FLORIDA POWER CORPORATION
CRYSTAL RIVER UNIT 3
NUCLEAR GENERATING PLANT

REACTOR CONTAINMENT BUILDING
INTEGRATED LEAK RATE TEST

JULY 1983

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A017

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1.0 SYNOPSIS

The Crystal River Unit 3 Nuclear Generating Plant reactor containment building was subjected to an integrated leak rate test during the period from July 10, 1983 to July 11, 1983. The purpose of this test was to demonstrate the acceptability of the building leakage rate at an internal pressure of 49.6 psig (Pa). Testing was performed in accordance with the requirements of 10 CFR 50, Appendix J, ANSI N45.4-1972, Bechtel Topical Report BN-TOP-1 and Crystal River Unit 3 Nuclear Generating Plant FSAR.

The mass point method of analysis resulted in a measured leakage rate of 0.130 percent by weight per day at 49.6 psig. The leakage rate at the upper bound of the 95 percent confidence interval was 0.142 percent by weight per day. A correction factor of 0.001 percent by weight per day for two penetrations which were not vented for the test must be added to the test results. Therefore, the leakage rate at the upper bound of the 95 percent confidence interval is 0.143 percent by weight per day which is below the allowable leakage rate of 0.187 percent by weight per day at 49.6 psig.

Utilizing the total time method of analysis, the measured leakage rate was found to be 0.126 percent by weight per day and 0.173 percent by weight per day at the upper bound of the 95 percent confidence interval at the 49.6 psig pressure level. The mean of the measured leakage rates based on the total time calculations for the last five hours of the test was 0.170 percent by weight per day. All total time analyses are below the allowable leakage rate of 0.187 percent by weight per day and meet the criteria set forth in Bechtel Topical Report BN-TOP-1 for conduct of a short duration integrated leakage rate test.

An equivalent leakage rate reduction of 0.005 percent by weight per day was achieved by performing Type B and C tests prior to the integrated leakage rate test. Therefore, the "as found" reactor

containment integrated leakage rate is the corrected measured leakage rate of 0.143 percent by weight per day plus the 0.005 percent by weight per day or 0.148 percent by weight per day. This is well below the allowable "as found" leakage rate of 0.25 percent by weight per day.

The supplemental instrumentation verification test at Pa demonstrated an agreement between measured reactor containment building integrated leakage rates of 19.2 percent, which is within the 25 percent requirement of 10 CFR 50, Appendix J, Section III A.3.b.

Testing was performed by Florida Power Corporation with the technical assistance of Gilbert Associates Inc. Procedural and calculatonal methods were witnessed by Nuclear Regulatory Commission personnel.

2.0 INTRODUCTION

The objective of the integrated leak rate test was the establishment of the degree of overall leak tightness of the reactor containment building at the calculated design basis accident pressure of 49.6 psig. The allowable leakage is defined by the design basis accident applied in the safety analysis in accordance with site exposure guidelines specified by 10 CFR 100. For Crystal River Unit 3, the maximum allowable integrated leak rate at the design basis accident pressure of 49.6 psig (P_a) is 0.25 percent by weight per day (L_a).

Testing was performed in accordance with the procedural requirements as stated in Florida Power Corporation Crystal River Unit 3 Surveillance Procedure, SP-178. This procedure was approved by the Crystal River Unit 3 Plant Review Committee prior to the commencement of the test.

With the exception of valves SFV-18,SFV-19 and DWV-160 all reactor containment isolation valves and penetrations subject to type B and C testing were tested prior to commencement of the integrated leak rate test. Their combined leakage was less than 60 percent of the maximum allowable leakage rate (L_a) at 49.6 psig in accordance with 10 CFR 50, Appendix J.

Leakage rate testing was accomplished at the pressure level of 49.6 psig for a period of 11 hours. The 11 hour period was followed by a 4 hour supplemental test for a verification of test instrumentation.

3.0 GENERAL AND TECHNICAL DATA

3.1 GENERAL DATA

Owner:	Florida Power Corporation
Docket No.:	50-302
Location:	Approximately 5 miles north of Crystal River, Florida
Containment Description:	Reinforced concrete structure composed of cylindrical walls (prestressed with a post-tensioning tendon system in vertical and horozontal directions), with a flat foundation mat (conventional reinforcing) and a shallow dome roof (prestressed utilizing a three-way post tensioning tendon system). The inside surface is lined with a carbon steel liner.
Date Test Completed:	July 11, 1983

3.2 TECHNICAL DATA

Containment Net Free Volume:	2×10^6 cubic feet
Design Pressure:	55 psig

Design Temperature:	281°F
Calculated Accident Peak Pressure:	49.6 psig
Calculated Accident Peak Temperature:	281°F

4.0 ACCEPTANCE CRITERIA

4.1 TECHNICAL SPECIFICATION ACCEPTANCE CRITERIA

Acceptance criteria established prior to the test and as specified by 10 CFR 50, Appendix J, ANSI N45.4-1972 and the Crystal River Unit 3 Nuclear Generating Plant FSAR, Section 15.4.2.2, Amendment 49, are as follows:

a. The measured leakage rate (L_{am}) at the calculated design basis accident pressure of 49.6 psig (P_a) shall be less than 75 percent of the maximum allowable leakage rate (L_a), specified as 0.25 percent by weight of the building atmosphere per day. The acceptance criteria is determined as follows:

$$L_a = 0.25\%/\text{day}$$
$$0.75L_a = 0.187\%/\text{day}$$

b. The test instrumentation shall be verified by means of a supplemental test. Agreement between the containment leakage measured during the Type A test and the containment leakage measured during the supplemental test shall be within 25 percent of L_a.

4.2 SHORT DURATION TESTING ACCEPTANCE CRITERIA

In addition to the acceptance criteria mentioned above, the following short duration testing acceptance criteria contained in Bechtel Topical Report BN-TOP-1, Revision 1, dated November 1, 1972 was used:

a. The trend report based on total time calculations shall indicate that the magnitude of the calculated leak rate is tending to stabilize at a value less than the maximum allowable leak rate (L_a).

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

c. The mean of the measured leak rates based on total time calculations over the last five hours of test or last twenty data points, whichever provides the most data, shall be less than the maximum allowable leak rate.

d. At least twenty data points shall be provided for statistical analysis.

5.0 TEST INSTRUMENTATION

5.1 SUMMARY OF INSTRUMENTS

Test instruments employed are described, by system, in the following subsections:

5.1.1 Temperature Indicating System

Components:

a. Resistance Temperature Detectors

Quantity	22
Manufacturer	Temtex
Type	100 ohm platinum
Range, ° F	80-120
Accuracy, ° F	± .25% of reading
Sensitivity, ° F	± 0.1

Quantity	2
Manufacturer	Rosemount
Type	78-S 100 ohm platinum
Range, ° F	70-130
Accuracy, ° F	± 0.1
Sensitivity, ° F	± 0.1

b. Digital Temperature Scanner/Printer

Quantity	1
Manufacturer	Doric Scientific Corp.
Type	*210-40-NSR-08-17 Digital Data Logger

Accuracy, ° F	± 0.1
Repeatability, ° F	± 0.1

*Also equipped with 25 Rosemount Model 401R-4 bridge cards

5.1.2 Dewpoint Indicating System

Components:

a. Dewcell Elements

Quantity	9
Manufacturer	Panametrics
Type	2100 M2W
Range, ° F	0 - 140
Accuracy, ° F	± 3.6
*Repeatability, ° F	NA

b. Dewpoint Readout

Quantity	2
Manufacturer	Panametrics
Type	2100 - 151
Range, ° F	0 - 140
Resolution, ° F	± 0.1
Repeatability, ° F	± 0.9

*Repeatability specification for probe and readout device is the same as each probe/readout channel is calibrated as a unit.

5.1.3 Pressure Monitoring System

Precision Pressure Gauges

Quantity	2
Manufacturer	Texas Instruments
Type	145-01
Range, psia	0 - 100
Accuracy, psia	± 0.010% of reading plus 0.002% of full scale
Repeatability, psia	± 0.001% of full scale
Sensor Sensitivity, psia	± 0.0013% of full scale

5.1.4 Supplemental Test Flow Monitoring System

Mass Flow Meter

Quantity	1
Manufacturer	Volumetrics
Model	14326
Range, SLPM	0-600
Accuracy,	± 1% of reading

5.2 SCHEMATIC ARRANGEMENT

The arrangement of the four measuring systems summarized in Section 5.1 is depicted in Appendix A. Drybulb temperature sensors were placed throughout the reactor containment vessel volume to permit monitoring of internal temperature variations at 24 locations. Dewpoint temperature sensors were placed at 9 locations to permit monitoring of the reactor containment partial pressure of water vapor. A temperature survey was performed after the sensors were installed which verified there were no large areas of temperature variation.

5.3 CALIBRATION CHECKS

Temperature, dewpoint and pressure measuring systems were checked for calibration before the test as recommended by ANSI N45.4-1972, Section 6.2 and 6.3. The results of the calibration checks are on file at Crystal River Unit 3. The supplemental test at 49.6 psig confirmed the instrumentation acceptability.

5.4 INSTRUMENTATION PERFORMANCE

During the installation phase of the test equipment one dewcell exhibited erratic behavior and was not used for the test. The remaining nine dewcells, twenty-four RTD's, two precision pressure gauges and mass flow meter performed satisfactorily throughout the performance of the integrated leak rate test and provided more than adequate coverage of the containment.

5.5 VOLUME WEIGHTING FACTORS

Weighting factors were assigned to each operable drybulb temperature sensor and dewpoint temperature sensor based on the calculated volume of the reactor containment building each sensing device monitored. Drybulb and dewpoint temperature sensors elevation and weighting factor for the test were as follows:

Elevation (Feet)	Temperature Element	Weighting Factor
100	LR-42-HE	.040
105	LR-20-TE	.024
105	LR-21-TE	.024
105	LR-22-TE	.024
105	LR-41-HE	.050
108	LR-23-TE	.025
108	LR-52-TE	.031
120	LR-44-HE	.062

Elevation (Feet)	Temperature Element	Weighting Factor
140	LR-24-TE	.045
140	LR-25-TE	.045
140	LR-26-TE	.045
140	LR-27-TE	.031
140	LR-53-TE	.025
140	LR-43-HE	.167
179.5	LR-54-TE	.045
179.5	LR-55-TE	.045
180	LR-29-TE	.045
180	LR-31-TE	.045
180	LR-49-HE	.072
180	LR-50-HE	.072
186.2	LR-28-TE	.045
200	LR-48-HE	.179
215.5	LR-35-TE	.066
215.5	LR-38-TE	.066
215.5	LR-46-HE	.179
215.5	LR-47-HE	.179
220	LR-34-TE	.066
238.7	LR-37-TE	.043
242.7	LR-33-TE	.043
242.7	LR-36-TE	.043
242.7	LR-39-TE	.043
260	LR-30-TE	.043
260	LR-32-TE	.043

5.6 SYSTEMATIC ERROR ANALYSIS

Systematic error, in this test, is induced by the operation of the temperature indicating system, dewpoint indicating system and the pressure indicating system.

Justification of instrumentation selection was accomplished, using manufacturer's sensitivity and repeatability tolerances stated in Section 5.1, by computing the instrumentation selection guide (ISG) formula.

Containment leakage determined by the absolute method requires accurate measurement of small changes in containment pressure with suitable corrections for temperature and water vapor. Since the absolute method utilizes the change in a reading (i.e., pressure and temperature) to calculate leak rate, the repeatability, sensitivity and readability of the instrument system is of more concern than the accuracy. To perform the Instrument Selection Guide (ISG) calculation the sensitivity error of the sensor and the repeatability error of the measurement system must be used.

Sensitivity is defined as "the capability of a sensor to respond to change." Sensitivity is usually a function of the system measuring the sensor output. When the sensor energy state is raised or lowered an amount equal to the smallest value which the entire system will process, a change of indication will occur. To determine sensitivity for ILRT sensors, it is necessary to analyze the smallest value of the analog sensor output which will cause a one digit change in the digital display.

Repeatability is defined as "the capability of the measurement system to reproduce a given reading from a constant source."

Utilizing the methods, techniques and assumptions in Appendix G to ANS 56.8-1981, the ISG formula was computed for the absolute method as follows:

a. Conditions

L_a = 0.25%/day
P = 64.3 psia

T = 550° R drybulb

T_{dp} = 78.8° F dewpoint

t = 11 hours

b. Total Absolute Pressure: e_p

No. of Sensors: 2

Range 0-100 psia

Sensor sensitivity error (E_p): ± 0.0013% of full scale

Measurement system error (ε_p): ± 0.001% of full scale

E_p = 0.0013 psia

ε_p = 0.00100 psia

$$e_p = \pm \left[(E_p)^2 + (\varepsilon_p)^2\right]^{1/2} / \left[\text{no. of sensors}\right]^{1/2}$$

$$e_p = \left[(0.0013)^2 + (0.001)^2\right]^{1/2} / \left[2\right]^{1/2}$$

e_p = ± 0.00116 psia

c. Water Vapor Pressure: e_{pv}

No. of sensors: 9

*Sensor sensitivity error (E_{pv}): NA

*Sensitivity is not specified for probes by the manufacturer. Probe/readout device repeatability is specified and considered equal as each probe/readout channel is calibrated as a unit.

Measurement system error (ε_{pv}), excluding sensor: ± 0.9° F

At a dewpoint temperature of 78.8° F, the equivalent water vapor pressure change (as determined from the steam tables) is 0.016 psia/°F.

E_{pv} = NA

$\varepsilon_{pv} = \pm 0.9^\circ F (0.016 psia/^\circ F)$

$\varepsilon_{pv} = \pm 0.014$ psig

$e_{pv} = \pm \varepsilon_{pv} / [\text{no. of sensors}]^{1/2}$

$e_{pv} = \pm 0.014 / [9]^{1/2}$

$e_{pv} = \pm 0.0046$ psia

d. Temperature

No. of sensors: 24

Sensor sensitivity error (E_T): ± 0.10° F = ± 0.10° R

Measurement system error (ε_T), excluding sensor: ± 0.1° F = ± 0.1° R

$e_T = \pm [(E_T)^2 + (\varepsilon_T)^2]^{1/2} / [\text{no. of sensors}]^{1/2}$

$e_T = \pm [(0.10)^2 + (0.1)^2]^{1/2} / [24]^{1/2}$

$e_T = \pm 0.0289^\circ R$

e. Instrument Selection Guide (ISG)

$$ISG = \pm \frac{2400}{t}\left[2\left(\frac{e_p}{p}\right)^2 + 2\left(\frac{e_{pv}}{p}\right)^2 + 2\left(\frac{e_T}{T}\right)^2\right]^{1/2}$$

$$ISG = \pm \frac{2400}{11}\left[2\left(\frac{0.00116}{64.3}\right)^2 + 2\left(\frac{0.0046}{64.3}\right)^2 + 2\left(\frac{0.0289}{550}\right)^2\right]^{1/2}$$

$$ISG = \pm 218.18\left[6.509 \times 10^{-10} + 1.024 \times 10^{-8} + 5.522 \times 10^{-9}\right]^{1/2}$$

$$ISG = \pm 0.028\%/\text{day}$$

The ISG formula does not exceed 0.25 L_a (0.0625%/day) and it is therefore concluded that the instrumentation selected was acceptable for use in determining the reactor containment integrated leakage rate.

5.7 SUPPLEMENTAL VERIFICATION

In addition to the calibration checks described in Section 5.3, test instrumentation operation was verified by a supplemental test subsequent to the completion of the 11 hour leakage rate test. This test consisted of imposing a known calibrated leakage rate on the reactor containment building. After the flow rate was established, it was not altered for the duration of the test.

During the supplemental test, the measured leakage rate was

$$L_c = L_v' + L_o$$

where

L_c = measured composite leakage rate consisting of the reactor containment building leakage rate plus the imposed leakage rate

L_o = imposed leakage rate

L_v' = leakage rate of the reactor containment building during the supplemental test phase

Rearranging the above equation,

$$L_v' = L_c - L_o$$

The reactor containment building leakage during the supplemental test can be calculated by subtracting the known superimposed leakage rate from the measured composite leakage rate.

The reactor containment building leakage rate during the supplemental test (L_v') was then compared to the measured reactor containment building leakage rate during the preceding 11 hour test (L_{am}) to determine instrumentation acceptability. Instrumentation is considered acceptable if the difference between the two building leakage rates is within 25 percent of the maximum allowable leakage rate (L_a).

6.0 TEST PROCEDURE

6.1 PREREQUISITES

Prior to commencement of reactor containment building pressurization, the following prerequisites were satisfied:

a. Proper operation of all test instrumentation was verified.

b. All reactor containment building isolation valves were closed using the normal mode of operation. All associated system valves were placed in post-accident positions.

c. Equipment within the reactor containment building, subject to damage, was protected from external differential pressures.

d. Portions of fluid systems, which under post-accident conditions become extensions of the containment boundary, were drained and vented.

e. Pressure gauges were installed on the following systems to provide a means of detection for leakage into these systems:

   1. Purge Supply
   2. Purge Exhaust
   3. Main Steam Loop A
   4. Main Steam Loop B
   5. Personnel Access Hatch
   6. Equipment Hatch Airlock
   7. Personnel Access Hatch Seal
   8. Equipment Hatch Seals

f. With exception of valves SFV-18, SFV-19 and DWV-160 all type B and C testing was completed with a leakage value less than 0.6 L_a. However, these valves were lined up in their post accident position for conduct of the ILRT.

g. Containment pressurization system was operational

h. Containment recirculation fans were in operation.

i. Potential pressure sources were removed or isolated from the containment.

j. A general inspection of the accessible interior and exterior surfaces of the containment was completed.

6.2 GENERAL DISCUSSION

Following the satisfaction of the prerequisites stated in Section 6.1, the reactor containment building pressurization was initiated at a rate of approximately 3.0 psi per hour. Vessel pressure, temperature, and the amperage required by the containment recirculation unit fans were monitored hourly. After the containment was stabilized leak rate testing was initiated at the 49.6 psig pressure level. For the duration of the 11 hour leak test and the 4 hour supplemental test average internal containment temperature remained within a band of $\pm$ 0.25° F.

During the test the following occured at fifteen minute intervals (see Appendix B - Reduced Leakage Data):

a. Readings indicated by the two precision pressure gauges were recorded and entered into the computer. The computer program converted this reading, using calibration equations, to psia and computed the average.

b. Readings indicated by the twenty-four RTD's were recorded and entered into the computer. The computer program calculated the average containment building drybulb temperature by use of a weighting factor that was assigned to each RTD. This value was subsequently converted to degrees Rankine for use in the ideal gas law equation to calculate containment building weight of air.

c. Readings indicated by the nine dewpoint temperature sensors were recorded and entered into the computer. The computer program then calculated the average containment dewpoint temperature by use of a weighting factor assigned to each sensor. This weighted average dewpoint temperature was then converted to a partial pressure of water vapor.

The use of water vapor pressure (Pwv), temperature (T) and the total pressure (P_t) is described in more detail in Section 7.1. All original data is on file at Crystal River Unit No. 3.

Data was entered into an Omotron attache micro computer located at the leak rate panel. The ILRT computer program utilized for the test had been previously checked with sample data of known results and certified prior to the test at Crystal River Unit No. 3. The computer program then calculated the following at fifteen minute intervals:

a. Total weight of containment air
b. Mass point least squares fit leakage rate
c. Mass point 95 percent upper confidence level leakage rate
d. Observed total time leakage rate
e. Total time mean leakage rate
f. Total time least squares fit leakage rate
g. Total time 95 percent upper confidence level leakage rate

A plot of weighted average containment temperature, containment total pressure, containment average dewpoint temperature and weight of air was performed for each fifteen minute data set (see Appendix C).

Immediately following the 11 hour leak test, a superimposed leakage rate was established for an additional 4 hour period. During this time, temperature, pressure and vapor pressure were monitored as described above.

6.3 TEST PERFORMANCE

6.3.1 Pressurization and Stabilization Phase

Pressurization of the reactor containment building was started on July 9, 1983 at 0510. The pressurization rate was approximately 3.0 psi per hour. During pressurization a substantial buildup of pressure was observed between both the purge supply valves and purge exhaust valves. With approximately 8 psig in the containment and between the inboard and outboard purge supply and exhaust valves, operations personnel entered the purge supply and exhaust duct work to determine the leak tightness of the outboard valves. At this time only a small leak was observed on the purge supply valve around one end of the actuator assembly.

When containment internal pressure reached 49.6 psig at approximately 2300 on July 9, 1983, pressurization was secured. By 0400 on July 10, 1983 chemistry had completed taking a reactor building sample, temperature stabilization criteria had been met and leakage rate data recording, reduction and analysis began.

6.3.2 Integrated Leak Rate Testing Phase

Fifteen minute frequency test data showed relatively unstable conditions within containment for the first several hours. From approximately 0900 several data points indicated that containment atmospheric conditions were tending to stabilize compared to the previous data. As a result, it was decided to commence the test starting at 0900 on July 10, 1983.

For the 11 hour period from 0900 on July 10, 1983 to 2000 on July 10, 1983 an acceptable leakage rate of 0.130%/day with an associated 95 percent confidence interval of 0.012 percent by weight per day was obtained.

6.3.3 Supplemental Leakage Rate Test Phase

Following completion of the 11 hour integrated leak rate test, a leakage rate of 8.79 scfm was imposed on the containment building through the mass flow meter at 2030 on July 10, 1983. Leakage rate data was again collected at fifteen minute intervals for a period of 4 hours. With an imposed leak rate of 0.152% per day a measured composite leakage rate of 0.234% per day was obtained. This results in a containment building leakage rate agreement within 19.2% of L_a with the results of the 11 hour test, which is within the acceptance limit of 25 percent of L_a.

6.3.4 Depressurization Phase

After all required data was obtained and evaluated, containment building depressurization to 0 psig was started. A post test inspection of the reactor containment building interior at 0 psig was completed with no significant findings.

7.0 METHODS OF ANALYSIS

7.1 GENERAL DISCUSSION

The absolute method of leakage rate determination was employed during testing at the 49.6 psig pressure level. The Gilbert Associates, Inc. ILRT computer code calculates the percent per day leakage rate for the mass point and total time methods.

7.1.1 Mass Point Analysis

The mass point method of computing leakage rates uses the following ideal gas law equation to calculate the weight of air inside containment for each fifteen minute interval:

$$W = \frac{144\ PV}{RT} = \frac{KP}{T}$$

where,

W = mass of air inside containment, lbm

$K = 144\ V/R = 5.39831 \times 10^6\ \frac{\text{lbm} - {}^{\circ}\text{R} - \text{in.}^2}{\text{lbf}}$

P = partial pressure of air, psia

T = average internal containment temperature, $^{\circ}$ R

$V = 2 \times 10^6\ \text{ft}^3$

$R = 53.35\ \frac{\text{lbf} - \text{ft}}{\text{lbm} - {}^{\circ}\ \text{R}}$

The partial pressure of air, P, is calculated as follows:

$$P = P_T - P_{wv}$$

where,

P_T = true corrected pressure by converting pressure gauge readings and averaging, psia

P_{wv} = partial pressure of water vapor determined by averaging the nine dewpoint temperatures and converting to partial pressure of water vapor, psia.

The average internal containment temperature, T, is calculated as follows:

T = Sum of the products of each RTD x assigned weighting factor + 459.69^{o} R

The weight of air is plotted versus time for the 11 hour test and for the 4 hour supplemental test. The Gilbert Associates, Inc. ILRT computer code fits the locus of these points to a straight line using a linear least squares fit. The equation of the linear least squares fit line is of the form $W = W_o + W_1 t$ where W_1 is the slope in lbm per hour and W_o is the initial weight at time zero. The least squares parameters are calculated as follows:

$$W_o = \frac{\Sigma\, t_i^2\, \Sigma\, W_i \;-\; \Sigma\, t_i \;\; \Sigma\, t_i\, W_i}{S_{xx}}$$

$$W_1 = \frac{N \;\; \Sigma\, t_i\, \Sigma\, W_i \;-\; \Sigma\, t_i \;\; \Sigma \;\; W_i}{S_{xx}}$$

where,

$$S_{xx} = N\, \Sigma\, t_i^2 - (\Sigma\, t_i)^2$$

The weight percent leakage per day can then be determined from the following equation:

$$\text{wt. \%/day} = \frac{-2400\, W_1}{W_o}$$

where the negative sign is used since W_1 is a negative slope to express the leakage rate as a positive quantity.

7.1.2 Total Time Analysis

The total time method utilizes the following equation to determine the leakage rate of the reactor containment building:

$$L = \frac{2400}{t}\left[1 - \frac{T_1 P_2}{T_2 P_1}\right]$$

where,

L = measured leak rate in weight percent per day

t = time interval, in hours, between measurements

T_1, T_2 = average internal containment temperature, $^\circ$R, at the beginning and the end of the test interval respectively.

P_1, P_2 = average containment pressure (corrected for water vapor pressure) at the beginning and end of the test interval respectively.

The mean total time leakage rate is derived from the above individual total time calculations. The equation for the mean leakage rate is in the form:

$$\bar{L} = \frac{\varepsilon_i L_i}{n}$$

where,

L_i = individual total time leakage rates

n = the number of total time leakage rates

The individual leakage rates are then plotted against time for the duration of the 11 hour test. The Gilbert Associates, Inc. ILRT computer code fits the locus of these points to a straight line using a linear least squares fit. The equation is of the form $\bar{L} = L_o + L_1 t$ where L_1 is the slope in percent per hour and L_o is the initial leakage rate at time zero. The least squares parameters are calculated as follows:

$$L_o = \frac{\Sigma t_i^2 \, \Sigma L_i - \Sigma t_i \, \Sigma L_i}{S_{xx}}$$

$$L_1 = \frac{N \, \Sigma t_i \, \Sigma L_i - \Sigma t_i \, \Sigma L_i}{S_{xx}}$$

where,

$$S_{xx} = N \, \Sigma t_i^2 - (\Sigma t_i)^2$$

7.2 STATISTICAL EVALUATION

7.2.1 General

After performing the least squares fit, the ILRT computer code calculates the following statistical parameters:

a. Limits of the 95 percent confidence interval for the mass point leakage rate (C_M).

b. Limits of the 95 percent confidence interval for the total time leakage rate (C_L).

These statistical parameters are then used to determine that the measured leakage rate plus the 95 UCL meet the acceptance criteria.

7.2.2 Mass Point Confidence

The 95 percent confidence limit for the mass point leakage rate is calculated as follows:

$$C_M = t_{95}\ Se \left[\frac{N}{S_{xx}} + \frac{S_{xx} + (\Sigma t_1)^2}{NS_{xx}} \right]^{1/2}$$

where,

t_{95} = Student's t distribution with N-2 degrees of freedom

Se = Standard error of confidence and is defined as follows:

$$S_e = \left[\frac{\Sigma \ W_i - (W_o + W_1 \ t_i)^2}{N-2} \right]^{1/2}$$

where;

W_i = observed mass of air

$(W_o + W_1 \ t_i)$ = least squares calculated mass of air

N = number of data points

This parameter is an expression of the uncertainty in the measured leakage rate. The values of $t_{0.95}$ used by the ILRT program establish an upper limit for the measured leakage such that there is a 95 percent chance the actual leakage rate is less than the 95 percent upper confidence leakage rate.

7.2.3 Total Time Confidence

The 95 percent confidence limit for the total time leakage rate is calculated as follows:

$$C_L = t_{95}\ Se \left[1 + \frac{1}{n} + \frac{(t-\bar{t})^2}{\Sigma \ (t_i - t)^2} \right]^{1/2}$$

where,

t = total time interval

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

t_i = time interval for each data point

n = number of individual total time leakage rates

8.0 DISCUSSION OF RESULTS

8.1 RESULTS AT P_a

8.1.1 Mass Point Method of Analysis

Data obtained during the leak rate test at P_a indicated the following changes during the 11 hour test period:

Variable	Maximum Change
P_T	0.012 psia
P_{wv}	0.008 psia
T	0.23° F

The method used in calculating the mass point leakage rate is defined in Section 7.1.1. The results of this calculation is a mass point leakage rate of 0.130%/day. (See Appendix D)

The 95 percent confidence limit associated with this leakage rate is 0.012 percent per day. Thus the leakage rate at the upper bound of the 95 percent confidence level becomes

$$UCL = 0.130 + 0.012$$
$$UCL = 0.142\%/day$$

The measured leakage rate and the measured leakage rate at the upper bound of the 95 percent confidence level are well below the acceptance criteria of 0.187 percent per day (0.75 L_a).

8.1.2 Total Time Method of Analysis

The method used in calculating the total time leakage rates is defined in Section 7.1.2. The results of these calculations are as follows:

a. The measured total time leakage rate for the 11 hour test was 0.126 percent by weight per day.

b. The 95 percent confidence limit associated with this leakage rate is 0.047 percent per day. Thus the leakage rate at the upper bound of the 95 percent confidence level becomes

UCL = 0.126 + 0.047
UCL = 0.173%/day

c. The mean of the measured leakage rates based on the last five hours of the test was 0.170 percent by weight per day.

The total time measured leakage rate, the measured leakage rate at the upper bound of the 95 percent confidence level and the mean of the measured leakage rates based on the last five hours of testing are below the acceptance criteria of 0.187 percent per day.

Therefore, the reactor containment building leakage rate, based on both the mass point method and total time method of analysis, at the calculated design basis accident pressure (P_a) of 49.6 psig is acceptable.

8.2 SUPPLEMENTAL TEST RESULTS

After conclusion of the 11 hour test at 49.6 psig (P_a), the mass flowmeter was placed in service and a flow rate of 8.79 SCFM was established. This flow rate is equivalent to a leakage rate of 0.152 percent per day. After the flow rate was established, it was not altered for the duration of the supplemental test. The

measured leakage rate (L_c) during the supplemental test was calculated to be 0.234 percent per day using the mass point method of analysis. (See Appendix D). The upper bound of the 95 percent confidence limit associated with this leakage rate is 0.010 percent per day.

The building leakage rate during the supplemental test is then determined as follows:

$$L_v' = L_c - L_o$$

$$L_v' = 0.234\%/\text{day} - 0.152\%/\text{day}$$

$$L_v' = 0.082\%/\text{day}$$

Comparing this leakage rate with the building leakage rate measured during the 11 hour test yields the following:

$$\left|\frac{L_{am} - L_v'}{L_a}\right| = \left|\frac{(0.130) - (0.082)}{0.25\%\ \text{day}}\right| = .192$$

The building leakage rates agree within 19.2 percent of L_a which is below the acceptance criteria of 25 percent of L_a.

Using the formulation of ANS 56.8-1981,

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

$$(0.152 + 0.130 - 0.0625) \leq L_c \leq (0.152 + 0.130 + 0.0625)$$

$$0.2195 \leq L_c \leq 0.3445$$

Since L_c was measured to be 0.234 percent per day, this value falls within the acceptable range of 0.2195 to 0.3445 percent per day. Therefore, the acceptability of the test instrumentation is considered to have been verified.

9.0 REFERENCES

1. Crystal River Unit 3 Nuclear Generating Plant Final Safety Analysis Report.

2. SP-178, "Containment Leakage Test - Type A, Including Liner Plate".

3. Code of Federal Regulations, Title 10, Part 50, Appendix J.

4. ANSI N45.4-1972, Leakage Rate Testing of Containment Structures for Nuclear Reactors, American Nuclear Society, (March 16, 1972).

5. Steam Tables, American Society of Mechanical Engineers, (1967).

6. ILRT, Computer code, Gilbert Associates, Inc.

7. ANS-56.8-1981, "Containment System Leakage Testing Requirements", American Nuclear Society.

8. Crystal River Unit 3 Nuclear Generating Plant Reactor Containment Building Integrated Leak Rate Test", Florida Power Corporation, (September 3, 1980).

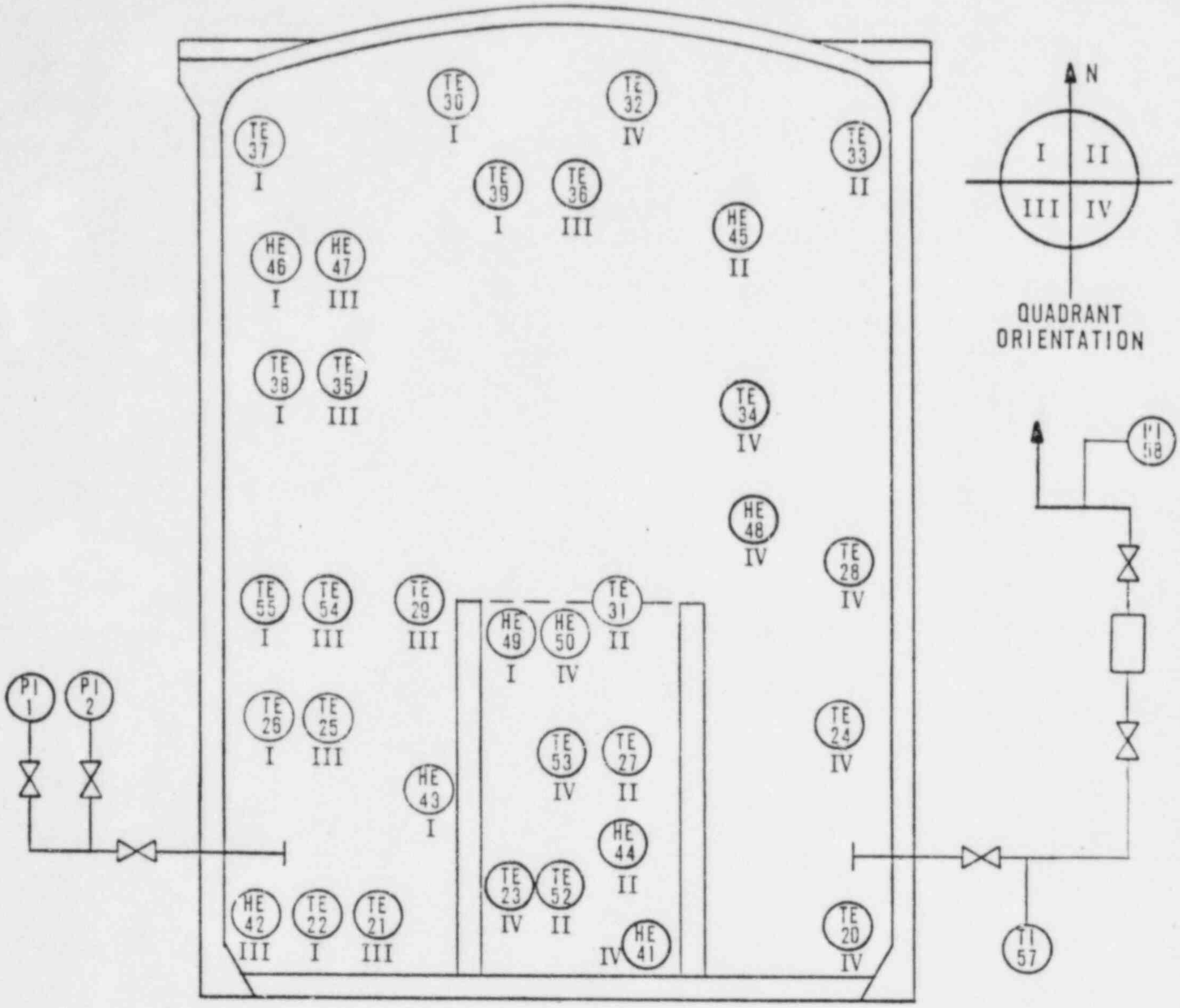
9. BN-TOP-1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants", Revision 1, November 1, 1972.

APPENDICES

APPENDIX A

SCHEMATIC ARRANGEMENT OF TEST INSTRUMENTATION

APPENDIX A
SCHEMATIC ARRANGEMENT OF TEST INSTRUMENTATION



INST. TAG	ELEV.	INST. TAG	ELEV.	INST. TAG	ELEV.
LR-20-TE	105'-0"	LR-32-TE	260'-0"	LR-41-HE	105'-0"
LR-21-TE	105'-0"	LR-33-TE	242'-8"	LR-42-HE	100'-0"
LR-22-TE	105'-0"	LR-34-TE	220'-0"	LR-43-HE	140'-0"
LR-23-TE	108'-0"	LR-35-TE	215'-6"	LR-44-HE	120'-0"
LR-24-TE	140'-0"	LR-36-TE	242'-8"	* LR-45-HE	242'-8"
LR-25-TE	140'-0"	LR-37-TE	238'-8"	LR-46-HE	215'-6"
LR-26-TE	140'-0"	LR-38-TE	215'-6"	LR-47-HE	215'-6"
LR-27-TE	140'-0"	LR-39-TE	242'-8"	LR-48-HE	200'-0"
LR-28-TE	186'-2"	LR-52-TE	108'-0"	LR-49-HE	180'-0"
LR-29-TE	180'-0"	LR-53-TE	140'-0"	LR-50-HE	180'-0"
LR-30-TE	260'-0"	LR-54-TE	179'-6"		
LR-31-TE	180'-0"	LR-55-TE	179'-6"		

*Not used for test.

APPENDIX B

REDUCED LEAKAGE RATE DATA

APPENDIX B
REDUCED TEST DATA

Date	Time	Containment Pressure (psia)	Containment Partial Pressure Water Vapor (psia)	Containment Temperature (^oR)	Weight of Containment Air (lbm)
7-10-83	0900	64.309	.481	549.91	626,578
	0915	64.307	.481	549.91	626,553
	0930	64.305	.482	549.91	626,534
	0945	64.304	.482	549.89	626,535
	1000	64.302	.483	549.92	626,483
	1015	64.301	.484	549.91	626,481
	1030	64.300	.485	549.91	626,451
	1045	64.299	.485	549.90	626,460
	1100	64.298	.485	549.90	626,445
	1115	64.297	.485	549.92	626,412
	1130	64.296	.485	549.92	626,404
	1145	64.295	.485	549.91	626,399
	1200	64.295	.485	549.93	626,380
	1215	64.295	.485	549.94	626,375
	1230	64.293	.485	549.95	626,341
	1245	64.292	.485	549.95	626,332
	1300	64.291	.486	549.95	626,314
	1315	64.290	.486	549.95	626,302
	1330	64.290	.486	549.95	626,298
	1345	64.290	.486	549.96	626,287
	1400	64.290	.486	549.96	626,287
	1415	64.290	.486	549.98	626,270
	1430	64.289	.486	549.98	626,249
	1445	64.290	.487	549.98	626,254
	1500	64.290	.487	550.01	626,227
	1515	64.290	.487	550.00	626,228
	1530	64.291	.487	550.01	626,231
	1545	64.291	.487	550.02	626,221
	1600	64.293	.487	550.04	626,221
	1615	64.295	.488	550.03	626,233
	1630	64.295	.488	550.06	626,206
	1645	64.296	.488	550.04	626,230
	1700	64.297	.488	550.04	626,243

APPENDIX B
REDUCED TEST DATA (Cont'd)

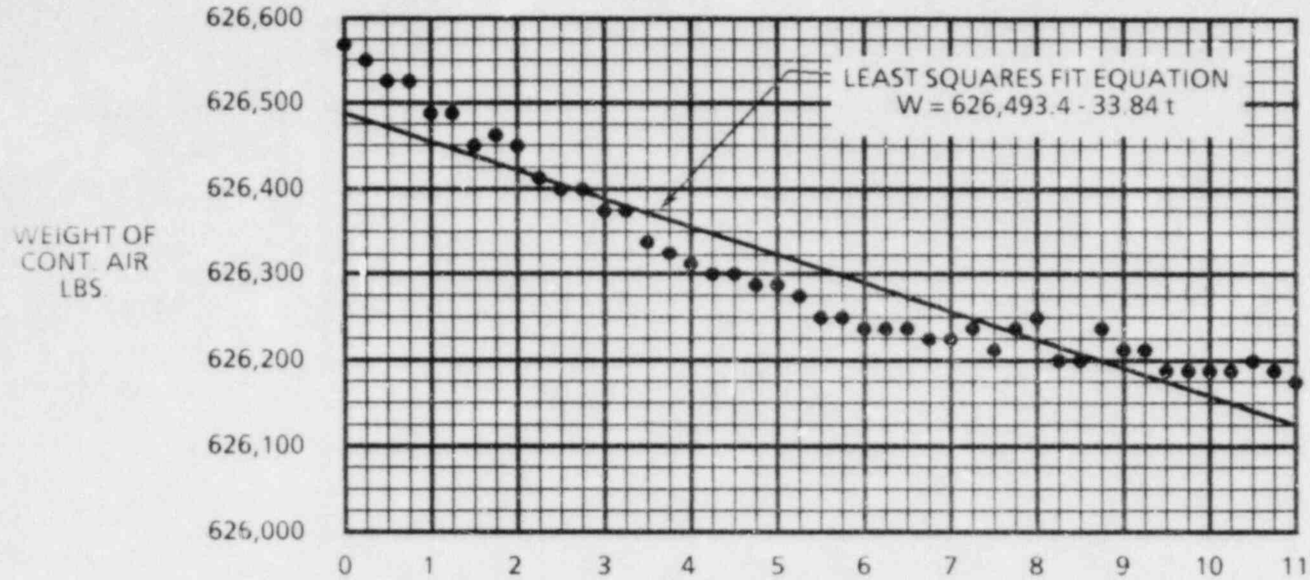
Date	Time	Containment Pressure (psia)	Containment Partial Pressure Water Vapor (psia)	Containment Temperature (^oR)	Weight of Containment Air (lbm)
7-10-83	1715	64.297	.488	550.08	626,203
	1730	64.298	.488	550.09	626,196
	1745	64.300	.488	550.08	626,228
	1800	64.300	.488	550.10	626,208
	1815	64.300	.487	550.10	626,213
	1830	64.300	.488	550.12	626,184
	1845	64.300	.488	550.12	626,182
	1900	64.300	.488	550.11	626,190
	1915	64.299	.488	550.11	626,186
	1930	64.298	.487	550.09	626,202
	1945	64.297	.487	550.09	626,194
	2000	64.296	.487	550.10	626,182
			SUPERIMPOSED TEST		
7-10-83	2030	64.294	.488	550.09	626,164
	2045	64.291	.488	550.09	626,139
	2100	64.289	.487	550.06	626,145
	2115	64.285	.488	550.04	626,127
	2130	64.283	.488	550.05	626,103
	2145	64.279	.488	550.02	626,093
	2200	64.277	.487	550.03	626,071
	2215	64.274	.487	550.02	626,047
	2230	64.272	.486	550.01	626,057
	2245	64.269	.487	550.00	626,020
	2300	64.267	.487	550.01	626,002
	2315	64.264	.488	549.98	625,994
	2330	64.261	.487	549.96	625,988
	2345	64.259	.487	549.96	625,966
7-11-83	0000	64.256	.486	549.95	625,957
	0015	64.254	.487	549.95	625,937
	0030	64.252	.487	549.95	625,920

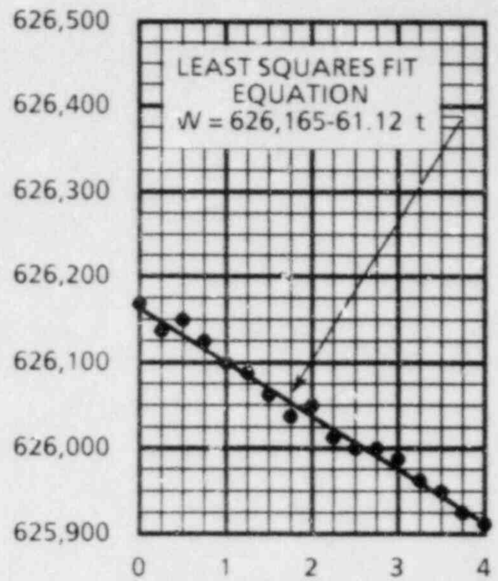
APPENDIX C

LEAKAGE RATE TEST GRAPHS

APPENDIX C

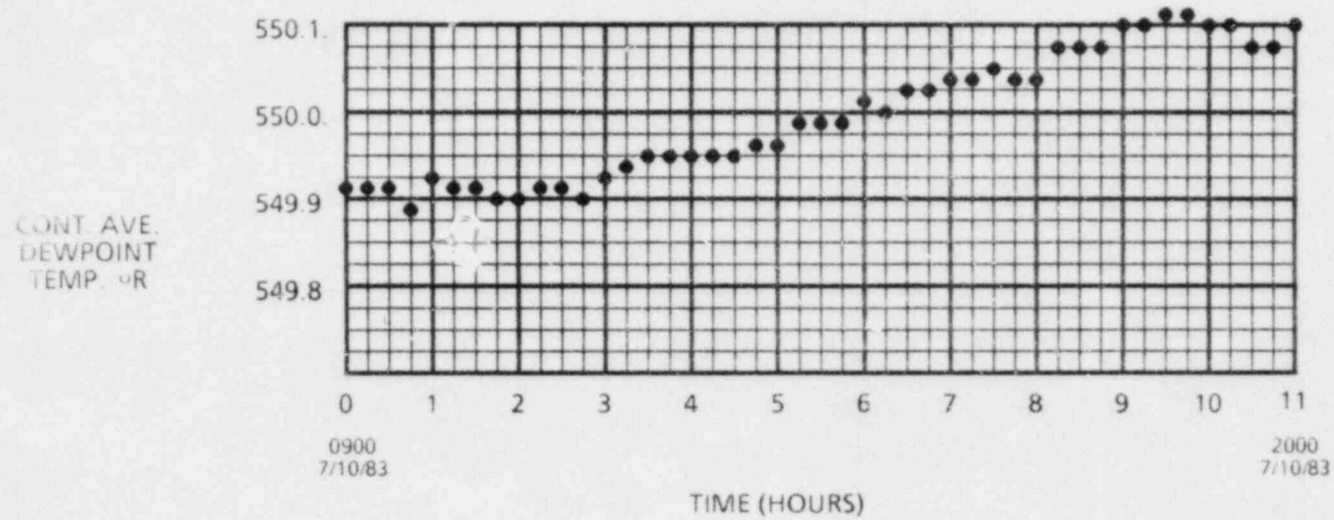
WEIGHT OF CONTAINMENT AIR AND CONTAINMENT AVERAGE TEMPERATURE VERSUS TIME

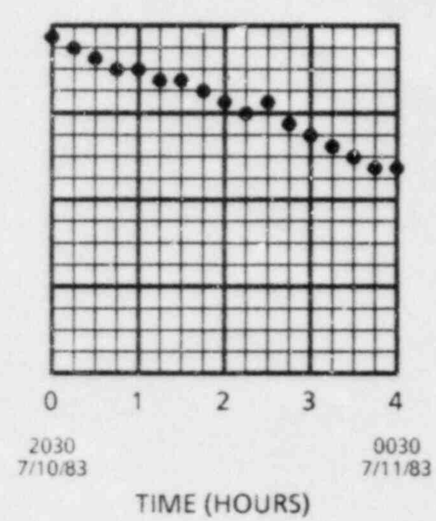




11 HOUR LEAK TEST

4 HOUR SUPERIMPOSED LEAK TEST





APPENDIX D

COMPUTER RESULTS

APPENDIX D

COMPUTER RESULTS

1. MASS POINT RESULTS

A = SLOPE OF LEAST SQUARES LINE (LBS/HR) IS -33.8425

B = INTERCEPT OF LEAST SQUARES LINE (LBS) IS 626,493.4

L_{am} = MEASURED LEAK RATE IS 0.1296%/DAY

UCL = 95 PERCENT UPER CONFIDENCE LEAKAGE RATE IS 0.1418%/DAY

2. TOTAL TIME RESULTS

A = SLOPE OF LEAST SQUARES LINE (%/DAY/HR) IS -0.0174

B = INTERCEPT OF LEAST SQUARES LINE (%/DAY) IS 0.3176

L_{am} = MEASURED LEAK RATE IS 0.1257%/DAY

UCL = 95 PERCENT UPPER CONFIDENCE LEAKAGE RATE IS 0.1728%/DAY

MEAN LEAKAGE RATE FOR LAST FIVE HOURS IS 0.170%/DAY

3. VERIFICATION TEST

A = SLOPE OF LEAST SQUARES LINE (LBS/HR) IS -61.12

B = INTERCEPT OF LEAST SQUARES LINE (LBS) IS 626,165

L_c = COMPOSITE LEAKAGE RATE IS 0.234%/DAY

APPENDIX E

LOCAL LEAK RATE TEST RESULTS - 1982

TYPE B TEST - REFUEL 3

	As Found (SCCM)	As Left (SCCM)
Equipment Hatch Resilient Seals	0	0
Fuel Transfer Tube Gasket - 3B	0	0
Fuel Transfer Tube Gasket	0	0
LRV-44 and Blind Flange	90	90
Chemical Cleaning Penetration Gaskets 119	2	2
Chemical Cleaning Penetration Gaskets 120	2	2
Total Type B	94	94

TYPE C TESTS - REFUEL 3

NOTE: All leakrate measurements are in SCCM

		As Found		As Left	
Pen. No.	Valve No.	Valve	Path	Valve	Path
329	DHV-93	52	52	52	52
	DHV-91	2		2	
439	CAV-1	50		50	
	CAV-3	60		60	
	CAV-126	3200	3310	3200	3310
	CAV-2	80		80	
206	CIV-41	73	73	73	73
207	CIV-40	8000	8000	2	2
366	CIV-34	2	2	2	2
367	CIV-35	389	389	389	389
117	DWV-162	2540	2540	2540	2540
	DWV-160	407		407	
333	MUV-40	15	23	15	23
	MUV-41	8		8	
	MUV-49	2		2	
377	MUV-258	2		2	
	MUV-259	2		2	
	MUV-260	2		2	
	MUV-261	29		29	
	MUV-253	30	35	30	35
339	WDV-3	780	780	780	780
	WDV-4	120		120	
349	WDV-60	0		0	
	WDV-61	>20000	>20000	2	2

Pen. No.	Valve No.	As Found Valve	As Found Path	As Left Valve	As Left Path
354	WDV-405	440		440	
	WDV-406	481	481	481	481
374	WDV-94	20	20	20	20
	WDV-62	19		19	
315	WSV-3	100		100	
	WSV-4	110	110	110	110
332	WSV-5	2		2	
	WSV-6	41	41	41	41
356	WSV-1	37	37	37	37
	WSV-2	33		33	
347	SFV-18	>20000	>20000	37026	27026
	SFV-19	0		0	
373	CFV-19	1490		1490	
	CFV-25	1984	1984	1984	1984
123	CFV-20	607		607	
	CFV-28	689	689	689	689
350	CFV-18	7050	7050	7050	7050
	CFV-26	6150		6150	
124	CFV-17	7140	7140	7140	7140
	CFV-27	5904		5904	
351	CFV-16	9	12	9	12
	CFV-15	3		3	
	CFV-29	2		2	
352	CFV-11	3		3	
	CFV-12	5	8	5	8
	CFV-42	3		3	

Pen. No.	Valve No.	As Found Valve	As Found Path	As Left Valve	As Left Path
355	NGV-62	1655	1655	1655	1655
372	NGV-82	130	130	130	130
110	SAV-24	>20000	>20000	2	
	SAV-122	3670		3670	3670
	SAV-23				
111	IAV-28	2688	2688	2688	2688
116	LRV-45	2		2	
	LRV-46	55	55	55	55
121	LRV-50	1656		1656	
	LRV-36	2158	2158	2158	2158
122	LRV-51	12491		4112	4112
	LRV-35	>20000	>20000	2	
	LRV-47				
125	LRV-49	>20000	>20000	2	
	LRV-38	2916		2916	2916
	LRV-52				
113	AHV-1C	11065	11065	45	
	AHV-1D	0		45	45
357	AHV-1A	>20000	>20000	140	
	AHV-1B	>3000		140	140
430	FSV-262	NA	NA	5320	5320
	FSV-261	NA		1600	
Total Type C			170,527		84,695

LeakRate(Results)DN8-3

LOCAL LEAK RATE TEST REPORT

APPENDIX E-2

LLRT'S PERFORMED BETWEEN REFUELING OUTAGES

Description	As Found SSC/M	Retest SCC/M	As Left SCC/M	Date Tested
AHV-1C/D	61,327	N/A	290	12/17/80
AHV-1A/B	894	0	0	2/6/81-2/11/81*
AHV-1C/D	0	N/A	0	2/12/81
AHV-1C/D	**285,000	24,276	24,276	3/2/81*
CFV-15/16	330	N/A	330	3/5/81
AHV-1C/D	72	N/A	72	3/11/81*
AHV-1A/B	19,890	N/A	19,890	4/4/81
AHV-1C/D	35	N/A	35	3/20/81*
AHV-1C/D	**2.2×10^6	2,732	2,732	4/4/81*
AHV-1C/D	0	N/A	0	4/9/81*
AHV-1C/D	686	N/A	686	4/15/81*
AHV-1C/D	0	N/A	0	4/24/81*
AHV-1C/D	0	N/A	0	5/1/81*
CAV-2	230	N/A	230	6/7/81
AHV-1C/D	**522,778	0	0	6/26/81*
AHV-1A/B	0	N/A	0	6/26/81
AHV-1C/D	0	N/A	0	6/29/81
AHV-1C/D	658	N/A	658	7/1/81
AHV-1C/D	**5.2×10^5	1,253	1,253	7/8/81*

* Series of tests run to insure operability of valves.

**See appendix E-3 for analysis of failures.

APPENDIX E-3

AHV 1A & B

One failure on 5/10/79. Leakage greater than .6La.
Valves subsequently passed after adjustment of discs and EPR seat.
No failures since.

AHV 1C & D

Failure on 1/5/80 - valve sealed after four hour period.

Failure on 12/16/80 - valve sealed after 20 minutes.

These two failures were diagnosed as being temperature related. Low ambient air would cool the seals causing shrinkage and distortion. From 1/5/81 through 2/12/81 a series of tests were run to determine the temperature sensitivity of the seats. A large number of these tests were "failures," but this was due to the different test conditions (i.e., low temperature). A temperature of approximately 85° was determined to be the minimum temperature that would still allow sealing.

Valves were tested and failed on 3/1/81, after being reset from 90° to 65°. This was after a forced outage during which valves had been opened to 90°. Valves were tested after maintenance, not in their "as found" condition.

Valves tested on 4/4/81, again after a forced outage during which they had been opened to 90°, and also after maintenance had been performed. Another "failure."

Valves tested on 6/25/81, after being reset from 65° to 55°. Failure attributed to testing after maintenance.

Valves tested 7/7/81 after being reset to 90°. Failure attributed to testing after maintenance.

Current Program:

1. Maintain 95° with purge heaters.

2. Obtain "as found" condition - test prior to maintenance.

3. Test every 6 months - will be increased to every 3 months.

Have had no failures since 7/7/81.

APPENDIX F

LOCAL LEAK RATE TEST RESULTS - 1983

TYPE B TEST - REFUEL 4

	As Found (SCCM)	As Left (SCCM)
Equipment Hatch Resilient Seals	4.1	9.9
Fuel Transfer Tube Gasket - 3B	2	2.41
Fuel Transfer Tube Gasket	2	2.0
LRV-44 and Blind Flange	88.0	28.6
Chemical Cleaning Penetration Gaskets 119	2	2
Chemical Cleaning Penetration Gaskets 120	2	52
Total Type B	100.1	96.91

TYPE C TESTS - REFUEL 4

NOTE: All leakrate measurements are in SCCM

		As Found		As Left	
Pen. No.	Valve No.	Valve	Path	Valve	Path
329	DHV-93	6	6	6	
	DHV-91	2.8		7.2	7.2
439	CAV-1	95		2	
	CAV-3	6		2	
	CAV-126	1730	1831	2	
	CAV-2	238		238	238
440	CAV-4	3.6		3.6	
	CAV-6	151	151	151	151
441	CAV-5	2	530	2	
	CAV-7	530		530	530
439	CAV-424	NA	NA	2520	2520
	CAV-431			1069	
439	CAV-430	NA	NA	801	
	CAV-432			2780	2780
425	CAV-433	NA	NA	2	2
	CAV-435			2	
425	CAV-434	NA	NA	2	
	CAV-436			2	2
206	CIV-41	838	838	838	838
207	CIV-40	4460	4460	1945	1945
366	CIV-34	2.5	2.5	2.5	2.5
367	CIV-35	122.5	122.5	122.5	122.5

Pen. No.	Valve No.	As Found Valve	As Found Path	As Left Valve	As Left Path
117	DWV-162	1805	1805	1805	
	DWV-160	1040		6260	6260
333	MUV-40	4.1		2.0	
	MUV-41	1375	1379.1	9200	9202
	MUV-49	459		459	
377	MUV-258	2		148.2	154.2
	MUV-259	2		2	
	MUV-260	2		2	
	MUV-261	6.75	12.75	2	
	MUV-253	2		2	
121	LRV-50	195.3		195.3	
	LRV-36	358	358	358	358
122	LRV-51	89.6		89.6	
	LRV-35				
	LRV-47	11240	11240	1841	1841
125	LRV-49	412	412	412	412
	LRV-38				
	LRV-52	202		202	
116	LRV-45	2.5		2.5	
	LRV-46	1394	1394	1394	1394
305	LRV-70	NA	NA	36.5	36.5
	LRV-72	NA		9.8	
306	LRV-73	NA		3.1	3.1
	LRV-71	NA	NA	2	
123	CFV-20	424	424	424	424
	CFV-18	350		350	
373	CFV-19	314		148.5	
	CFV-25	1597	1597	189	189

Pen. No.	Valve No.	As Found Valve	As Found Path	As Left Valve	As Left Path
124	CFV-17	3070	3070	179.9	
	CFV-27	1178		558	558
350	CFV-18	3420	3420	101.6	
	CFV-26	157.6		4190	4190
351	CFV-15	2		2	
	CFV-16	26.1	28.1	2	
	CFV-29	6.3		2	4
352	CFV-11	2.7		33.8	35.8
	CFV-12	2.0		2.0	
	CFV-42	26.6	26.6	2.0	
355	NGV-62	150.3	150.3	150.3	150.3
372	NGV-82	24.8	24.8	24.8	24.8
317	NGV-81	517	517	517	517
110	SAV-24	1000		1000	
	SAV-122				
	SAV-23	2300	2300	2300	2300
111	IAV-28	89.5	89.5	89.5	89.5
339	WDV-3	2		5.24	5.24
	WDV-4	69.9	69.9	2	
349	WDV-60	NA	0	11.1	11.1
	WDV-61	NA		2	
354	WDV-405	24.6	24.6	3.1	
	WDV-406	21.2		7.2	7.2
374	WDV-94	2		2	
	WDV-62	2	2	170	170

LeakRate(Results)DN8-3

Pen. No.	Valve No.	As Found Valve	As Found Path	As Left Valve	As Left Path
315	WSV-3	70		21.1	21.1
	WSV-4	72	72	5.6	
332	WSV-5	52.4		2	
	WSV-6	189	189	27	27
356	WSV-1	51.1	51.1	51.1	51.1
	WSV-2	48.5		48.5	
356	WSV-34	NA	NA	14.4	14.4
	WSV-35	NA		2.8	
356	WSV-30	NA	NA	19.6	19.6
	WSV-31	NA		4.5	
356	WSV-38	NA	NA	3.47	
	WSV-39	NA		3.5	3.5
306	WSV-28	NA	NA	14.96	14.96
	WSV-29	NA		4.67	
306	WSV-26	NA	NA	4.85	
	WSV-27	NA		5.3	5.3
306	WSV-32	NA	NA	11.05	
	WSV-33	NA		11.65	11.65
376	WSV-41	NA	NA	2	
	WSV-40	NA		2	2
	WSV-42	NA		2	
	WSV-43	NA	NA	2	2
113	AHV-1C		1600		802
	AHV-1D				
357	AHV-1A		690		590
	AHV-1B				

LeakRate(Results)DN8-3

		As Found		As Left	
Pen. No.	Valve Nc.	Valve	Path	Valve	Path
112	IAV-29	594	594	594	594
347	SFV-18	28000	28000	34000	34000
	SFV-19	12340		9310	
430	FSV-262	1980	1980	1980	1980
	FV-261	25		25	
316	MSV-114	106	106	106	106
320	MSV-132	132	132	132	132
318	MSV-128	2.5	2.5	2.5	2.5
314	MSV-146	1740	1740	1740	1740
427	MSV-130	189	189	189	189
428	MSV-148	27.6	27.6	27.6	27.6
Total Type C			71,658.85		77,810.65

NOTE: All "As Found" leakage rates with NA in the column are due to modifications during Refuel IV. The valves did not exist prior to shutdown for Refuel IV.

APPENDIX F-2

LLRT'S PERFORMED BETWEEN REFUELING OUTAGES

Description	As Found SSC/M	Retest SCC/M	As Left SCC/M	Date Tested
WDV-94	15.0	N/A	15.0	3/3/82
SAV-23/122	3670	N/A	3670	3/26/82
AHV-1C/1D	14.0	N/A	14.0	5/18/82
AHV-1A/1B	480.1	N/A	480.1	5/18/82
AHV-1C/1D	0.0	N/A	0.0	10/26/82
AHV-1A/1B	1856.0	N/A	1856.0	10/26/82
WDV-60/61	0.0	N/A	0.0	10/29/82
Equip. Hatch Resilient Seals	0.0	N/A	0.0	11/29/82
CAV-1	640.0	0.0	0.0	12/2/82
MUV-40/41	>20,000	11104.0	11104.0	12/3/82
AHV-1A/1B	2893	N/A	2893	12/18/82
AHV-1C/1D	346.0	N/A	346.0	12/18/82
Equip. Hatch Resilient Seals	0.0	N/A	0.0	12/18/82
MUV-49	330	N/A	330	12/19/82
PHAL (airlock)	41.41	N/A	41.41	6/25/82
EHAL (airlock)	427	N/A	427	6/22/82
PHAL (airlock)	2220	N/A	2220	1/21/83
EHAL (airlock)	10330	N/A	10330	1/25/83