THOSE CASES WHERE THE MEASURING SYSTEM IS MADE UP OF SEVERAL COMPONENTS, THE SQUARE ROOT SUM OF THE SQUARES SHALL BE COMPUTED FROM THE ERROR ASSOCIATED WITH EACH INDIVIDUAL COMPONENT TO DETERMINE THE OVERALL SYSTEM ERROR.

THE ERROR ASSOCIATED WITH THE COMPLETE MEASURING SYSTEM INCLUDING SENSOR, CONDITIONING EQUIPMENT AND RECORDING EQUIPMENT SHALL BE DETERMINED AND USED TO COMPUTE THE AFFECT ON THE LEAKAGE RATE AND EXPRESSED IN % WT./24 HOURS.

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
Range: 0-30 PSIA
ACCURACY: ± 0.01 % full scale

THUS Error for PRESSURE = $E_P = \pm 0.003$ PSI

1.2 CONTAINMENT TEMPERATURE

MANUFACTURER: HY-CAL ENGINEERING
Type: 100 Ω PLATINUM RTD w/ LINEARIZED BRIDGE
Model RTS-4233-B ESD-9050 A
RANGE: 0-100 °F
ACCURACY: ± 0.06 °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

$$E_T = \sqrt{(0.06)^2 + (0.05)^2}$$

$$E_T = \pm 0.078\ °F \text{ or } \pm 0.078\ °R$$

SUBJECT ILRT- INSTRUMENT ERROR ANALYSIS

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

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

$$ERROR = \pm 0.50\ °F \quad \text{(In Dew Point)}$$

OVERALL ERROR IN DEW POINT TO VAPOR PRESSURE CONVERSION.

UPPER VOLUME

* EXPERIENCED DEW POINTS BETWEEN 30 - 35 °F
AVERAGE Δ VAPOR PRESS. / °F = 0.00364 PSIA/°F
THUS ERROR IN UPPER VOL. VAPOR PRESS.

$$E_{VPU} = (\pm 0.50\ °F)(0.00364\ PSIA/°F)$$

$$\boxed{E_{VPU} = \pm 0.002\ PSIA}$$

LOWER VOLUME

* EXPERIENCED DEW POINTS between:

43 to 54 °F VPL 1
57 TO 64 °F VPL 2

* SEE APPENDIX 'A' OF THIS CALCULATION.

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

1.3 CONTAINMENT VAPOR PRESSURE CONT'D.

FOR VPL-1 ; AVERAGE Δ VAPOR PRESS. / °F = 0.0063 PSIA/°F
THUS ERROR IN LOWER VOL. #1 IS:

VPL-1 = (0.50°F)(0.0063 PSIA/°F)

VPL-1 = ± 0.0032 PSIA

FOR VPL-2 ; AVERAGE Δ VAPOR PRESS. / °F = 0.0093 PSIA/°F
THUS ERROR IN LOWER VOL. #2 IS:

VPL-2 = (±0.50°F)(0.0093 PSIA/°F)

VPL-2 = ± 0.0047 PSIA

BUT AN AVERAGE VALUE FOR LOWER VOLUME VAPOR PRESSURE IS USED IN THE LEAK RATE CALCULATIONS; THUS:

$$E_{VPL} = \sqrt{\frac{(E_{VPL1})^2 + (E_{VPL2})^2}{2}}$$

$$E_{VPL} = \pm 0.004 \text{ PSIA}$$

ICE CONDENSER VOLUME

* EXPERIENCED DEW POINTS BETWEEN 15 TO 18 °F
AVERAGE Δ VAPOR PRESS. / °F = 0.0021 PSIA /°F
THUS ERROR IN ICE COND. VOL. VAPOR PRESS. IS:

$$E_{VPI} = (\pm 0.50\,°F)(0.0021 \text{ PSIA}/°F)$$

$$\boxed{E_{VPI} = \pm 0.001 \text{ PSIA}}$$

* SEE APPENDIX 'A' OF THIS CALCULATION.

SUBJECT ILRT Instrument Error Analysis

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

$$E^2_{P-VP} = (0.003)^2 + (0.002)^2$$

$$\boxed{(E^2_{P-VP})_{UPPER} = 1.3 \times 10^{-5}}$$

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

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

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

2.1.3 E^2_{P-VP} for Ice Cond. Vol.

$$E^2_{P-VP} = (0.003)^2 + (0.001)^2$$

$$\boxed{(E^2_{P-VP})_{ICE} = 1.0 \times 10^{-5}}$$

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

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

IF: $A = B/C$

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

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 P-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 64 HAS BEEN USED. WITH ASSOCIATED DATA LISTED IN APPENDIX 'B'.

2.2.1 $E_{\frac{P-VP}{T}}$ FOR UPPER VOLUME

$$E^2_{\frac{P-VP}{T}} = \left[\frac{1.3 \times 10^{-5}}{(26.5439)^2} + \frac{(7.8 \times 10^{-2})^2}{(534.08)^2}\right] \times \left(\frac{26.5439}{534.08}\right)^2$$

$$E^2_{\frac{P-VP}{T}} = \boxed{9.83 \times 10^{-11} = E^2_{UPPER}}$$

FORM GE-8

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
2 BROADWAY
NEW YORK

2-P1-07 SHEET 8 OF 17
DATE 4/10/78 BY MGT. CK E.B.K.
COMPANY I&M Power G.O.
PLANT D.C. Cook Nuclear

SUBJECT ILRT Instrument Error Analysis

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

$$E^2_{\frac{P-VP}{T}} = \left[\frac{2.5\times10^{-5}}{(26.4536)^2} + \frac{(7.8\times10^{-2})^2}{(538.18)^2}\right] \times \left(\frac{26.4536}{538.18}\right)^2$$

$$E^2_{\frac{P-VP}{T}} = \boxed{1.37\times10^{-10} = E^2_{LOWER}}$$

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

$$E^2_{\frac{P-VP}{T}} = \left[\frac{1.0\times10^{-5}}{(26.5927)^2} + \frac{(7.8\times10^{-2})^2}{(481.86)^2}\right] \times \left(\frac{26.5927}{481.86}\right)^2$$

$$E^2_{\frac{P-VP}{T}} = \boxed{1.23\times10^{-10} = E^2_{ICE}}$$

2.2.4 Calculation Summary for Section 2.2

Containment Compartment	Error (E^2)
Upper Volume	9.83×10^{-11}
Lower Volume	1.37×10^{-10}
Ice Condenser	1.23×10^{-10}

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

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: $E_B^2 = k_1^2 b^2$, $E_C^2 = k_2^2 c^2$, $E_D^2 = k_3^2 d^2$

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:

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

$$E^2_{W_i} = \left[(2.0144)^2 (9.83 \times 10^{-11})\right] + \left[(1.0000)^2 (1.37 \times 10^{-10})\right] + \left[(0.4559)^2 (1.23 \times 10^{-10})\right]$$

$$\boxed{E^2_{W_i} = 5.61 \times 10^{-10}}$$

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

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 AT RUN "i"; W_i

E_C = ERROR IN C; C = THE ORIGINAL WEIGHT OF AIR WITHIN THE CONTAINMENT; W_o

SUBSTITUTING:

$$W_n = W_i / W_o$$

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

It can be assumed that W_i / W_o IS ESSENTIALLY = 1
THUS:

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

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

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

2.4 ERROR FOR W_n Cont'd.

THE ILRT LEAK RATE COMPUTER PROGRAM CALCULATES W_i from:

$$W_i = (VWFU)\left(\frac{P-VP}{T}\right)_U + (VWFL)\left(\frac{P-VP}{T}\right)_L + (VWFI)\left(\frac{P-VP}{T}\right)_I$$

$$W_i = (2.0144)\left[\frac{26.6287-0.0848}{534.08}\right] + (1.0000)\left[\frac{26.6385-0.1849}{538.18}\right] + (0.4559)\left[\frac{26.6330-0.0403}{481.86}\right]$$

$$W_i = 0.1744 \text{ AND } W_i^2 = 0.0304 = 3.04\times10^{-2}$$

$E^2_{W_i} = 5.61\times10^{-10}$ AS PER SECTION 2.3

THEN:

$$E^2_{W_n} = 2\left[\frac{5.61\times10^{-10}}{3.04\times10^{-2}}\right]$$

$$\boxed{E^2_{W_n} = 3.69\times10^{-8}}$$

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

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:

$$E_{LR}^2 = 100^2\,E_{W_n}^2$$

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

Where:
E_{LR} = ERROR IN LEAKAGE RATE ; % WT. /24 HRS.
$E_{W_n}^2$ = ERROR^2 IN NORMALIZED WEIGHT OF CONTAINMENT AIR FROM SECTION 2.4

SUBSTITUTING:

$$E_{LR} = 100\sqrt{3.69\times10^{-8}}$$

$$\boxed{E_{LR} = \pm\,0.019\ \%\,\text{WT.}/24\ \text{HRS}}$$

SINCE L_A = 0.25 % WT. /24 HRS.

$$\boxed{E_{LR} = \pm\,0.076\,L_A}$$

SUBJECT ILRT - INSTRUMENT ERROR ANALYSIS

APPENDIX 'A'

UPPER VOLUME - DEW POINT TEMPERATURES

DEW PT. °F	VAPOR PRESSURE* "HG	VAPOR PRESSURE* PSIA	Δ PSIA
35	0.20342	0.09991	
			0.00391
34	0.19546	0.09600	
			0.00377
33	0.18778	0.09223	
			0.00365
32	0.18036	0.08858	
			0.00351
31	0.17321	0.08507	
			0.00339
30	0.16631	0.08168	
		Σ	0.01823
		AVERAGE ΔVP	0.00364

* VAPOR PRESSURES IN "Hg. from SMITHSONIAN METEOROLOGICAL TABLES.

$$PSIA = \frac{\text{"Hg.}}{2.036}$$

ICE CONDENSER - DEW POINT TEMPERATURES

DEW PT. °F	VAPOR PRESSURE* "HG	VAPOR PRESSURE* PSIA	Δ PSIA
18	0.09326	0.04580	
			0.00217
17	0.08884	0.04363	
			0.00207
16	0.08461	0.04156	
			0.00199
15	0.08056	0.03957	
		Σ	0.00623
		AVERAGE ΔVP	0.0021

FORM GE-8

ENGINEERING DEPT.

AMERICAN ELECTRIC POWER SERVICE CORP.

2 BROADWAY

NEW YORK

2-P1-07

SHEET 14 OF 17

DATE 4/10/75 BY MJT CK E.D.K.

COMPANY I&M POWER G.O.

PLANT D. C. COOK NUCLEAR

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

APPENDIX 'A' Cont'd.

LOWER VOLUME - DEW POINT TEMPERATURES No. 1

Dew Pt. °F	VAPOR PRESSURE* "Hg.	VAPOR PRESSURE* PSIA	Δ PSIA
54	0.42003	0.20630	
			0.00750
53	0.40492	0.19880	
			0.00711
52	0.39028	0.19169	
			0.00696
51	0.37611	0.18473	
			0.00674
50	0.36240	0.17799	
			0.00651
49	0.34913	0.17148	
			0.00631
48	0.33629	0.16517	
			0.00610
47	0.32387	0.15907	
			0.00590
46	0.31185	0.15317	
			0.00571
45	0.30023	0.14746	
			0.00552
44	0.28899	0.14194	
			0.00533
43	0.27813	0.13661	
		Σ	0.06969
		AVERAGE Δ VP	0.0063

* VAPOR PRESSURES IN "Hg. from SMITHSONIAN METEROLOGICAL TABLES

$$PSIA = \frac{\text{"Hg.}}{2.036}$$

FORM GE-8

ENGINEERING DEPT.

AMERICAN ELECTRIC POWER SERVICE CORP.

2 BROADWAY

NEW YORK

2-PT-07 SHEET 15 OF 17

DATE 4/10/78 BY M.J.T. CK C.D.R.

COMPANY I&M POWER G.O.

PLANT D.C. COOK NUCLEAR

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

APPENDIX 'A' Cont.'d.

LOWER VOLUME - DEW POINT TEMPERATURES No. 2

DEW PT. °F	VAPOR PRESSURE* "Hg.	VAPOR PRESSURE* PSIA	Δ PSIA
64	0.60073	0.29505	
			0.01017
63	0.58002	0.28488	
			0.00986
62	0.55994	0.27502	
			0.00956
61	0.54047	0.26546	
			0.00928
60	0.52160	0.25618	
			0.00898
59	0.50330	0.24720	
			0.00870
58	0.48558	0.23850	
			0.00844
57	0.46840	0.23006	
		Σ	0.06499
	AVERAGE ΔVP		0.00928

* VAPOR PRESSURES IN "Hg from SMITHSONIAN METEROLOGICAL TABLES.

$$PSIA = \frac{"Hg.}{2.036}$$

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS

APPENDIX 'B'

DATA FROM PRE-OPERATIONAL ILRT - UNIT NO. 2 ; RUN 64

CONTAINMENT PRESSURE*	PSIA
UPPER VOLUME	26.6287
LOWER VOLUME	26.6385
ICE CONDENSER	26.6330

* VALUES ARE AVERAGES OF REDUNDANT PRESSURE SENSORS / VOLUME.

CONTAINMENT TEMPERATURE**	°R
UPPER VOLUME	534.08
LOWER VOLUME	538.18
ICE CONDENSER	481.86

** VALUES ARE WEIGHTED AVERAGES / VOLUME.

CONTAINMENT VAPOR PRESS.	PSIA
UPPER VOLUME	0.0848
LOWER VOLUME	0.1849
ICE CONDENSER	0.0403

CONTAINMENT VOLUME WEIGHTING FACTORS	VWF
UPPER VOLUME	2.0144
LOWER VOLUME	1.0000
ICE CONDENSER	0.4559

RUN NUMBER 64
ELAPSED TIME 31.50

CONTAINMENT TEMPERATURES DATA CHECK

UPPER VOLUME			LOWER VOLUME			ICE CONDENSER		
RTD	MILLI-VOLTS	DEG. F.	RTD	MILLI-VOLTS	DEG. F.	RTD	MILLI-VOLTS	DEG. F.
ETR-101	37.19	74.38	ETR-122	45.96	91.92	ETR-115	11.28	22.56
ETR-102	37.14	74.28	ETR-123	45.35	90.70	ETR-116	10.48	20.96
ETR-103	37.14	74.28	ETR-124	45.56	91.12	ETR-117	13.74	27.48
ETR-104	37.45	74.90	ETR-125	45.59	91.18	ETR-118	12.67	25.34
ETR-105	36.68	73.36	ETR-126	39.87	79.74	ETR-119	10.26	20.52
ETR-106	37.09	74.18	ETR-127	38.60	77.20	ETR-120	10.47	20.94
ETR-107	36.95	73.90	ETR-129	37.63	75.26	ETR-121	11.44	22.88
ETR-108	37.10	74.20	ETR-130	39.97	79.94			
ETR-109	37.41	74.82	ETR-131	38.67	77.34			
ETR-110	37.43	74.86	ETR-132	37.20	74.40			
ETR-111	37.32	74.64	ETR-134	38.76	77.52			
ETR-112	37.78	75.56	ETR-135	39.00	78.00			
ETR-114	37.20	74.40	ETR-136	37.65	75.30			
ETR-128	35.72	71.44	ETR-137	39.26	78.52			
ETR-133	36.70	73.40	ETR-138	38.24	76.48			
ETR-113	38.48	76.96	ETR-139	37.32	74.64			
			ETR-140	33.77	67.54			
			ETR-141	36.79	73.58			
			ETR-142	36.45	72.90			
			ETR-143	34.69	69.38			
			ETR-144	37.19	74.38			
			ETR-145	38.26	76.52			
			ETR-146	36.44	72.88			

SUMMARY OF WEIGHTED AVERAGE TEMPERATURES

UPPER VOLUME (DEG. F.)	74.35	LOWER VOLUME (DEG. F.)	78.48	ICE CONDENSER (DEG. F.)	22.16
UPPER VOLUME (DEG. R.)	534.06	LOWER VOLUME (DEG. R.)	538.18	ICE CONDENSER (DEG. R.)	481.86

CONTAINMENT VAPOR PRESSURE DATA CHECK

HYGROMETER	MILLI-VOLTS	DEW POINT (DEG. F.)	VAPOR PRESSURE (PSIA)
VPU-1	33.00	30.91	0.0848
VPL-1	36.00	43.09	0.1371
VPL-2	39.55	57.33	0.2328
VPI-1	29.13	15.38	0.0403

SUMMARY OF VAPOR PRESSURES

UPPER CONTAINMENT (PSIA)	0.0848
AVERAGE LOWER CONTAINMENT (PSIA)	0.1849
ICE CONDENSER (PSIA)	0.0403

CONTAINMENT PRESSURES DATA CHECK

MANOMETER	UNCORRECTED READING (PSIA)	CORRECTED READING (PSIA)
PU-1	26.6110	26.6327
PU-2	26.0910	26.6247
PL-1	26.4804	26.6273
PL-2	26.7292	26.6498
PI-1	26.6323	26.6294
PI-2	25.9553	26.6366
AMBIENT	14.1760	14.4963

SUMMARY OF CORRECTED AVERAGE PRESSURES

AVERAGE UPPER PRESSURE (PSIA)	26.6287
AVERAGE LOWER PRESSURE (PSIA)	26.6385
AVERAGE ICE CONDENSER PRESSURE (PSIA)	26.6330
AVERAGE CONTAINMENT PRESSURE (PSIA)	26.6334
AVERAGE CONTAINMENT PRESSURE (PSIG)	12.1471

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
2 BROADWAY
NEW YORK

SUBJECT ILRT INSTRUMENT ERROR ANALYSIS
APPENDIX 'B' CONT'D.
ILRT COMPUTER PRINTOUT
RUN 64

2-P1-07
SHEET 17 OF 17
DATE 4/10/78 BY ______ CK ______
COMPANY I&M Power G.O.
PLANT D.C. COOK NUCLEAR

8.0 ILRT TABULATED SUMMARY

The following pages are tables listing the measured parameters and calculated values for the data taken during the Unit No. 2 Pre-Operational Containment ILRT.

8.1 Containment ILRT and Supplemental Test

Table 8.1.1	ILRT - Results of Linear Regression Analysis
Table 8.1.2	ILRT - Summary of Averages
Table 8.1.3	Supplemental Test - Results of Linear Regression Analysis
Table 8.1.4	Supplemental Test - Summary of Averages
Table 8.1.5	Computer Program Fixed Input Data

8.2 Parametric Case I

Table 8.2.1	Parametric Case I - Results of Linear Regression Analysis (ILRT)
Table 8.2.2	Parametric Case I - Summary of Averages (ILRT)
Table 8.2.3	Parametric Case I - Results of Linear Regression Analysis (Supplemental Test)
Table 8.2.4	Parametric Case I - Summary of Averages (Supplemental Test)
Table 8.2.5	Parametric Case I - Computer Program Fixed Input Data

8.3 Parametric Case II

Table 8.3.1	Parametric Case II - Results of Linear Regression Analysis (ILRT)
Table 8.3.2	Parametric Case II - Summary of Averages (ILRT)
Table 8.3.3	Parametric Case II - Results of Linear Regression Analysis (Supplemental Test)
Table 8.3.4	Parametric Case II - Summary of Averages (Supplemental Test)
Table 8.3.5	Parametric Case II - Computer Program Fixed Input Data

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

TABLE 8.1.1

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	0.99995	-2.80122	-0.11966	2.56190	1.00002	1.00000	0.99957
4	0.99992	-0.50648	-0.09618	0.31412	0.99996	1.00000	0.99959
5	0.99991	-0.25699	-0.07900	0.09900	0.99996	1.00002	0.99950
6	0.99982	-0.25426	-0.12688	0.00049	0.99981	1.00005	0.99936
7	0.99982	-0.21411	-0.13052	-0.04693	0.99977	1.00011	0.99944
8	0.99983	-0.17794	-0.11442	-0.05091	0.99981	1.00013	0.99926
9	0.99990	-0.14631	-0.07846	-0.01011	0.99993	1.00024	0.99912
10	0.99982	-0.12914	-0.07586	-0.02258	0.99978	1.00028	0.99910
11	0.99994	-0.10367	-0.04479	0.01409	0.99993	1.00042	0.99904
12	0.99983	-0.09464	-0.04634	0.00196	0.99981	1.00039	0.99890
13	0.99989	-0.07854	-0.03621	0.00612	0.99990	1.00044	0.99878
14	0.99982	-0.07417	-0.03820	-0.00222	0.99979	1.00054	0.99853
15	0.99984	-0.06707	-0.03607	-0.00507	0.99983	1.00061	0.99838
16	0.99988	-0.05772	-0.02965	-0.00158	0.99986	1.00067	0.99841
17	0.99986	-0.05096	-0.02595	-0.00095	0.99982	1.00073	0.99836
18	0.99987	-0.04518	-0.02272	-0.00026	0.99983	1.00075	0.99830
19	0.99999	-0.03541	-0.01045	0.01451	1.00000	1.00087	0.99826
20	0.99992	-0.02919	-0.00625	0.01668	0.99985	1.00101	0.99810
21	1.00009	-0.01911	0.00713	0.03337	1.00019	1.00104	0.99780
22	1.00007	-0.00996	0.01620	0.04236	1.00018	1.00106	0.99770
23	0.99997	-0.00607	0.01782	0.04171	1.00002	1.00110	0.99761
24	0.99984	-0.00999	0.01269	0.03537	0.99984	1.00110	0.99743
25	0.99993	-0.00842	0.01240	0.03322	0.99985	1.00125	0.99767
26	0.99993	-0.00688	0.01229	0.03146	0.99993	1.00115	0.99760
27	0.99985	-0.00920	0.00895	0.02710	0.99984	1.00121	0.99727
28	0.99981	-0.01275	0.00479	0.02232	0.99975	1.00127	0.99723
29	0.99984	-0.01430	0.00226	0.01882	0.99973	1.00137	0.99730
30	0.99985	-0.01501	0.00055	0.01611	0.99985	1.00137	0.99690
31	0.99984	-0.01586	-0.00119	0.01349	0.99976	1.00138	0.99717
32	0.99987	-0.01553	-0.00177	0.01198	0.99980	1.00144	0.99707
33	0.99987	-0.01512	-0.00221	0.01071	0.99981	1.00150	0.99695
34	0.99985	-0.01513	-0.00296	0.00922	0.99973	1.00166	0.99685
35	0.99990	-0.01406	-0.00258	0.00890	0.99982	1.00161	0.99689
36	0.99987	-0.01377	-0.00294	0.00790	0.99974	1.00168	0.99686
37	0.99983	-0.01432	-0.00400	0.00631	0.99972	1.00168	0.99666
38	0.99984	-0.01444	-0.00465	0.00515	0.99968	1.00171	0.99633
39	0.99976	-0.01624	-0.00666	0.00291	0.99954	1.00171	0.99653
40	0.99993	-0.01461	-0.00540	0.00380	0.99979	1.00180	0.99656
41	0.99993	-0.01313	-0.00429	0.00455	0.99980	1.00184	0.99672
42	0.99995	-0.01154	-0.00300	0.00555	0.99985	1.00187	0.99659
43	0.99982	-0.01195	-0.00376	0.00444	0.99969	1.00189	0.99634
44	0.99996	-0.01039	-0.00242	0.00555	0.99999	1.00175	0.99633
45	0.99991	-0.00958	-0.00194	0.00569	0.99984	1.00199	0.99615
46	0.99987	-0.00937	-0.00209	0.00521	0.99978	1.00197	0.99613
47	0.99988	-0.00901	-0.00203	0.00496	0.99980	1.00201	0.99611
48	0.99985	-0.00908	-0.00238	0.00432	0.99971	1.00202	0.99618
49	0.99994	-0.00814	-0.00166	0.00482	0.99990	1.00206	0.99598
50	0.99997	-0.00701	-0.00069	0.00563	0.99994	1.00211	0.99593
51	0.99995	-0.00613	-0.00001	0.00611	0.99990	1.00214	0.99588
52	0.99990	-0.00583	0.00005	0.00594	0.99965	1.00207	0.99508
53	0.99981	-0.00649	-0.00076	0.00497	0.99973	1.00208	0.99574
54	0.99979	-0.00728	-0.00167	0.00395	0.99966	1.00200	0.99587
55	0.99984	-0.00746	-0.00203	0.00340	0.99977	1.00211	0.99572
56	0.99993	-0.00681	-0.00165	0.00371	0.99985	1.00213	0.99596

TABLE 8.1.1

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
57	0.99989	-0.00655	-0.00148	0.00359	0.99979	1.00217	0.99584
58	0.99986	-0.00655	-0.00165	0.00325	0.99985	1.00213	0.99548
59	0.99985	-0.00661	-0.00187	0.00286	0.99984	1.00211	0.99552
60	0.99986	-0.00657	-0.00199	0.00259	0.99986	1.00214	0.99543
61	0.99975	-0.00753	-0.00296	0.00161	0.99972	1.00215	0.99518
62	0.99979	-0.00798	-0.00351	0.00095	0.99977	1.00210	0.99540
63	0.99980	-0.00829	-0.00394	0.00041	0.99977	1.00209	0.99549
64	0.99981	-0.00850	-0.00428	-0.00005	0.99981	1.00213	0.99533

FINAL LEAKAGE RATE (% PER DAY) = -0.00428   INTERCEPT= 0.99991

FINAL CONFIDENCE LIMITS FOR THE RATE ARE -0.00850 TO -0.00005

SUMMARY OF AVERAGES

TABLE 8.1.2

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	75.7610	26.7155	0.0979	80.1140	26.7272	0.2491	21.4759	26.7200	0.0408
2	0.50	75.7181	26.7134	0.1011	80.0734	26.7255	0.2510	21.5342	26.7182	0.0389
3	1.00	75.7048	26.7127	0.0973	80.0400	26.7247	0.2502	21.6289	26.7173	0.0411
4	1.50	75.6961	26.7108	0.0976	80.0108	26.7227	0.2495	21.6616	26.7154	0.0368
5	2.00	75.6691	26.7088	0.0970	79.9734	26.7207	0.2488	21.6018	26.7134	0.0406
6	2.50	75.6531	26.7068	0.0995	79.9292	26.7185	0.2480	21.5971	26.7113	0.0424
7	3.00	75.6328	26.7059	0.1009	79.9063	26.7174	0.2466	21.5540	26.7104	0.0417
8	3.50	75.6284	26.7045	0.0985	79.8699	26.7160	0.2452	21.6081	26.7090	0.0423
9	4.00	75.5933	26.7031	0.0959	79.8470	26.7148	0.2434	21.5707	26.7078	0.0468
10	4.50	75.5946	26.7014	0.0931	79.8059	26.7132	0.2427	21.6642	26.7046	0.0390
11	5.00	75.5595	26.7007	0.0950	79.7439	26.7122	0.2410	21.6936	26.7052	0.0395
12	5.50	75.5405	26.6983	0.0968	79.7364	26.7099	0.2399	21.7748	26.7029	0.0391
13	6.00	75.5247	26.6976	0.0945	79.7304	26.7092	0.2383	21.7477	26.7024	0.0408
14	6.50	75.5117	26.6967	0.0971	79.6899	26.7081	0.2366	21.8176	26.7016	0.0426
15	7.00	75.4997	26.6954	0.0953	79.6592	26.7071	0.2352	21.8280	26.7004	0.0450
16	7.50	75.4801	26.6945	0.0945	79.6390	26.7058	0.2334	21.8604	26.6992	0.0411
17	8.00	75.4577	26.6932	0.0954	79.6056	26.7044	0.2320	21.8304	26.6981	0.0430
18	8.50	75.4392	26.6917	0.0947	79.5895	26.7026	0.2303	21.9043	26.6964	0.0388
19	9.00	75.4148	26.6925	0.0921	79.5628	26.7034	0.2292	21.9037	26.6972	0.0437
20	9.50	75.4250	26.6922	0.0953	79.5294	26.7030	0.2268	21.9795	26.6967	0.0405
21	10.00	75.3828	26.6914	0.0874	79.5315	26.7022	0.2251	22.0417	26.6961	0.0443
22	10.50	75.3457	26.6858	0.0870	79.4914	26.6996	0.2241	22.0115	26.6935	0.0460
23	11.00	75.3337	26.6864	0.0896	79.4705	26.6972	0.2216	21.9982	26.6911	0.0468
24	11.50	75.3260	26.6840	0.0924	79.4450	26.6947	0.2204	22.0814	26.6887	0.0446
25	12.00	75.3012	26.6829	0.0921	79.3855	26.6936	0.2183	21.9782	26.6875	0.0426
26	12.50	75.3115	26.6809	0.0876	79.3979	26.6915	0.2180	21.9937	26.6855	0.0416
27	13.00	75.2391	26.6794	0.0921	79.3620	26.6901	0.2168	22.0898	26.6841	0.0438
28	13.50	75.2362	26.6767	0.0919	79.3200	26.6875	0.2147	22.0592	26.6815	0.0440
29	14.00	75.2257	26.6751	0.0913	79.3011	26.6876	0.2131	22.0837	26.6817	0.0408
30	14.50	75.1803	26.6749	0.0903	79.2893	26.6858	0.2117	22.1443	26.6793	0.0463
31	15.00	75.1792	26.6725	0.0903	79.2785	26.6839	0.2104	22.0824	26.6773	0.0400
32	15.50	75.1383	26.6719	0.0905	79.2488	26.6827	0.2088	22.0926	26.676.	0.0417
33	16.00	75.1273	26.6697	0.0887	79.2190	26.6813	0.2074	22.0909	26.6737	0.0419
34	16.50	75.1233	26.6696	0.0910	79.1434	26.6811	0.2066	22.1562	26.6724	0.0398
35	17.00	75.0912	26.6698	0.0905	79.1968	26.6811	0.2054	22.1463	26.6728	0.0395
36	17.50	75.0807	26.6679	0.0912	79.1611	26.6794	0.2036	22.0964	26.6710	0.0414
37	18.00	75.0622	26.6660	0.0906	79.1325	26.6771	0.2027	22.1236	26.6686	0.0423
38	18.50	75.0134	26.6641	0.0921	79.1167	26.6756	0.2012	22.0375	26.6672	0.0415
39	19.00	74.9931	26.6626	0.0953	79.1032	26.6737	0.2600	21.9937	26.6654	0.0423
40	19.50	74.9570	26.6614	0.0894	79.0640	26.6727	0.1985	22.0034	26.6647	0.0402
41	20.00	74.9467	26.6601	0.0883	79.0367	26.6712	0.1973	22.0488	26.6632	0.0398
42	20.50	74.9282	26.6594	0.0873	79.0239	26.6703	0.1957	22.0347	26.6628	0.0409
43	21.00	74.9261	26.6565	0.0886	78.9790	26.6673	0.1950	22.1255	26.6596	0.0420
44	21.50	74.8857	26.6563	0.0826	78.9681	26.6620	0.1937	22.1308	26.6596	0.0407
45	22.00	74.8479	26.6553	0.0873	78.9336	26.6658	0.1927	22.2404	26.6580	0.0394
46	22.50	74.8304	26.6534	0.0879	78.9245	26.6639	0.1921	22.1732	26.6550	0.0416
47	23.00	74.7978	26.6518	0.0876	78.8994	26.6626	0.1910	22.1524	26.6543	0.0414
48	23.50	74.7882	26.6510	0.0894	78.8722	26.6612	0.1905	22.1128	26.6576	0.0412
49	24.00	74.7344	26.6491	0.0853	78.8419	26.6593	0.1893	22.2005	26.6520	0.0400
50	24.50	74.7116	26.6498	0.0859	78.8307	26.6602	0.1891	22.2051	26.6519	0.0423
51	25.00	74.6970	26.6487	0.0866	78.7990	26.6588	0.1887	22.2204	26.6512	0.0403
52	25.50	74.7079	26.6461	0.0849	78.7984	26.6563	0.1881	22.1836	26.6485	0.0400
53	26.00	74.6547	26.6437	0.0883	78.7660	26.6541	0.1873	22.1807	26.6452	0.0419
54	26.50	74.6769	26.6431	0.0884	78.7394	26.6530	0.1874	22.1143	26.6475	0.0432

TABLE 8.1.2

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
55	27.00	74.6119	26.6419	0.0876	78.7088	26.6520	0.1871	22.1000	26.6464	0.0470
56	27.50	74.6039	26.6414	0.0850	73.6923	26.6515	0.1870	22.0341	26.6460	0.0437
57	28.00	74.5858	26.6399	0.0863	78.6604	26.6503	0.1863	22.1403	26.6445	0.0397
58	28.50	74.5466	26.6390	0.0848	73.6501	26.6404	0.1858	22.2620	26.6426	0.0407
59	29.00	74.5221	26.6360	0.0343	78.6117	26.6463	0.1861	22.2139	26.6406	0.0402
60	29.50	74.4790	26.6346	0.0843	78.5037	26.6449	0.1854	22.2056	26.6393	0.0418
61	30.00	74.4834	26.6333	0.0866	78.5577	26.6436	0.1852	22.2600	26.6380	0.0441
62	30.50	74.4345	26.6309	0.0855	78.5369	26.6413	0.1850	22.1477	26.6357	0.0423
63	31.00	74.4229	26.6297	0.0849	78.5235	26.6402	0.1849	22.1189	26.6337	0.0394
64	31.50	74.3793	26.6287	0.0848	78.4840	26.6385	0.1849	22.1650	26.6330	0.0403

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

TABLE 8.1.3

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	1.00006	-0.54203	0.13844	0.81890	1.00011	0.99994	1.00035
4	0.99992	-0.76060	-0.11720	0.52620	0.99994	0.99989	0.99965
5	0.99990	-0.44098	-0.15681	0.12736	0.99994	0.99985	0.99976
6	0.99908	-0.32775	-0.16493	-0.00212	0.99994	0.99982	0.99973
7	0.99982	-0.28566	-0.17743	-0.06920	0.99989	0.99980	0.99958
8	0.99984	-0.24081	-0.16031	-0.07981	0.99997	0.99950	0.99943
9	0.99983	-0.20964	-0.14649	-0.08334	0.99994	0.99976	0.99948
10	0.99971	-0.21543	-0.16210	-0.10877	0.99989	0.99972	0.99897
11	0.99965	-0.22139	-0.17532	-0.12925	0.99982	0.99970	0.99888
12	0.99969	-0.20781	-0.16925	-0.13069	0.99997	0.99969	0.99858
13	0.99951	-0.22868	-0.18836	-0.14804	0.99971	0.99964	0.99846
14	0.99945	-0.24249	-0.20341	-0.16433	0.99964	0.99956	0.99849
15	0.99949	-0.23682	-0.20327	-0.16973	0.99975	0.99951	0.99842
16	0.99955	-0.22475	-0.19293	-0.16110	0.99981	0.99950	0.99859
17	0.99946	-0.21837	-0.19029	-0.16222	0.99968	0.99953	0.99845

FINAL LEAKAGE RATE (% PER DAY) = -0.19029 INTERCEPT= 1.00007

FINAL CONFIDENCE LIMITS FOR THE RATE ARE -0.21837 TO -0.16222

SUMMARY OF AVERAGES

TABLE 8.1.4

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	74.3581	26.6254	0.0856	78.4707	26.6352	0.1843	22.2100	26.6298	0.0408
2	0.50	74.3350	26.6246	0.0852	78.4432	26.6341	0.1838	22.1365	26.6288	0.0394
3	1.00	74.2957	26.6228	0.0831	78.4376	26.6322	0.1844	22.1880	26.6258	0.0373
4	1.50	74.2916	26.6196	0.0846	78.4133	26.6290	0.1838	22.1995	26.6236	0.0391
5	2.00	74.2781	26.6171	0.0828	78.3895	26.6266	0.1837	22.1671	26.6211	0.0353
6	2.50	74.2324	26.6156	0.0837	78.3780	26.6252	0.1835	22.0954	26.6197	0.0444
7	3.00	74.1826	26.6140	0.0857	78.3563	26.6237	0.1836	22.1167	26.6181	0.0453
8	3.50	74.1790	26.6131	0.0831	78.3526	26.6230	0.1832	22.1902	26.6173	0.0446
9	4.00	74.1498	26.6107	0.0827	78.3162	26.6207	0.1837	22.2186	26.6150	0.0395
10	4.50	74.1513	26.6089	0.0823	78.3167	26.6189	0.1829	22.3961	26.6130	0.0413
11	5.00	74.1333	26.6072	0.0832	78.2894	26.6172	0.1831	22.4337	26.6114	0.0398
12	5.50	74.0741	26.6060	0.0811	78.2669	26.6162	0.1834	22.4628	26.6093	0.0433
13	6.00	74.1038	26.6035	0.0839	78.2557	26.6137	0.1828	22.5664	26.6076	0.0400
14	6.50	74.0515	26.6003	0.0853	78.2331	26.6105	0.1828	22.4832	26.6046	0.0408
15	7.00	74.0333	26.5970	0.0799	78.1996	26.6072	0.1826	22.4475	26.6012	0.0412
16	7.50	74.0031	26.5967	0.0796	78.1890	26.6067	0.1828	22.3761	26.6008	0.0402
17	8.00	74.0003	26.5955	0.0820	78.1547	26.6054	0.1826	22.4391	26.5997	0.0395

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

TABLE 8.1.5

RTD MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS

UPPER LOWER ICE

2.00 0.0 2.00 0.0 2.00 0.0

HYGROMETER MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS

UPPER LOWER-1

0.00227 3.87667 -99.49390 0.00234 3.86672 -99.14546

LOWER-2 ICE

0.00277 3.83471 -98.67056 0.00192 3.90355 -99.95728

MANOMETER PRESSURE CORRECTION COEFFICIENTS

PU-1

27.9573 27.9346 27.4580 27.4347 26.9581 26.9376 26.4596 26.4373 25.9603 25.9388

PU-2

27.9573 27.4035 27.4580 26.9099 26.9581 26.4208 26.4596 25.9277 25.9603 25.4322

PL-1

27.9573 27.8136 27.4580 27.3102 26.9581 26.8110 26.4596 26.3128 25.9603 25.8090

PL-2

27.9573 28.0288 27.4580 27.5317 26.9581 27.0359 26.4596 26.5400 25.9603 26.0427

PI-1

27.9573 27.9575 27.4580 27.4606 26.9501 26.9630 26.4596 26.4614 25.9603 25.9613

PI-2

27.9573 27.2318 27.4580 26.7394 26.9581 26.2529 26.4596 25.7604 25.9603 25.2719

P-ATM

16.4746 16.1106 14.9769 14.6549 13.4792 13.1928 11.9815 11.7310 10.4838 10.2681

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

.0750 .0750 .0725 .0725 .2213 .2766 .2071

VOLUME WEIGHTING FACTORS

UPPER LOWER ICE

2.0144 1.0000 0.4559

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

TABLE 8.2.1

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	0.99996	-2.90316	-0.10107	2.70602	1.00002	1.00000	0.99957
4	0.99992	-0.51050	-0.08309	0.34439	0.99996	1.00000	0.99959
5	0.99992	-0.25258	-0.06797	0.11664	0.99996	1.00002	0.99950
6	0.99982	-0.24932	-0.11742	0.01448	0.99981	1.00005	0.99936
7	0.99982	-0.21034	-0.12349	-0.03664	0.99977	1.00011	0.99944
8	0.99984	-0.17304	-0.10735	-0.04165	0.99981	1.00018	0.99926
9	0.99991	-0.14086	-0.07052	-0.00017	0.99993	1.00024	0.99912
10	0.99984	-0.12300	-0.06820	-0.01340	0.99978	1.00028	0.99910
11	0.99996	-0.09688	-0.03686	0.02316	0.99993	1.00042	0.99904
12	0.99985	-0.08729	-0.03808	0.01113	0.99981	1.00039	0.99860
13	0.99991	-0.07088	-0.02775	0.01539	0.99990	1.00044	0.99878
14	0.99984	-0.06599	-0.02936	0.00726	0.99979	1.00054	0.99853
15	0.99987	-0.05839	-0.02679	0.00432	0.99983	1.00061	0.99838
16	0.99991	-0.04887	-0.02025	0.00836	0.99986	1.00067	0.99841
17	0.99990	-0.04207	-0.01660	0.00887	0.99982	1.00073	0.99835
18	0.99990	-0.03629	-0.01345	0.00940	0.99983	1.00075	0.99830
19	1.00003	-0.02640	-0.00113	0.02415	1.00000	1.00087	0.99826
20	0.99996	-0.02011	0.00310	0.02632	0.99985	1.00101	0.99810
21	1.00013	-0.00983	0.01697	0.04377	1.00019	1.00104	0.99780
22	1.00012	-0.00042	0.02638	0.05317	1.00018	1.00106	0.99770
23	1.00002	0.00367	0.02815	0.05263	1.00002	1.00110	0.99761
24	0.99989	-0.00011	0.02307	0.04626	0.99984	1.00110	0.99743
25	0.99997	0.00131	0.02259	0.04387	0.99985	1.00125	0.99767
26	0.99998	0.00270	0.02230	0.04190	0.99993	1.00115	0.99760
27	0.99990	0.00039	0.01893	0.03748	0.99984	1.00121	0.99727
28	0.99986	-0.00324	0.01467	0.03259	0.99975	1.00127	0.99723
29	0.99989	-0.00497	0.01198	0.02893	0.99973	1.00137	0.99730
30	0.99991	-0.00559	0.01032	0.02623	0.99985	1.00137	0.99690
31	0.99989	-0.00563	0.00840	0.02343	0.99976	1.00138	0.99717
32	0.99993	-0.00641	0.00769	0.02178	0.99980	1.00144	0.99707
33	0.99995	-0.00608	0.00716	0.02040	0.99981	1.00150	0.99695
34	0.99991	-0.00616	0.00633	0.01881	0.99973	1.00156	0.99605
35	0.99996	-0.00518	0.00659	0.01835	0.99982	1.00161	0.99689
36	0.99993	-0.00502	0.00609	0.01721	0.99974	1.00168	0.99606
37	0.99989	-0.00566	0.00494	0.01553	0.99972	1.00168	0.99666
38	0.99990	-0.00595	0.00412	0.01419	0.99968	1.00171	0.99603
39	0.99982	-0.00800	0.00189	0.01178	0.99954	1.00171	0.99603
40	0.99999	-0.00649	0.00299	0.01246	0.99979	1.00180	0.99586
41	0.99999	-0.00510	0.00398	0.01305	0.99980	1.00184	0.99672
42	1.00002	-0.00356	0.00519	0.01393	0.99985	1.00189	0.99659
43	0.99990	-0.00403	0.00436	0.01276	0.99969	1.00189	0.99634
44	1.00003	-0.00249	0.00565	0.01380	0.99999	1.00175	0.99638
45	0.99999	-0.00169	0.00611	0.01391	0.99984	1.00199	0.99515
46	0.99994	-0.00153	0.00593	0.01338	0.99978	1.00197	0.99613
47	0.99996	-0.00120	0.00594	0.01308	0.99980	1.00201	0.99611
48	0.99992	-0.00136	0.00550	0.01235	0.99971	1.00202	0.99618
49	1.00002	-0.00044	0.00619	0.01281	0.99990	1.00205	0.99598
50	1.00005	0.00070	0.00715	0.01360	0.99994	1.00211	0.99558
51	1.00003	0.00155	0.00779	0.01403	0.99990	1.00214	0.99563
52	0.99998	0.00180	0.00779	0.01379	0.99995	1.00207	0.99588
53	0.99989	0.00107	0.00693	0.01278	0.99973	1.00203	0.99574
54	0.99987	0.00017	0.00592	0.01167	0.99966	1.00209	0.99587
55	0.99992	-0.00007	0.00549	0.01106	0.99977	1.00211	0.99572
56	1.00001	0.00050	0.00588	0.01125	0.99985	1.00213	0.99596

TABLE 8.2.1

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
57	0.99997	0.00067	0.00585	0.01104	0.99979	1.00217	0.99584
58	0.99995	0.00064	0.00565	0.01066	0.99935	1.00213	0.99543
59	0.99994	0.00053	0.00538	0.01022	0.99984	1.00211	0.99552
60	0.99995	0.00053	0.00522	0.00991	0.99986	1.00214	0.99543
61	0.99984	-0.00046	0.00422	0.00889	0.99972	1.00215	0.99518
62	0.99988	-0.00098	0.00360	0.00818	0.99977	1.00210	0.99540
63	0.99989	-0.00139	0.00309	0.00756	0.99977	1.00209	0.99549
64	0.99990	-0.00166	0.00270	0.00705	0.99981	1.00210	0.99533

FINAL LEAKAGE RATE (% PER DAY) = 0.00270 INTERCEPT= 0.99992

FINAL CONFIDENCE LIMITS FOR THE RATE ARE -0.00166 TO 0.00705

SUMMARY OF AVERAGES

TABLE 8.2.2

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	75.7610	26.7155	0.0979	80.1140	26.7272	0.2491	21.4759	26.7200	0.0403
2	0.50	75.7181	26.7134	0.1011	80.0734	26.7255	0.2510	21.5342	26.7182	0.0389
3	1.00	75.7048	26.7127	0.0973	80.0400	26.7247	0.2502	21.6209	26.7173	0.0411
4	1.50	75.6961	26.7108	0.0976	80.0108	26.7227	0.2495	21.6616	26.7154	0.0368
5	2.00	75.6691	26.7085	0.0970	79.9734	26.7207	0.2488	21.6018	26.7134	0.0406
6	2.50	75.6531	26.7068	0.0995	79.9292	26.7185	0.2480	21.5971	26.7113	0.0424
7	3.00	75.6328	26.7059	0.1009	79.9063	26.7174	0.2466	21.5540	26.7104	0.0417
8	3.50	75.6284	26.7045	0.0985	79.8699	26.7160	0.2452	21.6081	26.7090	0.0423
9	4.00	75.5933	26.7031	0.0959	79.8470	26.7148	0.2434	21.5707	26.7078	0.0468
10	4.50	75.5946	26.7014	0.0981	79.8059	26.7132	0.2427	21.6642	26.7046	0.0390
11	5.00	75.5595	26.7007	0.0950	79.7439	26.7122	0.2410	21.6936	26.7052	0.0395
12	5.50	75.5405	26.6983	0.0968	79.7364	26.7099	0.2399	21.7748	26.7029	0.0391
13	6.00	75.5247	26.6976	0.0945	79.7304	26.7092	0.2383	21.7477	26.7024	0.0408
14	6.50	75.5117	26.6967	0.0971	79.6899	26.7081	0.2366	21.8176	26.7016	0.0426
15	7.00	75.4907	26.6954	0.0953	79.6592	26.7071	0.2352	21.8080	26.7004	0.0450
16	7.50	75.4801	26.6945	0.0945	79.6390	26.7058	0.2334	21.8604	25.6992	0.0411
17	8.00	75.4577	26.6932	0.0954	79.6056	26.7044	0.2320	21.8304	26.6981	0.0430
18	8.50	75.4392	26.6917	0.0947	79.5895	26.7026	0.2303	21.9043	26.6964	0.0388
19	9.00	75.4148	26.6925	0.0921	79.5628	26.7034	0.2292	21.9037	26.6972	0.0407
20	9.50	75.4250	26.6922	0.0953	79.5294	26.7030	0.2268	21.9795	26.6967	0.0405
21	10.00	75.3828	26.6914	0.0874	79.5315	26.7022	0.2251	22.0417	26.6961	0.0443
22	10.50	75.3457	26.6888	0.0870	79.4914	26.6996	0.2241	22.0115	26.6935	0.0460
23	11.00	75.3337	26.6864	0.0896	79.4705	26.6972	0.2216	21.9982	26.6911	0.0468
24	11.50	75.3260	26.6840	0.0924	79.4450	26.6947	0.2204	22.0814	26.6887	0.0446
25	12.00	75.3012	26.6329	0.0921	79.3855	26.6936	0.2183	21.9762	26.6875	0.0426
26	12.50	75.3115	26.6809	0.0876	79.3979	26.6915	0.2180	21.9937	26.6855	0.0416
27	13.00	75.2391	26.6794	0.0921	79.3620	26.6901	0.2168	22.0898	26.6841	0.0438
28	13.50	75.2362	26.6767	0.0919	79.3200	26.6875	0.2147	22.0592	26.6015	0.0440
29	14.00	75.2257	26.6751	0.0913	79.3011	26.6876	0.2131	22.0387	26.6017	0.0408
30	14.50	75.1803	26.6749	0.0903	79.2398	26.6858	0.2117	22.1443	26.6790	0.0463
31	15.00	75.1792	26.6725	0.0903	79.2785	26.6839	0.2104	22.0824	26.6773	0.0400
32	15.50	75.1383	26.6719	0.0905	79.2488	26.6827	0.2088	22.0926	26.6767	0.0417
33	16.00	75.1273	26.6697	0.0887	79.2190	26.6813	0.2074	22.0909	26.6737	0.0419
34	16.50	75.1233	26.6696	0.0910	79.1434	26.6811	0.2066	22.1552	26.6724	0.0395
35	17.00	75.0912	26.6698	0.0905	79.1968	26.6811	0.2054	22.1463	26.6728	0.0395
36	17.50	75.0007	26.6679	0.0912	79.1611	26.6794	0.2036	22.0964	26.6710	0.0414
37	18.00	75.0622	26.6660	0.0906	79.1325	26.6771	0.2027	22.1236	26.6636	0.0428
38	18.50	75.0134	26.6641	0.0921	79.1167	26.6756	0.2012	22.0375	26.6672	0.0415
39	19.00	74.9931	26.6626	0.0953	79.1032	26.6737	0.2000	21.9937	26.6654	0.0423
40	19.50	74.9570	26.6614	0.0894	79.0640	26.6727	0.1985	22.0034	26.6647	0.0402
41	20.00	74.9467	26.6601	0.0883	79.0367	26.6712	0.1973	22.0483	26.6632	0.0358
42	20.50	74.9282	26.6594	0.0873	79.0239	26.6703	0.1957	22.0347	26.6628	0.0409
43	21.00	74.9261	25.6565	0.0886	78.9790	26.6673	0.1950	22.1255	26.6596	0.0420
44	21.50	74.8857	26.6563	0.0826	78.9581	26.6620	0.1937	22.1398	26.6596	0.0407
45	22.00	74.8479	26.6553	0.0873	78.9336	26.6658	0.1927	22.2404	26.6580	0.0394
46	22.50	74.8304	26.6534	0.0879	78.9245	26.6639	0.1921	22.1732	26.6560	0.0416
47	23.00	74.7978	26.6518	0.0876	78.8994	26.6626	0.1910	22.1524	26.6543	0.0414
48	23.50	74.7882	26.6510	0.0894	78.8722	26.6612	0.1905	22.1128	26.6535	0.0412
49	24.00	74.7344	26.6491	0.0853	78.8419	26.6593	0.1893	22.2005	26.6520	0.0400
50	24.50	74.7116	26.6498	0.0859	78.8307	26.6602	0.1891	22.2051	26.6519	0.0423
51	25.00	74.6970	26.6487	0.0866	78.7990	26.6588	0.1887	22.2294	26.6512	0.0403
52	25.50	74.7079	26.6461	0.0849	78.7904	26.6563	0.1881	22.1886	26.6485	0.0400
53	26.00	74.6547	26.6437	0.0883	78.7660	26.6541	0.1873	22.1807	26.6462	0.0419
54	26.50	74.6769	26.6431	0.0884	78.7394	26.6530	0.1874	22.1143	26.6475	0.0432

TABLE 8.2.2

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
55	27.00	74.6119	26.6419	0.0876	78.7088	26.6520	0.1871	22.1009	26.6464	0.0470
56	27.50	74.6089	26.6414	0.0850	78.6923	26.6515	0.1870	22.0341	26.6460	0.0437
57	28.00	74.5958	26.6399	0.0863	78.6604	26.6503	0.1863	22.1403	26.6445	0.0397
58	28.50	74.5466	26.6380	0.0848	78.6501	26.6484	0.1858	22.2620	26.6426	0.0407
59	29.00	74.5221	26.6360	0.0843	78.6117	26.6463	0.1861	22.2139	26.6406	0.0402
60	29.50	74.4790	26.6346	0.0843	78.5837	26.6449	0.1854	22.2056	26.6393	0.0418
61	30.00	74.4834	26.6333	0.0866	78.5577	26.6436	0.1852	22.2600	26.6380	0.0441
62	30.50	74.4345	26.6309	0.0855	78.5369	26.6413	0.1850	22.1477	26.6357	0.0423
63	31.00	74.4229	26.6297	0.0849	78.5235	26.6402	0.1849	22.1189	26.6337	0.0394
64	31.50	74.3793	26.6287	0.0848	78.4840	26.6385	0.1849	22.1650	26.6330	0.0403

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

TABLE 8.2.3

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	1.00005	-0.45871	0.13818	0.73507	1.00011	0.99994	1.00006
4	0.99992	-0.74812	-0.11433	0.51946	0.99994	0.99989	0.99985
5	0.99990	-0.43453	-0.15420	0.12613	0.99994	0.99935	0.99986
6	0.99988	-0.32182	-0.16131	-0.00080	0.99994	0.99982	0.99973
7	0.99983	-0.27945	-0.17293	-0.06541	0.99989	0.99980	0.99958
8	0.99955	-0.23439	-0.15443	-0.07446	0.99997	0.99980	0.99943
9	0.99983	-0.20346	-0.14076	-0.07805	0.99994	0.99976	0.99948
10	0.99972	-0.20683	-0.15466	-0.10249	0.99939	0.99972	0.99897
11	0.99967	-0.21201	-0.16715	-0.12230	0.99982	0.99970	0.99383
12	0.99971	-0.19770	-0.15971	-0.12172	0.99997	0.99969	0.99858
13	0.99953	-0.21818	-0.17849	-0.13879	0.99971	0.99964	0.95346
14	0.99947	-0.23268	-0.19386	-0.15505	0.99964	0.99956	0.99849
15	0.99951	-0.22724	-0.19391	-0.16057	0.99975	0.99951	0.99842
16	0.99956	-0.21551	-0.18416	-0.15280	0.99981	0.99950	0.99859
17	0.99948	-0.20959	-0.18199	-0.15439	0.99968	0.99953	0.99845

FINAL LEAKAGE RATE (% PER DAY) = -0.18199 INTERCEPT= 1.00007

FINAL CONFIDENCE LIMITS FOR THE RATE ARE -0.20959 TO -0.15439

SUMMARY OF AVERAGES

TABLE 8.2.4

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	74.3581	26.6254	0.0856	78.4707	26.6352	0.1843	22.2100	26.6298	0.0408
2	0.50	74.3350	26.6246	0.0852	78.4432	26.6341	0.1838	22.1365	26.6288	0.0394
3	1.00	74.2957	26.6228	0.0831	78.4376	26.6322	0.1844	22.1880	26.6268	0.0373
4	1.50	74.2916	26.6196	0.0846	78.4133	26.6290	0.1830	22.1995	26.6236	0.0391
5	2.00	74.2781	26.6171	0.0828	78.3395	26.6266	0.1837	22.1671	26.6211	0.0383
6	2.50	74.2324	26.6156	0.0837	78.3780	26.6252	0.1835	22.0954	26.6197	0.0444
7	3.00	74.1826	26.6140	0.0857	78.3563	26.6237	0.1836	22.1167	26.6181	0.0453
8	3.50	74.1790	26.6131	0.0831	78.3526	26.6230	0.1832	22.1902	26.6173	0.0446
9	4.00	74.1490	26.6107	0.0827	78.3162	26.6207	0.1837	22.2186	26.6150	0.0395
10	4.50	74.1513	26.6039	0.0823	78.3167	26.6189	0.1829	22.3961	26.6130	0.0413
11	5.00	74.1333	26.6072	0.0832	78.2894	26.6172	0.1831	22.4337	26.6114	0.0398
12	5.50	74.0741	26.6060	0.0811	78.2669	26.6162	0.1834	22.4628	26.6083	0.0433
13	6.00	74.1038	26.6035	0.0839	78.2557	26.6137	0.1828	22.5664	26.6076	0.0400
14	6.50	74.0515	26.6003	0.0853	78.2331	26.6105	0.1828	22.4832	26.6046	0.0403
15	7.00	74.0333	26.5970	0.0799	78.1996	26.6072	0.1826	22.4475	26.6012	0.0412
16	7.50	74.0031	26.5967	0.0796	78.1890	26.6067	0.1828	22.3761	26.6008	0.0402
17	8.00	74.0003	26.5955	0.0820	78.1547	26.6054	0.1826	22.4391	26.5997	0.0395

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

TABLE 8.2.5

RTD MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS

UPPER		LOWER		ICE	
2.00	0.0	2.00	0.0	2.00	0.0

HYGROMETER MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS

UPPER			LOWER-1		
0.00227	3.87667	-99.49390	0.00234	3.86672	-99.14546

LOWER-2			ICE		
0.00277	3.83471	-98.67056	0.00192	3.90355	-99.95728

MANOMETER PRESSURE CORRECTION COEFFICIENTS

PU-1

27.9573 27.9346 27.4580 27.4347 26.9581 26.9376 26.4596 26.4373 25.9603 25.9388

PU-2

27.9573 27.4035 27.4580 26.9099 26.9581 26.4208 26.4596 25.9277 25.9603 25.4322

PL-1

27.9573 27.8136 27.4580 27.3102 26.9581 26.8110 26.4596 26.3128 25.9603 25.8090

PL-2

27.9573 28.0288 27.4580 27.5317 26.9581 27.0359 26.4596 26.5400 25.9603 26.0427

PI-1

27.9573 27.9575 27.4580 27.4606 26.9581 26.9630 26.4596 26.4614 25.9603 25.9613

PI-2

27.9573 27.2318 27.4580 26.7394 26.9581 26.2529 26.4596 25.7604 25.9603 25.2719

P-ATM

16.4746 16.1106 14.9769 14.6549 13.4792 13.1928 11.9815 11.7310 10.4838 10.2681

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 .0265 .0586 .1037
.1037 .1037 .1037 .0500 .0092 .0244 .0145 .0170 .0249 .0219 .0240 .0423 .0

ICE

.0750 .0750 .0725 .0725 .2213 .2766 .2071

VOLUME WEIGHTING FACTORS

UPPER	LOWER	ICE
2.0144	1.0000	0.3933

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

TABLE 8.3.1

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	0.99995	-2.75821	-0.12714	2.50394	1.00002	1.00000	0.99957
4	0.99991	-0.50501	-0.10144	0.30212	0.99996	1.00000	0.99959
5	0.99991	-0.25888	-0.08343	0.09202	0.99996	1.00002	0.99950
6	0.99981	-0.25629	-0.13069	-0.00508	0.99981	1.00005	0.99936
7	0.99981	-0.21571	-0.13335	-0.05100	0.99977	1.00011	0.99944
8	0.99983	-0.17995	-0.11727	-0.05458	0.99981	1.00016	0.99926
9	0.99989	-0.14923	-0.08166	-0.01408	0.99993	1.00024	0.99912
10	0.99982	-0.13163	-0.07894	-0.02625	0.99978	1.00028	0.99910
11	0.99993	-0.10642	-0.04798	0.01046	0.99993	1.00042	0.99904
12	0.99982	-0.09761	-0.04966	-0.00172	0.99981	1.00039	0.99880
13	0.99988	-0.08163	-0.03961	0.00240	0.99990	1.00044	0.99878
14	0.99981	-0.07747	-0.04175	-0.00603	0.99979	1.00054	0.99853
15	0.99983	-0.07057	-0.03980	-0.00904	0.99983	1.00061	0.99838
16	0.99987	-0.06129	-0.03343	-0.00557	0.99986	1.00067	0.99841
17	0.99983	-0.05455	-0.02972	-0.00489	0.99982	1.00073	0.99835
18	0.99985	-0.04876	-0.02645	-0.00414	0.99983	1.00075	0.99830
19	0.99998	-0.03904	-0.01420	0.01064	1.00000	1.00087	0.99826
20	0.99991	-0.03284	-0.01002	0.01281	0.99985	1.00101	0.99810
21	1.00007	-0.02285	0.00317	0.02920	1.00019	1.00104	0.99790
22	1.00005	-0.01381	0.01210	0.03801	1.00018	1.00106	0.99770
23	0.99995	-0.00999	0.01367	0.03733	1.00002	1.00110	0.99761
24	0.99982	-0.01397	0.00852	0.03100	0.99984	1.00110	0.99743
25	0.99991	-0.01233	0.00830	0.02894	0.99985	1.00125	0.99767
26	0.99992	-0.01073	0.00826	0.02726	0.99993	1.00115	0.99760
27	0.99983	-0.01306	0.00493	0.02293	0.99984	1.00121	0.99727
28	0.99979	-0.01657	0.00081	0.01819	0.99975	1.00127	0.99723
29	0.99982	-0.01805	-0.00164	0.01476	0.99973	1.00137	0.99730
30	0.99983	-0.01880	-0.00338	0.01204	0.99985	1.00137	0.99690
31	0.99982	-0.01958	-0.00504	0.00949	0.99976	1.00138	0.99717
32	0.99985	-0.01920	-0.00558	0.00804	0.99980	1.00144	0.99707
33	0.99985	-0.01876	-0.00597	0.00682	0.99981	1.00150	0.99695
34	0.99983	-0.01874	-0.00669	0.00537	0.99973	1.00166	0.99685
35	0.99987	-0.01763	-0.00627	0.00510	0.99982	1.00161	0.99689
36	0.99984	-0.01730	-0.00657	0.00416	0.99974	1.00168	0.99686
37	0.99980	-0.01781	-0.00760	0.00261	0.99972	1.00168	0.99666
38	0.99982	-0.01786	-0.00817	0.00152	0.99968	1.00171	0.99683
39	0.99974	-0.01956	-0.01010	-0.00065	0.99954	1.00171	0.99683
40	0.99990	-0.01788	-0.00878	0.00032	0.99979	1.00180	0.99606
41	0.99990	-0.01637	-0.00761	0.00114	0.99980	1.00154	0.99672
42	0.99992	-0.01476	-0.00629	0.00219	0.99985	1.00189	0.99659
43	0.99980	-0.01514	-0.00702	0.00110	0.99969	1.00189	0.99634
44	0.99993	-0.01357	-0.00566	0.00224	0.99999	1.00175	0.99636
45	0.99983	-0.01276	-0.00519	0.00239	0.99984	1.00199	0.99615
46	0.99984	-0.01256	-0.00532	0.00193	0.99978	1.00197	0.99613
47	0.99985	-0.01216	-0.00523	0.00170	0.99980	1.00201	0.99611
48	0.99982	-0.01220	-0.00555	0.00110	0.99971	1.00202	0.99610
49	0.99990	-0.01125	-0.00482	0.00161	0.99990	1.00206	0.99598
50	0.99993	-0.01011	-0.00384	0.00244	0.99994	1.00211	0.99598
51	0.99992	-0.00923	-0.00315	0.00293	0.99990	1.00214	0.99588
52	0.99986	-0.00890	-0.00306	0.00278	0.99985	1.00207	0.99588
53	0.99978	-0.00954	-0.00395	0.00184	0.99973	1.00203	0.99574
54	0.99976	-0.01029	-0.00472	0.00085	0.99966	1.00208	0.99587
55	0.99981	-0.01043	-0.00506	0.00032	0.99977	1.00211	0.99572
56	0.99990	-0.00975	-0.00453	0.00068	0.99985	1.00213	0.99596

TABLE 8.3.1

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
57	0.99985	-0.00947	-0.00443	0.00060	0.99979	1.00217	0.99584
58	0.99982	-0.00945	-0.00459	0.00027	0.99985	1.00213	0.99548
59	0.99981	-0.00949	-0.00479	-0.00009	0.99984	1.00211	0.99552
60	0.99982	-0.00943	-0.00489	-0.00035	0.99986	1.00214	0.99543
61	0.99971	-0.01038	-0.00585	-0.00132	0.99972	1.00215	0.99518
62	0.99975	-0.01080	-0.00637	-0.00195	0.99977	1.00210	0.99540
63	0.99976	-0.01108	-0.00677	-0.00247	0.99977	1.00209	0.99549
64	0.99977	-0.01126	-0.00708	-0.00289	0.99981	1.00210	0.99533

FINAL LEAKAGE RATE (% PER DAY) = -0.00708 INTERCEPT= 0.99990

FINAL CONFIDENCE LIMITS FOR THE RATE ARE -0.01126 TO -0.00289

SUMMARY OF AVERAGES

TABLE 8.3.2

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	75.7010	26.7155	0.0979	80.1140	26.7272	0.2491	21.4759	26.7200	0.0408
2	0.50	75.7181	26.7134	0.1011	80.0734	26.7255	0.2510	21.5342	26.7182	0.0389
3	1.00	75.7048	26.7127	0.0973	80.0400	26.7247	0.2502	21.6289	26.7173	0.0411
4	1.50	75.6961	26.7108	0.0976	80.0108	26.7227	0.2495	21.6616	26.7154	0.0358
5	2.00	75.6691	26.7088	0.0970	79.9734	26.7207	0.2488	21.6018	26.7134	0.0406
6	2.50	75.6531	26.7068	0.0995	79.9292	26.7185	0.2480	21.5971	26.7113	0.0424
7	3.00	75.6328	26.7059	0.1009	79.9063	26.7174	0.2466	21.5549	26.7104	0.0417
8	3.50	75.6284	26.7045	0.0985	79.8699	26.7160	0.2452	21.6681	26.7090	0.0423
9	4.00	75.5933	26.7031	0.0959	79.8470	26.7148	0.2434	21.57[illegible]	26.7070	0.0468
10	4.50	75.5946	26.7014	0.0981	79.8059	26.7132	0.2427	21.6642	26.7046	0.0390
11	5.00	75.5595	26.7007	0.0950	79.7439	26.7122	0.2410	21.6936	26.7052	0.0395
12	5.50	75.5405	26.6983	0.0968	79.7364	26.7099	0.2399	21.7748	26.7029	0.0391
13	6.00	75.5247	26.6976	0.0945	79.7304	26.7092	0.2383	21.7477	26.7024	0.0408
14	6.50	75.5117	26.6967	0.0971	79.6899	26.7081	0.2366	21.8176	26.7016	0.0426
15	7.00	75.4997	26.6954	0.0953	79.6592	26.7071	0.2352	21.8280	26.7004	0.0450
16	7.50	75.4801	26.6945	0.0945	79.6390	26.7058	0.2334	21.8604	26.6992	0.0411
17	8.00	75.4577	26.6932	0.0954	79.6056	26.7044	0.2320	21.8304	26.6981	0.0430
18	8.50	75.4392	26.6917	0.0947	79.5895	26.7026	0.2303	21.9043	26.6964	0.0388
19	9.00	75.4148	26.6925	0.0921	79.5628	26.7034	0.2292	21.9037	26.6972	0.0407
20	9.50	75.4250	26.6922	0.0953	79.5294	26.7030	0.2268	21.9795	26.6967	0.0405
21	10.00	75.3828	26.6914	0.0874	79.5315	26.7022	0.2251	22.0417	26.6951	0.0443
22	10.50	75.3457	26.6888	0.0870	79.4914	26.6996	0.2241	22.0115	26.6935	0.0460
23	11.00	75.3337	26.6864	0.0896	79.4705	26.6972	0.2216	21.9982	26.6911	0.0468
24	11.50	75.3260	26.6840	0.0924	79.4450	26.6947	0.2204	22.0014	26.6887	0.0446
25	12.00	75.3012	26.6829	0.0921	79.3855	26.6936	0.2183	21.9782	26.6875	0.0426
26	12.50	75.3115	26.6809	0.0876	79.3979	26.6915	0.2180	21.9937	26.6855	0.0416
27	13.00	75.2391	26.6794	0.0921	79.3620	26.6901	0.2168	22.0398	26.6831	0.0438
28	13.50	75.2362	26.6767	0.0919	79.3200	26.6875	0.2147	22.0592	26.6815	0.0440
29	14.00	75.2257	26.6751	0.0913	79.3011	26.6876	0.2131	22.0887	26.6817	0.0408
30	14.50	75.1803	26.6749	0.0903	79.2898	26.6858	0.2117	22.1443	26.6798	0.0463
31	15.00	75.1792	26.6725	0.0903	79.2785	26.6839	0.2104	22.0824	26.6773	0.0400
32	15.50	75.1383	26.6719	0.0905	79.2483	26.6827	0.2088	22.0926	26.6767	0.0417
33	16.00	75.1273	26.6697	0.0887	79.2190	26.6813	0.2074	22.0909	26.6737	0.0419
34	16.50	75.1233	26.6696	0.0910	79.1434	26.6811	0.2066	22.1562	26.6724	0.0398
35	17.00	75.0912	26.6698	0.0905	79.1968	26.6811	0.2054	22.1463	26.6728	0.0395
36	17.50	75.0807	26.6679	0.0912	79.1611	26.6794	0.2036	22.0964	26.6710	0.0414
37	18.00	75.0622	26.6660	0.0906	79.1325	26.6771	0.2027	22.1236	26.6686	0.0428
38	18.50	75.0134	26.6641	0.0921	79.1167	26.6756	0.2012	22.0375	26.6672	0.0415
39	19.00	74.9931	26.6626	0.0953	79.1032	26.6737	0.2000	21.9937	26.6554	0.0423
40	19.50	74.9570	26.6614	0.0894	79.0640	26.6727	0.1985	22.0034	26.6647	0.0402
41	20.00	74.9467	26.6601	0.0883	79.0367	26.6712	0.1973	22.0488	26.6632	0.0398
42	20.50	74.9282	26.6594	0.0873	79.0239	26.6703	0.1957	22.0847	26.6628	0.0409
43	21.00	74.9261	26.6565	0.0886	73.9790	26.6673	0.1950	22.1255	26.6596	0.0420
44	21.50	74.8857	26.6563	0.0826	78.9681	26.6620	0.1937	22.1308	26.6596	0.0407
45	22.00	74.8479	26.6553	0.0873	78.9386	26.6658	0.1927	22.2404	26.6580	0.0394
46	22.50	74.8304	26.6534	0.0879	78.9245	26.6639	0.1921	22.1732	26.6550	0.0416
47	23.00	74.7978	26.6518	0.0876	78.8994	26.6626	0.1910	22.1524	26.6543	0.0414
48	23.50	74.7882	26.6510	0.0894	78.8722	26.6612	0.1905	22.1128	26.6536	0.0412
49	24.00	74.7344	26.6491	0.0853	78.8419	26.6593	0.1893	22.2005	26.6520	0.0430
50	24.50	74.7116	26.6498	0.0859	78.8307	26.6602	0.1891	22.2051	26.6519	0.0423
51	25.00	74.6970	26.6487	0.0866	78.7990	26.6588	0.1887	22.2284	26.6512	0.0403
52	25.50	74.7079	26.6461	0.0849	78.7984	26.6563	0.1881	22.1896	26.6435	0.0400
53	26.00	74.6547	26.6437	0.0883	78.7660	26.6541	0.1873	22.1307	26.6452	0.0419
54	26.50	74.6769	26.6431	0.0884	78.7394	26.6530	0.1874	22.1143	26.6475	0.0432

TABLE 8.3.2

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
55	27.00	74.6119	26.6419	0.0876	78.7088	26.6520	0.1871	22.1009	26.6464	0.0470
56	27.50	74.6089	26.6414	0.0850	78.6923	26.6515	0.1870	22.0341	26.6460	0.0437
57	28.00	74.5958	26.6399	0.0863	78.6604	26.6503	0.1863	22.1403	26.6445	0.0397
58	28.50	74.5466	26.6380	0.0848	78.6501	26.6484	0.1858	22.2620	26.6426	0.0407
59	29.00	74.5221	26.6360	0.0843	78.6117	26.6463	0.1861	22.2139	26.6406	0.0402
60	29.50	74.4790	26.6346	0.0843	78.5837	26.6449	0.1854	22.2056	26.6393	0.0418
61	30.00	74.4834	26.6333	0.0866	78.5577	26.6436	0.1852	22.2600	26.6380	0.0441
62	30.50	74.4345	26.6309	0.0855	78.5369	26.6413	0.1850	22.1477	26.6357	0.0423
63	31.00	74.4229	26.6297	0.0849	78.5235	26.6402	0.1849	22.1189	26.6337	0.0394
64	31.50	74.3793	26.6287	0.0848	78.4840	26.6385	0.1849	22.1650	26.6330	0.0403

RESULTS OF THE LINEAR REGRESSION ANALYSIS TEST

TABLE 8.3.3

RUN #	W EXPERIMENTAL	LEAKAGE RATE LOWER LIMIT	LEAKAGE RATE	LEAKAGE RATE UPPER LIMIT	W UPPER CONTAINMENT	W LOWER CONTAINMENT	W ICE CONDENSER
3	1.00006	-0.57554	0.13854	0.85262	1.00011	0.99994	1.00006
4	0.99991	-0.76568	-0.11836	0.52396	0.99994	0.99989	0.99985
5	0.99990	-0.44361	-0.15787	0.12787	0.99994	0.99985	[illegible]
6	0.99987	-0.33015	-0.16639	-0.00263	0.99994	0.99982	0.99973
7	0.99982	-0.28018	-0.17925	-0.07031	0.99989	0.99980	0.99958
8	0.99984	-0.24342	-0.16268	-0.08193	0.99997	0.99980	0.99943
9	0.99982	-0.21215	-0.14830	-0.08545	0.99994	0.99976	0.99948
10	0.99970	-0.21893	-0.16509	-0.11126	0.99989	0.99972	0.99897
11	0.99965	-0.22520	-0.17861	-0.13202	0.99982	0.99970	0.99339
12	0.99968	-0.21193	-0.17309	-0.13426	0.99997	0.99969	0.99858
13	0.99950	-0.23294	-0.19233	-0.15172	0.99971	0.99964	0.99846
14	0.99944	-0.24646	-0.20725	-0.16804	0.99964	0.99956	0.99849
15	0.99948	-0.24070	-0.20704	-0.17337	0.99975	0.99951	0.99842
16	0.99954	-0.22849	-0.19645	-0.16442	0.99981	0.99950	0.99859
17	0.99945	-0.22192	-0.19364	-0.16535	0.99968	0.99953	0.99845

FINAL LEAKAGE RATE (% PER DAY) = -0.19364 INTERCEPT= 1.00007

FINAL CONFIDENCE LIMITS FOR THE RATE ARE -0.22192 TO -0.16535

SUMMARY OF AVERAGES

TABLE 8.3.4

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	74.3581	26.6254	0.0856	78.4707	26.6352	0.1843	22.2100	26.6298	0.0408
2	0.50	74.3350	26.6246	0.0852	78.4432	26.6341	0.1838	22.1365	26.6288	0.0394
3	1.00	74.2957	26.6228	0.0831	78.4376	26.6322	0.1844	22.1880	26.6268	0.0373
4	1.50	74.2916	26.6196	0.0846	78.4133	26.6290	0.1838	22.1995	26.6236	0.0391
5	2.00	74.2781	26.6171	0.0828	78.3395	26.6266	0.1837	22.1671	26.6211	0.0383
6	2.50	74.2324	26.6156	0.0837	78.3780	26.6252	0.1835	22.0954	26.6197	0.0444
7	3.00	74.1826	26.6140	0.0857	78.3563	26.6237	0.1836	22.1167	26.6181	0.0453
8	3.50	74.1790	26.6131	0.0831	78.3526	26.6230	0.1832	22.1902	26.6173	0.0446
9	4.00	74.1498	26.6107	0.0827	78.3162	26.6207	0.1837	22.2186	26.6150	0.0395
10	4.50	74.1513	26.6089	0.0823	78.3167	26.6189	0.1829	22.3961	26.6130	0.0413
11	5.00	74.1333	26.6072	0.0832	78.2894	26.6172	0.1831	22.4337	26.6114	0.0398
12	5.50	74.0741	26.6060	0.0811	78.2669	26.6162	0.1834	22.4628	26.6083	0.0433
13	6.00	74.1038	26.6035	0.0839	78.2557	26.6137	0.1828	22.5664	26.6076	0.0400
14	6.50	74.0515	26.6003	0.0853	78.2331	26.6105	0.1828	22.4832	26.6046	0.0408
15	7.00	74.0333	26.5970	0.0799	78.1996	26.6072	0.1826	22.4475	26.6012	0.0412
16	7.50	74.0031	26.5967	0.0796	78.1890	26.6067	0.1828	22.3761	26.6008	0.0402
17	8.00	74.0003	26.5955	0.0820	78.1547	26.6054	0.1826	22.4391	26.5997	0.0395

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

TABLE 8.3.5

RTD MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS

UPPER		LOWER		ICE	
2.00	0.0	2.00	0.0	2.00	0.0

HYGROMETER MILLI-VOLT TO FAHRENHEIT CONVERSION COEFFICIENTS

UPPER			LOWER-1		
0.00227	3.87667	-99.49390	0.00234	3.86672	-99.14546

LOWER-2			ICE		
0.00277	3.83471	-98.67056	0.00192	3.90355	-99.95728

MANOMETER PRESSURE CORRECTION COEFFICIENTS

PU-1

27.9573 27.9346 27.4580 27.4347 26.9581 26.9376 26.4596 26.4373 25.9603 25.9388

PU-2

27.9573 27.4035 27.4580 26.9099 26.9581 26.4208 26.4596 25.9277 25.9603 25.4322

PL-1

27.9573 27.8136 27.4580 27.3102 26.9581 26.8110 26.4596 26.3128 25.9603 25.8090

PL-2

27.9573 28.0288 27.4580 27.5317 26.9581 27.0359 26.4596 26.5400 25.9603 26.0427

PI-1

27.9573 27.9575 27.4580 27.4606 26.9581 26.9630 26.4596 26.4614 25.9603 25.9613

PI-2

27.9573 27.2318 27.4580 26.7394 26.9581 26.2529 26.4596 25.7604 25.9603 25.2719

P-ATM

16.4746 16.1106 14.9769 14.6549 13.4792 13.1928 11.9815 11.7310 10.4838 10.2681

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

.0750 .0750 .0725 .0725 .2213 .2766 .2071

VOLUME WEIGHTING FACTORS

UPPER	LOWER	ICE
2.0144	1.0000	0.4818

9.0 LOCAL LEAK TEST PROGRAM

A local leak test program was conducted in accordance with guidelines specified in 10CFR 50 Appendix 'J', FSAR, and Technical Specifications, under AEPSC written and I&M approved procedures, 2 PO-033-330 "Containment Penetration and Personnel Lock (Type 'B') Leak Test" and 2 PO-033-332 "Containment Isolation Valve (Type 'C') Leak Test". These tests were conducted as a prerequisite to the Integrated Leak Rate Test to systematically verify acceptable leakage across each containment penetration and pressure containing boundary. The program consisted of Type 'B' tests designed to determine leakage through the containment penetrations, air lock door seals, lock cover flange seal, ring body flange seal and overall air lock leakage, as well as Type 'C' tests designed to determine leakage across isolation valves.

The leakage detection instrumentation used in the conduct of the Type 'B' and 'C' tests were calibrated prior to the tests and are certified traceable to NBS. These instruments (Volumetrics Leak Rate Monitor) are self contained mass flow leak test systems capable of measuring small gaseous leak rates. The monitor pressurized the test volume to a predetermined setpoint (12.0 PSIG). After test pressure is attained precise pressure regulators, internal to the instrument, maintain the pressure setpoint by adding air through a thermal flow sensor. Since the test volume pressure remains constant during the test the amount of air leakage is equal to the amount of air added. This leak rate is electronically converted and displayed on a digital rate meter.

9.0 LOCAL LEAK TEST PROGRAM (Cont'd)

The following Type 'B' and 'C' penetrations were tested in the manner described above with the measured leakage rates as listed below:

	Measured Leakage	Acceptance Criteria
9.1 Personnel Air Lock (612)		
9.1.1 No simulated pressure force.		
Inner Seal	0.0 L_a	$\leq$ 0.5 L_a
Outer Seal	0.0 L_a	$\leq$ 0.5 L_a
9.1.2 With simulated pressure force.		
Inner Seal	0.0 L_a	$\leq$ 0.0005 L_a
Outer Seal	0.0 L_a	$\leq$ 0.0005 L_a
9.1.3 Overall leak rate	0.0 L_a	$\leq$ 0.05 L_a
9.2 Personnel Air Lock (650)		
9.2.1 No simulated pressure force.		
Inner Seal	0.0 L_a	$\leq$ 0.5 L_a
Outer Seal	0.0 L_a	$\leq$ 0.5 L_a
9.2.2 With simulated pressure force.		
Inner Seal	0.0 L_a	$\leq$ 0.0005 L_a
Outer Seal	0.0 L_a	$\leq$ 0.0005 L_a
9.2.3 Overall Leak Rate	0.0 L_a	$\leq$ 0.05 L_a
9.2.4 Cover Flange	1.0 SCCM	N/A
9.2.5 Ring Body Flange	0.0 SCCM	N/A

		Measured Leakage	Acceptance Criteria
9.3	Containment Penetrations	0.0 L_a	$\leq$ 0.157 L_a
9.4	Containment Isolation Valves (Total Leakage)	0.178 L_a	$\leq$ 0.443 L_a

Initial Type 'B' testing of the containment penetration pressurization system, Item 9.3 above, resulted in a leakage rate of 5,330 SCCM (0.048 L_a) which is well within the allotted allowable leakage rate. The origin of this leak was traced to containment penetrations CPN-6 and CPN-51. Examination of these penetrations revealed the expansion bellows, located outside the containment, were cracked in each case. Upon repair, both containment penetrations were re-tested by the local Type 'B' test method and found to have zero leakage. It should be noted that, while repair and re-test of the damaged expansion bellows was performed after performance of the containment ILRT, no action was taken to isolate the affected penetrations from the containment ILRT test pressure. Moreover, it is a prerequisite of the ILRT procedure to vent to containment atmosphere all interval zones of the containment weld channel system.

Table 9.4.1 is provided for an individual accounting of the containment isolation valve leak rates reported as total leakage in Item 9.4 above. In this table each valve is identified by tag number, valve diameter, allowable leakage and actual leakage as measured during the pre-operation leak test. The individual allowable leakage values were determined by allocating a portion of the total allowable leakage based on valve size (diameter). The allowable leakage values were determined as a guideline to enable the test engineer to decide which valves should be repaired, if necessary, to meet the total allowable leakage value of 48,827 SCCM (0.443 L_a).

Referring to Table 9.4.1 it can be seen that for some instances the "actual leakage" measured has exceeded its associated guideline "allowable leakage" limit. The local leak rate test, however, was considered acceptable because as per 10CFR 50, Appendix 'J', the combined leakage for all Type 'B' and 'C' tests must be less than the allowable limit of 0.6 L_a. A review of the test results indicates that the total actual leakage measured for both Type 'B' and 'C' leak rate tests was equal to 0.178 L_a or only 29.7 per cent of the allowable limit.

In addition to the valves and penetrations subjected to the Type 'B' and 'C' local leak rate tests as required in 10CFR 50; Appendix 'J', the spray header check valves associated with the Containment Spray System were leak tested in accordance with FSAR Question 022.15 (4). As specified by the NRC, the acceptance criteria for each check valve is such that the water inventory normally resident in the associated spray header shall not leak out within a thirty (30) day period. In response to this requirement, the volume of water resident in the spray headers was calculated from isometric drawings and the leak tests performed with the following results:

9.0 LOCAL LEAK TEST PROGRAM (Cont'd)

Check Valve	Measured Leakage $CM^3/MIN.$	Allowable Leakage $CM^3/MIN.$
CTS 127W	16.00	21.88
CTS 127E	5.00	23.38
CTS 131W	1.37	3.00
CTS 131E	1.83	3.73

9.0 LOCAL LEAK TEST PROGRAM

TABLE 9.4.1

VALVE I.D.	VALVE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (SCCM)	ACTUAL LEAKAGE (SCCM)
CPN-1 (Blind Flge.)	20.0	1240	100
CS 442-1	2.0	124	540
CS 442-2	2.0	124	204
CS 442-3	2.0	124	145
CS 442-4	2.0	124	157
SI-189	4.0	248	657
WCR-901	6.0	372	0
NSW 415-1	6.0	372	500
WCR-902; WCR-903	6.0	744	1
WCR-905	6.0	372	74
NSW-415-2	6.0	372	1581
WCR-906; WCR-907	6.0	744	49
WCR-909	6.0	372	3
NSW 415-3	6.0	372	516
WCR-910; WCR-911	6.0	744	8
WCR-913	6.0	372	100
NSW 415-4	6.0	372	45
WCR-914; WCR-915	6.0	744	13
WCR-921	3.0	372	77
NSW 419-1	3.0	372	2
WCR-922; WCR-923	3.0	744	78
WCR-945; WCR-951	3.0	744	114

9.0 LOCAL LEAK TEST PROGRAM

TABLE 9.4.1

VALVE I.D.	VALVE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (SCCM)	ACTUAL LEAKAGE (SCCM)
WCR-955; NSW 244-1	3.0	744	612
WCR-925	3.0	372	3
NSW 419-2	3.0	372	2
WCR-926; WCR-927	3.0	744	153
WCR-946; WCR-952	3.0	744	60
WCR-956; NSW 244-2	3.0	744	308
XCR-102; XCR-103	0.75	93	265
PA 243	2.0	248	106
NPX 151-V1	0.5	31	7
DCR-203; DCR-207	0.75; 1.0	93	10
DCR-201; N 160	0.75; 1.0	124	231
DCR-610; DCR-611	2.5	310	10
DCR-620; DCR-621	1.0	124	6
SM-1	1.0	62	742
GCR-314	1.0	62	12
N102	1.0	62	159
ECR-31; ECR-32	1.0	124	183
SI 171; SI 172; SI 194	0.75	139.5	1
NCR-252	3.0	186	21
PW 275	3.0	186	9
CS 321	3.0	186	34
QCR-300	2.0	124	5

9.0 LOCAL LEAK TEST PROGRAM

TABLE 9.4.1

VALVE I.D.	VALVE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (SCCM)	ACTUAL LEAKAGE (SCCM)
DW 211; DW 212	2.0	248	4
SF 152; SF 154	1.5	186	47
QCM-250; QCM-350	4.0	496	56
CCM-458; CCM-454; CCM-452	8.0; 4.0 8.0	1240	504
CCM-459; CCM-453 CCM-451	8.0; 4.0 8.0	1240	56
DCR-205; DCR-206	4.0	496	18
DCR-600; DCR-601	3.0	372	100
SF 159; SF 160	3.0	372	19
ICM-265	4.0	248	165
ICM-305	18.0	168	75
ICM-306	18.0	168	85
VCR-10; VCR-11	3.0	372	145
VCR-20; VCR-21	3.0	372	58
CPN-57 (Blind Flge.)	4.0	496	100
VCR-105; VCR-205	30.0	3720	0
VCR-106; VCR-206	24.0	2976	0
VCR-101; VCR-201	14.0	1736	2
VCR-102; VCR-202	14.0	1736	100
VCR-104; VCR-204	30.0	3720	100
VCR-103; VCR-203	24.0	2976	0
VCR-107; VCR-207	12.0	1488	0

9.0 LOCAL LEAK TEST PROGRAM

TABLE 9.4.1

VALVE I.D.	VALVE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (SCCM)	ACTUAL LEAKAGE (SCCM)
NCR-109; NCR-110	0.5	62	1
NCR-107; NCR-108	0.5	62	2
NCR-105; NCR-106	0.5	62	2
WCR-961; WCR-963	2.0	248	274
WCR-965; WCR-967	2.0	248	6
NSW-417-4; WCR-962	2.0	248	900
NSW-417-3; WCR-966	2.0	248	586
XCR-100; SCR-101	0.75	93	4
N-159	0.75	46.5	8
GCR-301	0.75	46.5	30
CCR-460; CCR-462	3.0	372	105
CPN-76 (Blind Flge.)	8.0	992	129
CPN-80 (Blind Flge.)	6.0	744	100
RCR-100; RCR-101	0.375	46.5	7
DCR-202; DCR-204	0.75	93	30
ICR-5; ICR-6	0.5	62	1
CCR-457; CCW-135	2.0	248	94
CCR-455; CCR-456	2.0	248	37
CA-181N	0.5	31	51
CA-181S	0.5	31	64
WCR-948; WCR-954	3.0	372	1500
WCR-958; NSW-244-4	3.0	372	298

9.0 LOCAL LEAK TEST PROGRAM

TABLE 9.4.1

VALVE I.D.	VALVE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (SCCM)	ACTUAL LEAKAGE (SCCM)
WCR-933	3.0	186	33
NSW-419-4	3.0	186	1
ICM-260	4.0	248	45
WCR-934; WCR-935	3.0	372	1100
WCR-929	3.0	186	1
NSW-419-3	3.0	186	84
WCR-930; WCR-931	3.0	372	114
WCR-947; WCR-953	3.0	372	2100
WCR-957; NSW-244-3	3.0	372	157
SM-8; SM-10	0.5	62	2
PPP-302	0.5	31	3
PPP-301	0.5	31	3
SM-4; SM-6	0.5	62	2
ECR-11; ECR-21	0.5	62	3
ECR-12; ECR-22	0.5	62	3
ECR-13; ECR-23	0.5	62	0
ECR-15; ECR-25	0.5	62	6
ECR-14; ECR-24	0.5	62	2
ECR-16; ECR-26	0.5	62	2
ECR-17; ECR-27	0.5	62	1
ECR-18; ECR-28	0.5	62	47
ECR-19; ECR-29	0.5	62	3

9.0 LOCAL LEAK TEST PROGRAM

TABLE 9.4.1

VALVE I.D.	VALVE DIAMETER (INCHES)	ALLOWABLE LEAKAGE (SCCM)	ACTUAL LEAKAGE (SCCM)
ECR-10; ECR-20	0.5	62	7
PPP-300	0.5	31	5
PPP-303	0.5	31	23
PPA-310; PPA-311	0.5	62	7
PPA-312; PPA-313	0.5	62	29
ICM-250	4.0	248	63
ICM-251	4.0	248	264
CPN-67 (Blind Flge.)	2.0	124	100
ECR-33	0.75	46.5	1600

10.0 REFERENCES

10.1 D. C. Cook Nuclear Plant
Final Safety Analysis Report

10.1.1 Initial Leakage Rate Testing of Containment.
Section 5.2.1

10.1.2 Initial Containment (Pre-Operational) Leakage Rate Test.
Section 5.7.2

10.1.3 Containment Leakage Test Program.
FSAR Question 5.93

10.1.4 Containment Integrated Leak Rate (Type 'A') Test Program and Surveillance Requirements.
FSAR Appendix 'Q' Question 022.6

10.1.5 Local Leak Rate (Type 'B' and 'C') Test Program and Surveillance Requirements.
FSAR Appendix 'Q' Question 022.7

10.1.6 Containment Integrated Leak Rate (Type'A') Testing.
FSAR Appendix 'Q' Question 022.14

10.1.7 Local Leak Rate (Type 'B' and 'C') Testing.
FSAR Appendix 'Q' Question 022.15

10.2 D. C. Cook Nuclear Plant - Unit No. 2
Technical Specifications.

10.2.1 Containment Systems - Containment Leakage
Specification: 3.6.1.2
Surveillance: Requirement 4.6.1.2

10.0 REFERENCES (Cont'd)

10.2.2 Containment Systems - Containment Air Locks.
Specification: 3.6.1.3
Surveillance Requirement: 4.6.1.3

10.3 American National Standard - ANSI, N45.4-1972 Leakage-Rate Testing of Containment Structures for Nuclear Reactors.

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

10.5 Basic Statistical Methods for Engineers and Scientists - A. M. Neville J. B. Kennedy

10.6 Hygrometric and Psychrometric Tables
Smithsonian Institution

10.7 D. C. Cook Nuclear Plant - Unit No. 2
Pre-Operational Test Procedures.

10.7.1 Containment Penetration and Personnel Lock (Type 'B') Leak Test.
2 PO-033-330

10.7.2 Containment Isolation Valve (Type 'C') Leak Test.
2 PO-033-332

10.7.3 Containment Integrated (Type 'A') Leak Rate Test.
2 PO-033-334

Unit 1

92043 ④

Sub vol	WF
1	0.01031
2	0.01746
3	0.04130
4	0.09628
5	0.14063
6	0.01797
7	0.25769
8	0.41836

Data set #	$\bar{T}$ method °R	$\frac{1}{T}$ method °R
2	556.41	556.10
4	556.45	556.137
42	556.91	556.57
86	557.24	556.90
142	557.69	557.33

Unit 1 1982 CILRT

# Rtds	Subvolumes	Max temp	Min temp	ΔT
2	1	115.3	113.6	1.7
2	2	119.5	117.2	2.3
4	3	120.9	113.8	7.1
4	4	115.2	109.00	6.2
4	5	108.8	105.6	3.2
4	6	104.9	90.6	14.3
4	7	107.9	104.1	3.3
6	8	83.00	80.3	2.7
30				

Max ΔT = 120.9 - 80.3 = 40.6 between subvolumes 3 & 8.

~~[illegible]~~

~~[illegible]~~

~~[illegible]~~

~~557.24~~

Bob Koenig 242

PT-PC-201 evaluation

AIR 1-83-354 verify closure

Deficiencies #90, 91, 92, 103, 106, + 107
112, 118 and 119, 113, 114, 115,
116, 117, 121, 120, 122

no PE involvement { 23, 29, 109 } check on 108, 109

P_{ac} → 39.6 psig & Personnel hatch seals @ 10 psig

item to look for
83-23-03 NC failure to follow procedure
a) spool piece
b) log of events
83-23-04 tagging of TIPS valve

H_2 Recombiners 15.6 psig ?

~~Deficiencies~~
~~53, 58, 62, 63~~

Data sets 123 - 125 not related

1983 CILRT

Unit 2

# RTD's	Subvolumes	Max temp	Min temp	ΔT
2	1	93.65	90.12	3.53
2	2	85.11	84.44	0.62
4	3	88.83	84.95	3.88
4	4	86.07	84.25	1.82
4	5	84.95	83.94	1.01
4	6	83.5	82.30	1.20
3	7	84.21	83.48	0.73
5	8	86.56	84.33	2.23
28				

Max ΔT = 93.65 - 82.30 = 11.35 between subvolumes 1 & 6.

2

.000018
.0000482
.0001198
.0002884
.0005368
.0005691
.0010255
.005

42

.000[illegible]
.0000481
.0001196
.0002879
.000536
.0005683
.001024
.0017967

142

.0000179
.000048
.0001194
.0002873
.0005348
.000567
.0010217
.0017943

41

.00019
.0000482
.0001198
.00028[illegible]3
.0005368
.000569
.0010254
.0017981

86

.0000481
.0001195
.0002876
.0005354
.0005676
.001023
.00

INDUCED LEAK-RATE CALCULATION
SUPPLEMENT TO ATTACHMENT U

$$LO = LM * \left(\frac{PM * TC}{PC * TM} \right)^{1/2}$$

LM = 405 SCFH

PM = 20.4 psig + 14.26

TC = 80°F + 459.69°R

PC = 40 psig + 14.69

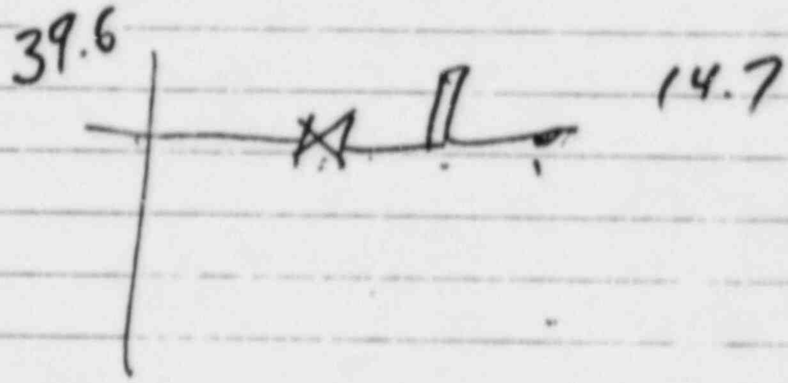
TM = 544.6 °R

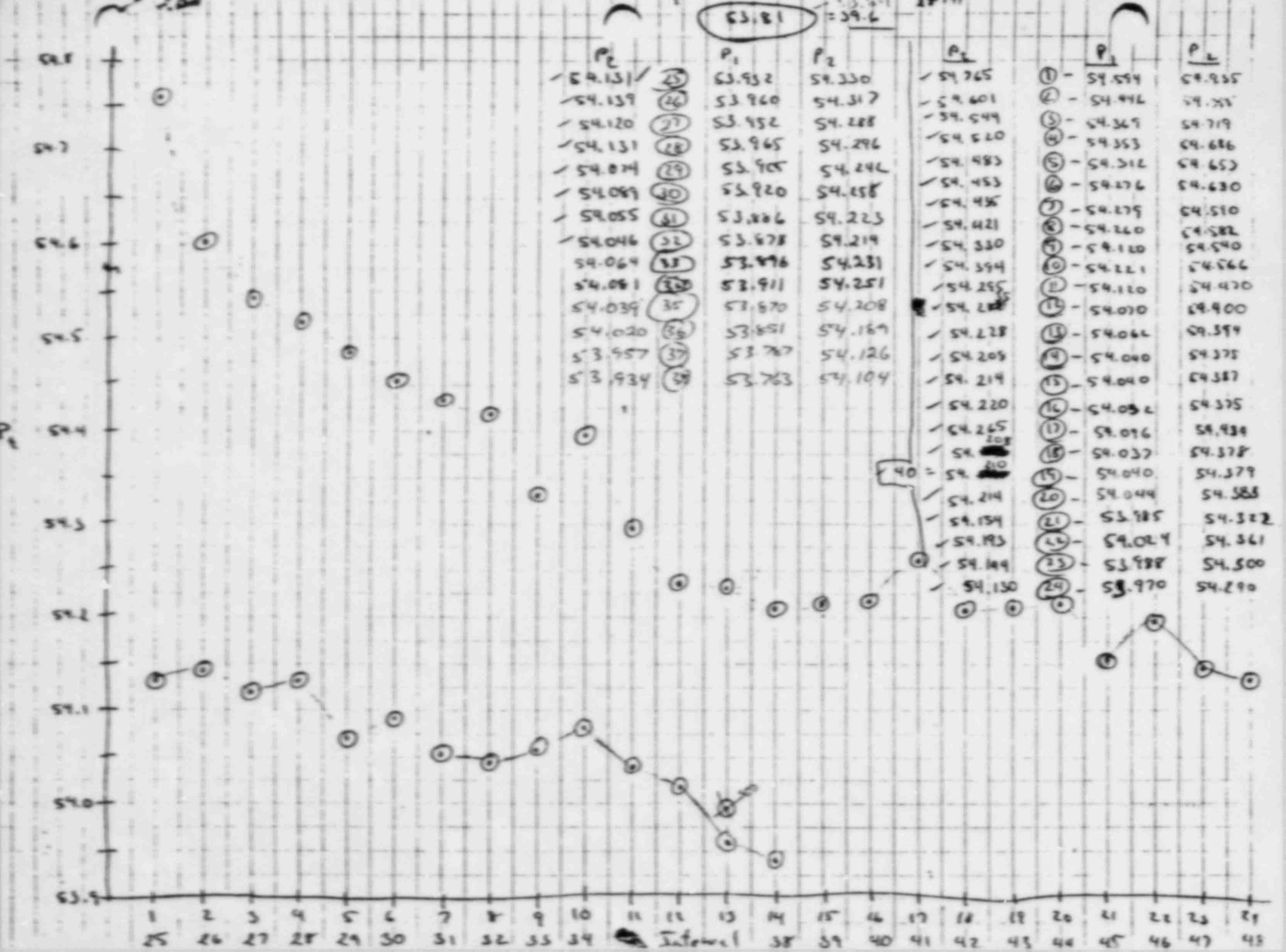
$$LO = 405 * \left(\frac{34.66 * 539.69}{54.69 * 544.6} \right)^{1/2}$$

$$= 405 * (.79248)$$

$$= 320.96 \text{ SCFH}$$

L_o = 5.349 SCFM


39.6
14.7



(53.81) = 39.6

P_t		P_1	P_2
54.131	(25)	53.932	54.330
54.139	(26)	53.960	54.317
54.120	(27)	53.952	54.288
54.131	(28)	53.965	54.296
54.074	(29)	53.905	54.242
54.089	(30)	53.920	54.258
54.055	(31)	53.886	54.223
54.046	(32)	53.878	54.219
54.064	(33)	53.896	54.231
54.081	(34)	53.911	54.251
54.039	(35)	53.870	54.208
54.020	(36)	53.851	54.189
53.957	(37)	53.787	54.126
53.934	(38)	53.763	54.104

P_t		P_1	P_2
54.765	(1)	54.554	54.955
54.601	(2)	54.446	54.755
54.549	(3)	54.365	54.719
54.520	(4)	54.353	54.686
54.483	(5)	54.312	54.653
54.453	(6)	54.276	54.630
54.435	(7)	54.275	54.610
54.421	(8)	54.260	54.582
54.330	(9)	54.120	54.540
54.394	(10)	54.221	54.566
54.255	(11)	54.120	54.420
54.2[illegible]	(12)	54.070	54.400
54.228	(13)	54.066	54.394
54.205	(14)	54.040	54.375
54.219	(15)	54.040	54.387
54.220	(16)	54.056	54.375
54.265	(17)	54.096	54.434
54.[redacted] 208	(18)	54.037	54.378
40 = 54.[redacted] 210	(19)	54.040	54.379
54.214	(20)	54.044	54.383
54.154	(21)	53.985	54.322
54.193	(22)	54.024	54.361
54.144	(23)	53.988	54.500
54.130	(24)	53.970	54.290

Test pressure 39.6 psig

.75 La = 0.476 w% /day ⇒ 289.3 SCFH

1) How are jumper or defeat accomplish for HPCS, LPCS, and A,B,C PCIS groups 2, & 4 attachment 2 RPA page 12

2) ✓ Page 13 Second person verification for racking breakers, manual valve

3) ✓ Page 15 Verification of Scram ?

4) ✓ Page 15 24 hours test Duration?

Volume ⇒ 394,639 ft^3

La = 0.635 w% /day

5) B & C ⇒ completed

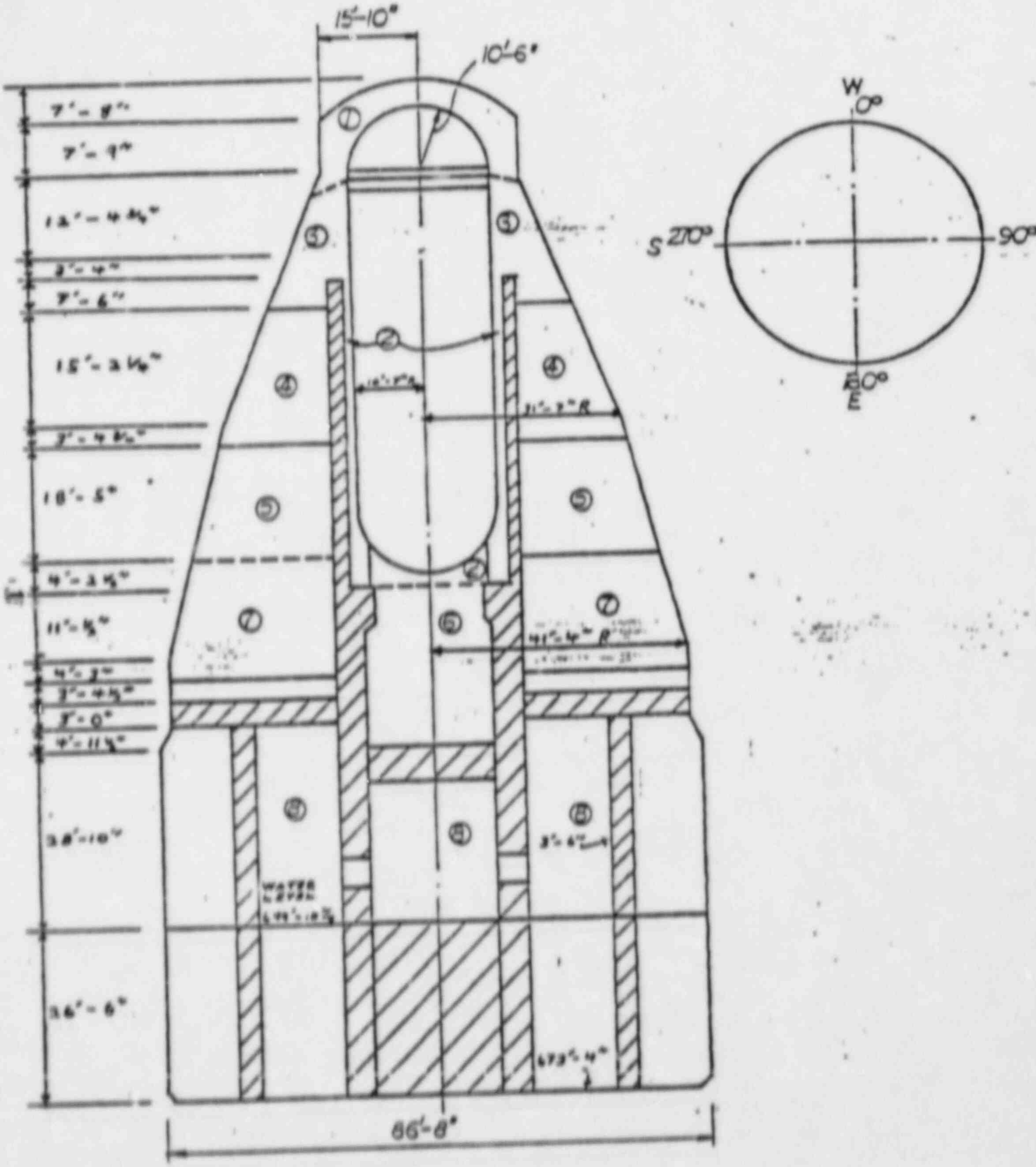


Fig. 1 - Elevation view of containment and subvolume locations