ATTACHMENT 2

Mississippi Power &
Light Company

# GRAND GULF NUCLEAR STATION UNIT 1

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## Primary Reactor Containment Integrated Leakage Rate Test

Final Report
November 1985

MISSISSIPPI POWER AND LIGHT COMPANY

GRAND GULF NUCLEAR STATION

UNIT 1

# REACTOR CONTAINMENT BUILDING

# INTEGRATED LEAKAGE RATE TEST

# FINAL REPORT

Prepared by
Bechtel Power Corporation
San Francisco, CA
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SU-088a

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## 1.0 INTRODUCTION

The first periodic Integrated Leakage Rate Test (ILRT) on the Grand Gulf Nuclear Station Unit 1 reactor containment building was performed on November 3-4, 1985. The test was conducted to demonstrate that leakage from the containment system at the design loss of coolant accident pressure does not exceed the maximum allowed by the Technical Specification (Ref. 6.1). The ILRT was conducted in accordance with a mechanical surveillance procedure (Ref. 6.2) which conformed to the general testing requirements established in Appendix J to 10CFR50 (Ref. 6.3), ANSI N45.4-1972 (Ref. 6.6), ANSI/ANS 56.8-1981 (Ref. 6.4) and Bechtel Topical Report BN-TOP-1 (Ref. 6.5).

The balance of this report presents test results, describes test events and methodology and lists the data necessary to support the stated results. The ensuing material is organized into the following sections.

- Section 2, Results Summary, lists the leakage rates determined during the test and the acceptance criteria.
- Section 3, Chronology, describes the activities performed in support of the test.
- Section 4, Methodology, describes test methods and instrumentation.
- Section 5, Test Data and Results Analysis, discusses the data acquired to establish the results and presents an analysis of the results.
- Section 6, References, lists the documents cited in the body of the report.
- The Appendices contain a description of the ILRT computer program and tabular listings of all supporting data.

## 2.0 RESULTS SUMMARY

Containment pressurization was completed at 1425 hours on November 3, 1985. Temperature stabilization criteria were met by 1830 hours. However, initially calculated leakage was outside the acceptance limit and the start of the formal test was delayed until the leakage source (main steam lines C and D isolation valves and spare standby liquid control isolation valves) had been found and isolated. The formal test commenced at 0545 hours on November 4 and was completed at 1415 hours. Results of the 8.5-hour test, which confirmed an acceptable leakage rate, are tabulated below.

| Calculation Method | Mass Point | | Total Time* | |
|---|---|---|---|---|
| | Calculated | 95% UCL | Calculated | 95% UCL |
| Calculated Rate | 0.137 wt.%/day | 0.141 wt.%/day | 0.129 wt.%/day | 0.183 wt.%/day |
| Additions (per Section 5) | 0.004 wt.%/day | 0.004 wt.%/day | 0.004 wt.%/day | 0.004 wt.%/day |
| Net Rate | 0.141 wt.%/day | 0.145 wt.%/day | 0.133 wt.%/day | 0.187 wt.%/day |
| Acceptance Limit | 0.328 wt.%/day | 0.328 wt.%/day | 0.328 wt.%/day | 0.328 wt.%/day |

The supplemental test calibrated leakage was imposed immediately following the 1415 hour data point. The supplemental test commenced at 1530 hours, following the required one hour stabilization period, and was completed at 1945 hours. Results of the 4.25 hour supplemental test, which confirmed the correctness of the leakage rate calculational method, are tabulated below.

| Calculation Method | Mass Point | Total Time |
|---|---|---|
| Upper Acceptance Limit | 0.684 wt.%/day | 0.675 wt.%/day |
| Calculated Rate | 0.543 wt.%/day | 0.555 wt.%/day |
| Lower Acceptance Limit | 0.465 wt.%/day | 0.457 wt.%/day |

* Additional Total Time results based on trend values and the corresponding acceptance criteria, which were satisfied, are presented in Section 5.

## 3.0 CHRONOLOGY

Test prerequisites specified in Ref. 6.2, including the containment exterior and interior inspections mandated in Ref. 6.3, were completed by November 3, 1985. No evidence of structural deterioration was found during the containment inspection. Completion of prerequisites, containment systems status and inspection results are documented in the Official Test Copy of Ref. 6.2, which is maintained as a part of permanent plant records. Containment pressurization commenced at 0630 hours on November 3, and was stopped at 1425 hours on the same day when containment pressure had reached 12.25 psig, which is 0.75 psig above the minimum test pressure of 11.5 psig. Pressurizing equipment consisted of air compressors with an aggregate capacity of approximately 6,000 SCFM, aftercooler/moisture separators and a refrigerated air dryer. This equipment maintained an almost constant pressurization rate of about 1.5 psi/hr. Containment fan coolers were run during pressurization to minimize temperature stratificaion. Cooling water was run through the fan cooler coils to control containment air temperature. Fan coolers and cooling water were shut off immediately following the completion of pressurization. Containment lights had been previously turned off.

Temperature stabilization criteria specified in Ref. 6.2 were met by 1830 hours, four hours following the completion of pressurization. Calculations performed using data recorded during the stabilization period indicated a stable leakage rate of about 0.7 wt.%/day, which was more than twice the 0.328 wt.%/day allowable. Data recorded over the next few hours confirmed this initially calculated rate. Leak search teams examined all containment penetrations and identified significant leakage at the open vents outboard of main steam isolation valves Q1B21F028C and Q1B21F028D. A possibly significant leak was identified at the open vent outboard of isolation valve Q1C41F150 in the spare standby liquid control line passing through penetration 61. These leakages were reduced to negligible values by shutting the vents.* This corrective action was completed at 0104 hours on November 4.

During the stabilization and subsequent leak search periods, reactor water level had dropped to 65 inches and required makeup. Level was restored to 84 inches by an injection starting at 0212 hours and ending at 0226 hours. Calculations performed using data recorded following the reactor makeup indicated that leakage had been reduced to an acceptable level. When this reduction had been confirmed using data recorded over a three-hour period, a formal test start was declared at 0545 hours.

Calculations using data recorded during the first 8 hours of test (the minimum acceptable test duration) showed a stable and acceptable leakage rate. It was intended to end the primary test and initiate the imposed leak for the supplemental test at 1345 hours. However, due to a delay in receiving the release authorization from Health Physics, the imposed leak

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* Additions to the calculated leakage rate are required by the resulting non-standard valve lineups. These are discussed in Section 5.

was not initiated until after 1415 hours. The primary test was extended for the additional half hour so that its end would coincide with the start of the supplemental test. The one-hour stabilization period for the supplemental test ended at 1530 hours and the supplemental test itself was concluded at 1945 hours (giving it a duration of 4.25 hours which is half the duration of the primary test).

The pressure at the end of the supplemental test was 12.1 psig. During the entire test period, pressure was between 12.25 psig and 12.1 psig, well within the 11.5 to 13.5 psig acceptable range.

The containment was depressurized following the supplemental test and plant systems aligned for the ILRT were restored, as required, to conditions required for the support of subsequent outage activities. Depressurization and restoration are documented in the Official Test Copy of the procedure (Ref. 6.2).

Various items of data needed to support or supplement the ILRT were recorded at regular intervals during the test. These data include outside atmospheric conditions, reactor level, suppression pool level, upper pool level and the quantity of water removed from the drywell sumps (the last two items were recorded only before and after the test). All recorded data are included in the Official Test Copy of the procedure (Ref. 6.2). Data required to support reported ILRT results are included in Section 5.

## 4.0 METHODOLOGY

The integrated leakage rate test is performed to verify that leakage from the containment system (steel liner, mechanical/electrical penetrations and accessways) at calculated accident pressure does not exceed the specified limit. The containment is prepared for the test by closing all accessways and aligning valves in specified post-accident positions.* All items which could be damaged by test pressure or which contain gasses at pressures higher than the test pressure are either removed from the containment or vented. The test objective is accomplished by pressurizing the containment with clean, relatively dry air, closing the pressurizing line valves, measuring containment atmosphere parameters and using those measurements to determine air mass loss over a specified time period. After the leakage rate has been determined, the calculational method is verified by a supplemental test during which an additional known leakage is imposed on the containment.

### 4.1 Leakage Rate Calculational Methods

Containment leakage rate is calculated using the mass point and total time methods described in References 6.4 and 6.5. Both methods use containment pressures and temperatures recorded at 15-minute intervals as input data. The mass of dry air** in the containment is calculated for each 15 minutes data set using the ideal gas law. Dry air partial pressure is computed by subtracting the partial pressure of the water vapor (as determined from measured dew point temperature) from measured total pressure. The mass point leakage rate is defined as the normalized (divided by the calculated start of test air mass) slope of a line fitted to the mass/time data by the method of least squares. The total time leakage rate is defined as the end of test ordinate (normalized) of a line fitted to a series of measured leakage rate/time data points. A measured leakage rate is defined as the calculated change in air mass since the start of the test divided by the time since the start of the test. Both the mass point and total time methods utilize the variance of data points about the fitted line to establish the 95% upper confidence limit on leakage rate. References 6.4 and 6.5 describe the calculations in detail.

The leakage rate is calculated for a test period of at least 8 hours duration (which provides a minimum of 33 data points). The first data

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* Certain valves may not be in specified positions during the ILRT. Measured leakage through these valves is added to the calculated leakage rate to account for the non-standard lineup as described in Section 5.

** Evaporation and condensation of water change the partial pressure of the vapor phase. This partial pressure is eliminated from the leakage rate calculation so that internal phase changes are not erroneously accounted for as actual out (or in) leakage.

point used in the calculation is recorded at least 4 hours after the completion of containment pressurization. This allows the containment atmosphere to attain a reasonable degree of temperature equilibrum following the transient conditions created by pressurization. References 6.4 and 6.5 impose conditions on temperature changes which must be met prior to using recorded data in leakage rate calculations. These conditions are normally met within the 4 hour (minimum) stabilization period. Following the determination of leakage rate (8 hour minimum test) a supplemental test is conducted to verify the correctness of the calculations.* The supplemental test consists of venting a small flow (approximately equal to the allowable leakage rate) from the containment through a flow measuring device and calculating the increased leakage rate. The calculated increased rate must equal the previously calculated rate plus the imposed flow plus or minus a tolerance of 25 percent of the allowable leakage rate, as required by References 6.3, 6.4, and 6.5. In addition, Reference 6.1 requires that the calculated increased rate minus the imposed flow shall be within plus or minus a tolerance of 25 percent of the previously calculated rate. The supplemental test has a duration of at least 4 hours. All calculations are performed by the computer program described in Appendix A.

## 4.2 Instrumentation and Test Data Acquisition

The calculations performed for the ILRT (primary and supplemental tests) require the measurement of containment absolute pressure, drybulb temperature, dewpoint temperature (or relative humidity), time and flow rate (supplemental test). Pressure is measured at a single point using one primary and one backup gauge. Temperatures, both drybulb and dewpont, are measured at numerous points to permit determination of reasonably accurate volume weighted mean values. Volume weights are calculated for each temperature sensor based on the geometry of the surrounding region, the presence of heat/moisture sources or sinks, and the tendency of temperature to stratify in the vertical direction in open areas. Time and flow are single point measurements.

Table 4.1 lists the locations of, and volume weights assigned to,** the 22 drybulb and 6 dewpoint temperature sensors placed in the Grand Gulf containment. As noted on the table, about 1/3 of the temperature sensors are located in the drywell, which is an essentially closed compartment with its own temperature and vapor pressure regimes. Since the drywell is vented to the rest of the containment through the blocked open personnel air lock, total pressure is equalized and separate compartment pressure measurements are not necessary.

The drybulb and dewpoint temperature sensors are connected to a data logger which provides appropriate conditioning for the sensor input

* The supplemental test also verifies the absence of a significant systematic error in the pressure measurement system.

** Calculations of volume weights are retained in permanent plant records.

signals. The logger, which has a built-in clock for time measurement, automatically generates date/time and temperature records at 15-minute intervals. Logger output consists of a printed paper tape and serial data transmission to a desktop computer which performs the leakage rate computations. Pressure and flow data are manually recorded and manually entered into the computer via keyboard.

Table 4.2 provides descriptions and performance specifications for the sensors and logger used to acquire data for the Grand Gulf test.

Reference 6.4 specifies an upper limit of 0.25 $L_a$ (the allowable leakage rate = 0.437 wt.%/day) on the mean square random error of the instrumentation system. The mean square error is based on the sensitivities and repeatabilities listed in Table 4.2. The complete calculation of the Instrument Selection Guide (ISG), which is given in Appendix B, shows this error to be 0.044 $L_a$ for an 8-hour test.

TABLE 4.1

INSTRUMENT LOCATIONS

| Instrument Type | Designation | Elevation | Radius | Azimuth | (1)C/D | Fraction |
|---|---|---|---|---|---|---|
| Drybulb Temperature | TE-1 | 290' | 18' | 0° | C | 0.023 |
| Drybulb Temperature | TE-2 | 280' | 18' | 180° | C | 0.038 |
| Drybulb Temperature | TE-3 | 260' | 40' | 270° | C | 0.062 |
| Drybulb Temperature | TE-4 | 270' | 12' | 90° | C | 0.052 |
| Drybulb Temperature | TE-5 | 228' | 30' | 45° | C | 0.087 |
| Drybulb Temperature | TE-6 | 250' | 30' | 135° | C | 0.067 |
| Drybulb Temperature | TE-7 | 215' | 30' | 225° | C | 0.090 |
| Drybulb Temperature | TE-8 | 240' | 30' | 315° | C | 0.077 |
| Drybulb Temperature | TE-9 | 184' | 52' | 222° | C | 0.058 |
| Drybulb Temperature | TE-10 | 174' | 52' | 305° | C | 0.057 |
| Drybulb Temperature | TE-11 | 165' | 27' | 150° | D | 0.022 |
| Drybulb Temperature | TE-12 | 150' | 52' | 150° | C | 0.057 |
| Drybulb Temperature | TE-13 | 150' | 52' | 90° | C | 0.057 |
| Drybulb Temperature | TE-14 | 122' | 52' | 0° | C | 0.057 |
| Drybulb Temperature | TE-15 | 122' | 52' | 180° | C | 0.058 |
| Drybulb Temperature | TE-16 | 148' | 27' | 230° | D | 0.022 |
| Drybulb Temperature | TE-17 | 114' | 27' | 90° | D | 0.022 |
| Drybulb Temperature | TE-18 | 130' | 27' | 180° | D | 0.023 |
| Drybulb Temperature | TE-19 | 165' | 27' | 340° | D | 0.022 |
| Drybulb Temperature | TE-20 | 149' | 27' | 32° | D | 0.022 |
| Drybulb Temperature | TE-21 | 114' | 27' | 270° | D | 0.022 |
| Drybulb Temperature | TE-22 | 108' | 0' | 0° | D | 0.005 |
| Dewpoint Temperature | ME-1 | 264' | 54' | 90° | C | 0.175 |
| Dewpoint Temperature | ME-2 | 232' | 58' | 225° | C | 0.321 |
| Dewpoint Temperature | ME-3 | 174' | 52' | 305° | C | 0.172 |
| Dewpoint Temperature | ME-4 | 122' | 48' | 0° | C | 0.172 |
| Dewpoint Temperature | ME-5 | 148' | 32' | 32° | D | 0.080 |
| Dewpoint Temperature | ME-6 | 114' | 26' | 270° | D | 0.080 |

(1) C - Containment/D - Drywell

TABLE 4.2

ILRT INSTRUMENTATION

| Number Used | Function/Description | (1) Specifications |
|---|---|---|
| | Pressure | |
| 2 | Quartz Bourdon Tube Precision Pressure Gage with Optical Sensor Tracking | Calibrated Range: 0-30 PSIA<br>Calibration Accuracy: 0.015% of Range<br>Sensitivity: 0.001 PSIA<br>Repeatability: 0.001 PSIA<br>Resolution: 0.0003 PSIA |
| | Drybulb Temperature | |
| 22 | 100 Ohm Platinum Resistance Temperature Detector | Calibrated Range: 60-120°F<br>Calibration Accuracy: 0.1°F<br>(2)System Accuracy: 0.6°F<br>Sensitivity: 0.1°F |
| 6 | Dewpoint Temperature<br>Chilled Mirror Hygrometer | Calibrated Range: 40-100°F<br>Calibration Accuracy: 0.1°F<br>(2)System Accuracy: 1.05°F<br>Sensitivity: 0.1°F |
| 1 | Flow<br>Float in Sight Glass Flowmeter | Calibrated Range: 2-20 SCFM<br>Calibration Accuracy: 0.2 SCFM<br>Sensitivity: 0.1 SCFM<br>Repeatability: 0.1 SCFM<br>Resolution: Analog |
| 1 | Time<br>Digital Clock with Julian Date, Hour, Minute and Second Display | Resolution: 1 sec.<br>Accuracy: 1 sec/24 hours |
| 1 | Data Logger<br>Relay Type Multiplexer with A/D Converter and Printed Paper Tape/ RS232 Output | Repeatability: 0.01°F for Drybulb and Dewpoint Temperatures |

(1) Calibration data are on file in permanent plant records. Calibration due date is May 1, 1986 for all instruments.

(2) System accuracy is established by comparing the data logger indication for an installed test sensor to the indication of a standard sensor placed alongside the test sensor.

## 5.0 TEST DATA AND RESULTS ANALYSIS

The data required to calculate containment leakage rate include: containment atmosphere parameters for determination of air mass; pool and sump levels to correct computed air mass for changes in containment free volume; and leakages through isolation valves in penetrations which were not in the specified drained and vented postLOCA configuration during the test. The leakages through the isolation valves are added to the calculated leakage rate to determine the rate which would have been measured had the associated penetrations been drained and vented. Subsections 5.1, 5.2 and 5.3 cover, respectively, calculated leakage (including the supplemental test), free volume corrections and local leakage rate (isolation valve leakage) additions. Subsection 5.4 summarizes composite test results. Subsection 5.5 lists plant specific data which are of interest and tabulates the types of data which are retained in permanent records.

### 5.1 Calculated Leakage Rate

Containment atmosphere parameters (pressure, drybulb temperature and dewpoint temperature) were recorded at 15 minute intervals from the completion of containment pressurization through the completion of the supplemental test.* Air masses (dry air component) calculated using these data are plotted with time in Figure 5.1. The transient conditions generated during pressurization affect the first two hours of the plot (initially rising followed by unchanging calculated air mass). After about 1630 hours (November 3), the distribution of temperatures in the containment had reached a condition of dynamic equilibrium and subsequent calculated masses followed the expected straight line trend. The slope of the initial line was 0.68wt.%/day which is in excess of the allowable leakage rate of 0.437wt.%/day. As discussed in Section 3, this large leakage rate was found to result from excessive flows through the isolation valves in main steam lines C and D and the spare standby liquid control line. These leaks were isolated at about 0100 hours on November 4. There appears to be a change in the slope of the mass/time plot starting at this point but the start of a new trend is obscured by the calculated mass increase resulting from an injection of makeup water to the reactor vessel between 0212 and 0226 hours. The makeup water injection appears as a mass increase since it reduces containment free volume.**

Following the injection, the air mass plot follows a straight line trend for 11 hours. The slope of the line is equivalent to 0.14wt.%/day which is well below the acceptance limit of 0.328wt.%/day. The acceptance

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* Additional data were recorded during pressurization but are not used in leakage rate determination. These data are retained in permanent plant records.

** Mass is calculated using the equation $M = PV/RT$ where M is air mass, P is absolute pressure, V is free volume, R is the gas constant for air, and T is absolute temperature.

limit, which applies to the composite leakage rate as discussed in subsection 5.4, is equal to 75% of the allowable leakage rate of 0.437wt%/day.

The final segment of the mass/time plot covers the supplemental test period. An additional leakage of 0.44wt.%/day was imposed just after 1415 hours and terminated just after 1945 hours. The slope of the mass/time plot over this 5.5 hour period is 0.54wt.%/day which is close to the expected value of 0.58wt.%/day.

The official test start was declared at 0545 hours on November 4 following the completion of reactor makeup water injection and subsequent evaluation of the effectiveness of main steam penetration isolation. The test continued until 1415 hours (8.5 hour duration) when Health Physics authorized the release of supplemental test flow into the auxiliary building. The following paragraphs discuss temperature stabilization, mass point calculation results, total time calculation results and supplemental test results.

### 5.1.1 Temperature Stabilization

Temperature variations which are excessively unsteady and nonuniform will distort mass calculations since the limited number of temperature sensors will not provide true mean temperature data under these conditions. Three temperature stabilization criteria must be met prior to starting a test. These are:

1. (Refs. 5.4 and 5.5) A minimum of four hours must have elapsed since the completion of pressurization.

2a. (Ref. 5.5) The rate of change of mean temperature is less than 1°F/hour averaged over the last 2 hours

OR

2b. The rate of change of mean temperature change is less than 0.5°F/hour$^2$ averaged over the last two hours.

3. (Ref. 5.4) The rate of change of mean temperature over the last hour does not deviate by more than 0.5°F/hour from the rate of change over the last four hours.

These criteria were all met by 1830 hours, four hours following the completion of pressurization, as shown in Table 5.1. Figure 5.2 is a plot of mean temperature over the entire period from completion of pressurization to completion of the supplemental test. Figure 5.3 plots mean vapor pressure (derived from dewpoint temperature) over the same time period. Both mean temperature and mean vapor pressure have smooth, asymptotic trends. Absolute pressure measured over the same time period is shown in Figure 5.4 for information. The effect of increasing reactor level is illustrated on the plot.

5.1.2 Mass Point Calculation Results

Mass point calculation summary data and results are listed in Table 5.2 and illustrated in Figure 5.5. The end of test 95% upper confidence limit (UCL) on the calculated leakage rate is 0.141wt.%/day which is well below the acceptance limit of 0.328wt.%/day (shown as $0.75L_a$, where $L_a$ is the 0.437 wt.%/day allowable leakage rate, on Figure 5.5). As is illustrated in Figure 5.5, the UCL converges to the calculated leakage rate as the calculation time interval increases.* Figure 5.6 expands the mass/time plot of Figure 5.1 over the 8.5-hour test period.

5.1.3 Total Time Calculation Results

Total time calculation summary data and results are listed in Tables 5.3 and 5.4 and illustrated in Figure 5.7. The end of test UCL on the calculated leakage rate (Table 5.3) is 0.183wt.%/day which is well below the acceptance limit of 0.328 wt.%/day. As illustrated in the Figure, the UCL is tending to converge on the calculated rate. The calculated mass point and total time end of test rates are close to equal (0.137 and 0.129, respectively). However, the total time end of test UCL is well above the mass point end of test UCL. This results from the conservatism inherent in the total time UCL calculation.

Table 5.4 lists the total time trends for leakage rates calculated in quarter-hour increments from 2 to 8.5 hours of data. This trend report shows that the calculated rate is tending to stabilize at a value below 0.328wt.%/day.

Table 5.3 lists the mean of the measured leakage rates determined for the last 5 hours of test data. The mean is less than 0.328wt.%/day.

5.1.4 Supplemental Test

The supplemental test was conducted for 4.25 hours with a 9.24 SCFM flow vented from the containment through a calibrated flow meter. This flow is equivalent to $L_a$ = 0.437wt.%/day at test pressure (no temperature correction is made in converting SCFM to wt.%/day since test and standard temperatures are not sufficiently different to justify the conversion). The containment was allowed to stabilize for one hour after imposing the flow. Supplemental test calculation summary data and results, using the acceptance criteria of references 6.3, 6.4, and 6.5, are listed in Table 5.5 and illustrated (Mass Point Analysis) in Figure 5.8. Calculated leakage rates and acceptance limits are:

* The rates and UCLs plotted are for calculations starting with 0545 data and ending with data taken at 0745, 0800, 0815, ......, 1400 and 1415.

| | CALCULATION METHOD | |
|---|---|---|
| | Mass Point | Total Time |
| Upper Limit | 0.684wt.%/day | 0.675wt.%/day |
| Calculated Leakage Rate | 0.543 | 0.555 |
| Lower Limit | 0.465 | 0.457 |

Calculated leakage rates are well within the limits for both the mass point and total time cases. Determination of the upper and lower limits is discussed in Section 4. The acceptance criteria of Reference 6.1 are significantly more conservative than those of References 6.3, 6.4, and 6.5 for the supplemental test. The calculated leakage rates and acceptance limits are:

| | CALCULATION METHOD | |
|---|---|---|
| | Mass Point | Total Time |
| Calculated leakage rate during ILRT ($L_v$) | .137 | .129 |
| Imposed leakage rate ($L_o$) | .437 | .437 |
| Calculated leakage rate during Supplemental Test ($L_c$) | .543 | .555 |
| Upper Limit (1.25 $L_v$) | .171 | .161 |
| $L_v' = L_c - L_o$ | .106 | .118 |
| Lower Limit (.75 $L_v$) | .103 | .097 |

Although the containment leakage rate ($L_v'$) is close to the lower limit by Mass Point calculations, it is still acceptable. The containment leakage rate is well within the limits by Total Time calculation.

### 5.2 Free Volume Corrections

The initial free volume of the containment (including drywell) with the upper and lower pools at specified levels was calculated at 1,670,360 cubic feet. Pre- and post-test measurements showed that upper pool and suppression pool levels did not change.

The drywell equipment drain tank/sump and floor drain sump were pumped down between 2200 and 2400 hours on November 2 and again between 0800 and 1000 hours on November 5. The following quantities of water were removed during the post-test pump down.

| | |
|---|---|
| Equipment Drain Tank/Sump | 520 gal. |
| Floor Drain Sump | 4,779 gal. |
| TOTAL | 5,299 gal. |

Reactor vessel levels recorded over the same time period are listed below:

| Date/Time | Level | Comment |
|---|---|---|
| 2 Nov/2330 | 81 in. | |
| 4 Nov/0211 | 65 in. | |
| 4 Nov/0226 | 84 in. | Raised by injection |
| 5 Nov/0730 | 75 in. | |
| Gross Drop | 6 in. | |
| Drop Restored By Injection | 19 in.* | |
| Net Drop | 25 in. | |

Volume Lost at 200 gal./in. = 5,000 gal.

The net gain in water inventory over the 56 hour (3 Nov/0000 to 5 Nov/0800) period is:

| | |
|---|---|
| Drywell Tank/Sump Gain | 5,299 gal. |
| Reactor Loss | -5,000 gal. |
| NET GAIN | 299 gal. |

The net gain of 299 gal. equates to 40 cubic feet. For a uniform rate of gain, 40 cubic feet in 56 hours is equivalent to 17.1 cubic feet in 24 hours. In the absence of containment leakage other than water inleakage, the net water gain would calculate to a negative leakage rate of 17.1/1,670,360 or 0.001 wt.%/day. Therefore, calculated leakage rates and UCL's are increased by 0.001 wt.%/day to account for gain in water inventory.

Complete data on tank, sump, reactor and pool levels are retained in permanent plant records.

* It is assumed that level would have dropped from 81 to 56 inches had there been no injection.

## 5.3 Local Leakage Rate Additions

A number of mechanical systems that penetrate containment and systems that are assumed (for design purposes) to be drained and vented postLOCA were maintained in operation during the test. Several penetrations were used for pressurization, pressure sensing and other purposes essential to test conduct, and were not in the specified postLOCA configurations. The penetrations serving main steam lines C and D and penetration 61, which serves as a spare standby liquid control line, were observed to be leaking potentially significant quantities of air during the initial phase of the test (see Section 3). These were isolated by closing vents.

To account for the leakage which would have passed through these penetrations in the normal postLOCA configuration, the minimum pathway local leakage for each is summed and the total is added to the calculated leakage rate UCLs. The leakages to be summed are determined as follows:

- o For all penetrations, the lesser of the leakages measured for a series path (in the simplest case, the lesser of the leakages measured through the inboard and outboard isolation valves).
- o For penetrations serving systems in service (including test penetrations), the as-left minimum pathway leakage determined during a local leakage rate test conducted before or after the integrated leakage rate test.
- o For test penetrations isolated with blind flanges having double O-ring or Flexitallic gasket seals, the local leakages measured following post-test replacement of the flanges.
- o For penetrations isolated to reduce leakage rate, the minimum pathway local leakage measured following post-test normal closure* or repair of the isolation valves.

Table 5.6 identifies all penetrations for which the penalty additions will be taken and lists the minimum pathway leakage rate. The total penalty leakage is 1650 SCCM which equates to a leakage rate of 0.003 wt.%/day at test pressure.

Appendix C contains a complete tabular listing of local leakage rate test results for all containment penetrations.

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* During the pre-test valve lineup, the main steam isolation valves were slow-closed using the test switches, rather than fast-closed. The SLC isolation valve, Q1C41F150, was not fully tightened.

5.4 Composite Test Results

The composite leakage rate is the sum of the calculated rate, the free volume correction and the local leakage rate penalty. Composite rates are summarized below:

| | Mass Point | | Total Time | |
|---|---|---|---|---|
| | Calculated | 95% UCL | Calculated | % UCL |
| Calculated Rate | 0.137 wt.%/day | 0.141 wt.%/day | 0.129 wt.%/day | 0.183 wt.%/day |
| Free Volume Correction | 0.001 wt.%/day | 0.001 wt.%/day | 0.001 wt.%/day | 0.001 wt.%/day |
| Local Leakage Penalty | 0.003 wt.%/day | 0.003 wt.%/day | 0.003 wt.%/day | 0.003 wt.%/day |
| Total (Composite) | 0.141 wt.%/day | 0.145 wt.%/day | 0.133 wt.%/day | 0.187 wt.%/day |
| Acceptance Limit | 0.328 wt.%/day | 0.328 wt.%/day | 0.328 wt.%/day | 0.328 wt.%/day |

5.5 Plant Specific and Retained Data

Table 5.7 lists various items of plant specific data and the major test parameters. Table 5.8 is a categorized listing of test backup data which is retained in permanent plant records.

TABLE 5.1

GRAND GULF NUCLEAR STATION 1985 ILRT
TEMPERATURE STABILIZATION

FROM A STARTING TIME AND DATE OF: 1430 1103 1985

| TIME (HOURS) | TEMP (°R) | AVE ΔT (4HRS) | ANSI AVE ΔT (1HR) | DIFF | BN-TOP-1 AVE ΔT (2HRS) |
|---|---|---|---|---|---|
| .00 | 541.65 | | | | |
| .25 | 541.17 | | | | |
| .50 | 540.93 | | | | |
| .75 | 540.77 | | | | |
| 1.00 | 540.68 | | | | |
| 1.25 | 540.62 | | | | |
| 1.50 | 540.58 | | | | |
| 1.75 | 540.55 | | | | |
| 2.00 | 540.52 | | | | -.562* |
| 2.25 | 540.50 | | | | -.335* |
| 2.50 | 540.49 | | | | -.221* |
| 2.75 | 540.47 | | | | -.148* |
| 3.00 | 540.47 | | | | -.106* |
| 3.25 | 540.46 | | | | -.079* |
| 3.50 | 540.45 | | | | -.063* |
| 3.75 | 540.44 | | | | -.055* |
| 4.00 | 540.42 | -.306 | -.042 | -.26* | -.025* |

* INDICATES TEMPERATURE STABILIZATION HAS BEEN SATISFIED

TABLE 5.2

GRAND GULF NUCLEAR STATION 1985 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 545 1104 1985
TEST DURATION: 8.50 HOURS

| TIME | TEMP (R) | PRESSURE (PSIA) | CTMT. AIR MASS (LBM) | MASS LOSS (LBM) | AVERAGE MASS LOSS (LBM/HR) |
|---|---|---|---|---|---|
| 545 | 540.230 | 26.3894 | 220236. | | |
| 600 | 540.230 | 26.3886 | 220230. | 6.3 | 25.3 |
| 615 | 540.231 | 26.3880 | 220224. | 5.9 | 24.5 |
| 630 | 540.221 | 26.3876 | 220225. | -.8 | 15.2 |
| 645 | 540.218 | 26.3870 | 220221. | 3.7 | 15.2 |
| 700 | 540.215 | 26.3866 | 220219. | 2.2 | 13.9 |
| 715 | 540.210 | 26.3860 | 220217. | 2.5 | 13.2 |
| 730 | 540.211 | 26.3855 | 220212. | 4.4 | 13.8 |
| 745 | 540.206 | 26.3851 | 220210. | 1.8 | 13.0 |
| 800 | 540.203 | 26.3842 | 220205. | 5.9 | 14.2 |
| 815 | 540.206 | 26.3840 | 220201. | 3.5 | 14.2 |
| 830 | 540.200 | 26.3831 | 220196. | 4.6 | 14.6 |
| 845 | 540.202 | 26.3827 | 220192. | 4.0 | 14.7 |
| 900 | 540.196 | 26.3821 | 220190. | 2.4 | 14.3 |
| 915 | 540.198 | 26.3817 | 220185. | 4.9 | 14.7 |
| 930 | 540.191 | 26.3814 | 220186. | -.9 | 13.5 |
| 945 | 540.192 | 26.3804 | 220177. | 9.1 | 14.9 |
| 1000 | 540.189 | 26.3801 | 220176. | 1.0 | 14.3 |
| 1015 | 540.189 | 26.3797 | 220173. | 3.1 | 14.2 |
| 1030 | 540.185 | 26.3788 | 220166. | 6.4 | 14.8 |
| 1045 | 540.173 | 26.3786 | 220170. | -3.8 | 13.3 |
| 1100 | 540.169 | 26.3781 | 220167. | 3.4 | 13.3 |
| 1115 | 540.167 | 26.3775 | 220163. | 4.1 | 13.4 |
| 1130 | 540.166 | 26.3769 | 220158. | 4.3 | 13.6 |
| 1145 | 540.167 | 26.3765 | 220155. | 3.3 | 13.6 |
| 1200 | 540.169 | 26.3763 | 220152. | 3.3 | 13.6 |
| 1215 | 540.167 | 26.3754 | 220145. | 6.3 | 14.0 |
| 1230 | 540.159 | 26.3751 | 220146. | -.8 | 13.4 |
| 1245 | 540.153 | 26.3750 | 220148. | -1.4 | 12.7 |
| 1300 | 540.161 | 26.3744 | 220140. | 8.1 | 13.4 |
| 1315 | 540.147 | 26.3739 | 220142. | -2.0 | 12.6 |
| 1330 | 540.147 | 26.3732 | 220135. | 6.5 | 13.1 |
| 1345 | 540.144 | 26.3729 | 220134. | 1.4 | 12.8 |
| 1400 | 540.135 | 26.3727 | 220136. | -2.0 | 12.2 |
| 1415 | 540.138 | 26.3721 | 220129. | 6.3 | 12.6 |

FREE AIR VOLUME USED (CU. FT.) = 1670360.
REGRESSION LINE
INTERCEPT (LBM) = 220232.
SLOPE (LBM/HR) = -12.6
MAXIMUM ALLOWABLE LEAKAGE RATE = .437
75% OF MAXIMUM ALLOWABLE LEAKAGE RATE = .328
THE UPPER 95% CONFIDENCE LIMIT = .141
THE CALCULATED LEAKAGE RATE = .137

TABLE 5.3

GRAND GULF NUCLEAR STATION 1985 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 545 1104 1985
TEST DURATION: 8.50 HOURS

| TIME | TEMP (R) | PRESSURE (PSIA) | MEASURED LEAKAGE RATE |
|---|---|---|---|
| 545 | 540.230 | 26.3894 | |
| 600 | 540.230 | 26.3886 | .276 |
| 615 | 540.231 | 26.3880 | .267 |
| 630 | 540.221 | 26.3876 | .166 |
| 645 | 540.218 | 26.3870 | .165 |
| 700 | 540.215 | 26.3866 | .151 |
| 715 | 540.210 | 26.3860 | .144 |
| 730 | 540.211 | 26.3855 | .151 |
| 745 | 540.206 | 26.3851 | .142 |
| 800 | 540.203 | 26.3842 | .154 |
| 815 | 540.206 | 26.3840 | .155 |
| 830 | 540.200 | 26.3831 | .159 |
| 845 | 540.202 | 26.3827 | .160 |
| 900 | 540.196 | 26.3821 | .156 |
| 915 | 540.198 | 26.3817 | .160 |
| 930 | 540.191 | 26.3814 | .147 |
| 945 | 540.192 | 26.3804 | .163 |
| 1000 | 540.189 | 26.3801 | .156 |
| 1015 | 540.189 | 26.3797 | .154 |
| 1030 | 540.185 | 26.3788 | .161 |
| 1045 | 540.173 | 26.3786 | .144 |
| 1100 | 540.169 | 26.3781 | .145 |
| 1115 | 540.167 | 26.3775 | .146 |
| 1130 | 540.166 | 26.3769 | .148 |
| 1145 | 540.167 | 26.3765 | .148 |
| 1200 | 540.169 | 26.3763 | .148 |
| 1215 | 540.167 | 26.3754 | .153 |
| 1230 | 540.159 | 26.3751 | .146 |
| 1245 | 540.153 | 26.3750 | .138 |
| 1300 | 540.161 | 26.3744 | .146 |
| 1315 | 540.147 | 26.3739 | .138 |
| 1330 | 540.147 | 26.3732 | .143 |
| 1345 | 540.144 | 26.3729 | .140 |
| 1400 | 540.135 | 26.3727 | .133 |
| 1415 | 540.138 | 26.3721 | .137 |

| | | |
|---|---|---|
| MEAN OF THE MEASURED LEAKAGE RATES | = | .157 |
| MAXIMUM ALLOWABLE LEAKAGE RATE | = | .437 |
| 75% OF MAXIMUM ALLOWABLE LEAKAGE RATE | = | .328 |
| THE UPPER 95% CONFIDENCE LIMIT | = | .183 |
| THE CALCULATED LEAKAGE RATE | = | .129 |

TABLE 5.4

GRAND GULF NUCLEAR STATION 1985 ILRT
TREND REPORT

TIME AND DATE AT START OF TEST: 545 1104 1985

| NO. PTS | END TIME | TOTAL MEAS. | TIME ANALYSIS CALCULATED | UCL | MASS POINT ANALYSIS CALCULATED | UCL |
|---|---|---|---|---|---|---|
| 4 | 630 | .166 | .181 | .546 | .175 | .331 |
| 5 | 645 | .165 | .154 | .307 | .154 | .232 |
| 6 | 700 | .151 | .135 | .248 | .140 | .189 |
| 7 | 715 | .144 | .123 | .222 | .131 | .166 |
| 8 | 730 | .151 | .121 | .220 | .133 | .158 |
| 9 | 745 | .142 | .116 | .210 | .130 | .149 |
| 10 | 800 | .154 | .119 | .214 | .135 | .151 |
| 11 | 815 | .155 | .121 | .216 | .139 | .153 |
| 12 | 830 | .159 | .125 | .218 | .144 | .156 |
| 13 | 845 | .160 | .128 | .220 | .147 | .158 |
| 14 | 900 | .156 | .130 | .219 | .149 | .158 |
| 15 | 915 | .160 | .132 | .219 | .151 | .159 |
| 16 | 930 | .147 | .131 | .214 | .149 | .156 |
| 17 | 945 | .163 | .134 | .216 | .152 | .159 |
| 18 | 1000 | .156 | .135 | .214 | .152 | .159 |
| 19 | 1015 | .154 | .135 | .213 | .152 | .158 |
| 20 | 1030 | .161 | .137 | .213 | .154 | .159 |
| 21 | 1045 | .144 | .136 | .209 | .151 | .157 |
| 22 | 1100 | .145 | .135 | .206 | .149 | .154 |
| 23 | 1115 | .146 | .134 | .203 | .147 | .153 |
| 24 | 1130 | .148 | .134 | .201 | .147 | .152 |
| 25 | 1145 | .148 | .134 | .200 | .146 | .151 |
| 26 | 1200 | .148 | .134 | .198 | .146 | .150 |
| 27 | 1215 | .153 | .134 | .198 | .146 | .150 |
| 28 | 1230 | .146 | .134 | .196 | .146 | .149 |
| 29 | 1245 | .138 | .133 | .193 | .144 | .148 |
| 30 | 1300 | .146 | .133 | .192 | .143 | .147 |
| 31 | 1315 | .138 | .132 | .190 | .142 | .145 |
| 32 | 1330 | .143 | .131 | .189 | .141 | .145 |
| 33 | 1345 | .140 | .131 | .187 | .140 | .144 |
| 34 | 1400 | .133 | .129 | .185 | .138 | .142 |
| 35 | 1415 | .137 | .129 | .183 | .137 | .141 |

TABLE 5.5
(SH. 1/2)

GRAND GULF NUCLEAR STATION 1985 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
MASS POINT ANALYSIS

TIME AND DATE AT START OF TEST: 1530 1104 1985
TEST DURATION: 4.25 HOURS

| TIME | TEMP (R) | PRESSURE (PSIA) | CTMT. AIR MASS (LBM) | MASS LOSS (LBM) | AVERAGE MASS LOSS (LBM/HR) |
|---|---|---|---|---|---|
| 1530 | 540.117 | 26.3631 | 220063. | | |
| 1545 | 540.121 | 26.3623 | 220054. | 8.3 | 33.3 |
| 1600 | 540.119 | 26.3599 | 220035. | 19.1 | 54.8 |
| 1615 | 540.118 | 26.3584 | 220024. | 11.4 | 51.8 |
| 1630 | 540.107 | 26.3566 | 220013. | 11.2 | 50.1 |
| 1645 | 540.109 | 26.3553 | 220001. | 11.4 | 49.2 |
| 1700 | 540.107 | 26.3537 | 219989. | 12.7 | 49.4 |
| 1715 | 540.097 | 26.3517 | 219976. | 12.3 | 49.4 |
| 1730 | 540.096 | 26.3499 | 219961. | 15.3 | 50.8 |
| 1745 | 540.096 | 26.3488 | 219952. | 8.9 | 49.1 |
| 1800 | 540.086 | 26.3466 | 219938. | 14.7 | 50.1 |
| 1815 | 540.089 | 26.3451 | 219924. | 13.5 | 50.5 |
| 1830 | 540.088 | 26.3437 | 219913. | 11.0 | 49.9 |
| 1845 | 540.078 | 26.3422 | 219904. | 8.6 | 48.7 |
| 1900 | 540.081 | 26.3401 | 219886. | 18.8 | 50.6 |
| 1915 | 540.076 | 26.3384 | 219874. | 11.9 | 50.4 |
| 1930 | 540.068 | 26.3372 | 219867. | 6.9 | 49.0 |
| 1945 | 540.073 | 26.3356 | 219852. | 15.0 | 49.7 |

FREE AIR VOLUME USED (CU. FT.) =1670360.
REGRESSION LINE
INTERCEPT (LBM) = 220063.
SLOPE (LBM/HR) = -49.8
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT = .684
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT = .465
THE CALCULATED LEAKAGE RATE = .543

TABLE 5.5
(SH. 2/2)

GRAND GULF NUCLEAR STATION 1985 ILRT
LEAKAGE RATE (WEIGHT PERCENT/DAY)
TOTAL TIME ANALYSIS

TIME AND DATE AT START OF TEST: 1530 1104 1985
TEST DURATION: 4.25 HOURS

| TIME | TEMP (R) | PRESSURE (PSIA) | MEASURED LEAKAGE RATE |
|---|---|---|---|
| 1530 | 540.117 | 26.3631 | |
| 1545 | 540.121 | 26.3623 | .363 |
| 1600 | 540.119 | 26.3599 | .598 |
| 1615 | 540.118 | 26.3584 | .564 |
| 1630 | 540.107 | 26.3566 | .546 |
| 1645 | 540.109 | 26.3553 | .536 |
| 1700 | 540.107 | 26.3537 | .539 |
| 1715 | 540.097 | 26.3517 | .539 |
| 1730 | 540.096 | 26.3499 | .555 |
| 1745 | 540.096 | 26.3488 | .536 |
| 1800 | 540.086 | 26.3466 | .546 |
| 1815 | 540.089 | 26.3451 | .550 |
| 1830 | 540.088 | 26.3437 | .545 |
| 1845 | 540.078 | 26.3422 | .531 |
| 1900 | 540.081 | 26.3401 | .552 |
| 1915 | 540.076 | 26.3384 | .550 |
| 1930 | 540.068 | 26.3372 | .534 |
| 1945 | 540.073 | 26.3356 | .542 |

MEAN OF THE MEASURED LEAKAGE RATES = .537
VERIFICATION TEST LEAKAGE RATE UPPER LIMIT = .675
VERIFICATION TEST LEAKAGE RATE LOWER LIMIT = .457
THE CALCULATED LEAKAGE RATE = .555

TABLE 5.6

LOCAL LEAKAGE RATE PENALTIES

| Penet. No. | Service | For Penalty | Leakage SCCM |
|---|---|---|---|
| 4 | Fuel Transfer Tube | See Note (1) | 10 |
| 7 | Main Steam C | See Note (2) | 0 |
| 8 | Main Steam D | See Note (2) | 436 |
| 9 | Feedwater A | See Note (3) | 59 |
| 10 | Feedwater B | See Note (3) | 813 |
| 14 | RHR Shutdown Cooling Suction | See Note (3) | 0 |
| 18 | RHR to RPV Head Spray | See Note (3) | 0 |
| 20 | RHR LPCI A | See Note (3) | 232 |
| 21 | RHR LPCI B | See Note (3) | 0 |
| 22 | RHR LPCI C | See Note (3) | 0 |
| 26 | HPCS Discharge to RPV | See Note (3) | 0 |
| 31 | LPCS Discharge to RPV | See Note (3) | 40 |
| 36 | Plant Service Water Return | See Note (3) | 0 |
| 37 | Plant Service Water Supply | See Note (3) | 0 |
| 38 | Chilled Water Supply | See Note (3) | 0 |
| 39 | Chilled Water Return | See Note (3) | 0 |
| 40 | Containment Pressurization (ILRT) | See Note (4) | 0 |
| 56 | Condensate Makeup to Upper Containment Pool | See Note (3) | 0 |
| 61 | Standby Liquid Control (Spare) | See Note (2) | 29 |
| 73 | RHR Relief Valve Discharge | See Note (3) | 0 |
| 76B | RHR Relief Valve Discharge | See Note (3) | 0 |
| 82 | Drywell Pressurization (ILRT) | See Note (4) | 0 |
| 101C | Drywell Pressure Instrumentation | See Note (3) | 0 |
| 101F | Drywell Pressure Instrumentation | See Note (3) | 30 |
| 102D | Drywell Pressure Instrumentation | See Note (3) | 0 |
| 103D | Containment Pressure Instrumentation | See Note (3) | 0 |
| 104D | Containment Pressure Instrumentation | See Note (3) | 0 |
| 105A | Containment Hydrogen Sample | See Note (3) | 0 |
| 106A | Drywell Hydrogen Sample | See Note (3) | 0 |
| 106B | Drywell Hydrogen Sample | See Note (3) | 0 |
| 106E | Containment Hydrogen Sample | See Note (3) | 0 |
| 107B | Containment Hydrogen Sample | See Note (3) | 0 |
| 107D | Drywell Hydrogen Sample | See Note (3) | 0 |
| 107E | Drywell Hydrogen Sample | See Note (3) | 0 |
| 108A | Containment Hydrogen Sample | See Note (3) | 0 |
| 109A | Drywell Fission Products Monitor Sample | See Note (3) | 0 |
| 109B | Drywell Fission Products Monitor Sample | See Note (3) | 0 |
| 109D | Containment Pressure Instrumentation | See Note (3) | 0 |
| 110A | Drywell Pressure Sensing (ILRT) | See Note (4) | 0 |
| 110C | Containment Pressure Sensing (ILRT) | See Note (4) | 0 |
| 110F | Verification Flow (ILRT) | See Note (4) | 0 |
| 114 | Suppression Pool Level Instrumentation | See Note (3) | 0 |
| 116 | Suppression Pool Level Instrumentation | See Note (3) | 0 |
| 118 | Suppression Pool Level Instrumentation | See Note (3) | 0 |
| 120 | Suppression Pool Level Instrumentation | See Note (3) | 0 |
| | TOTAL (SCCM) | | 1650 |

Notes:

(1) The transfer tube closure flange was locally tested using air but submerged in water during the ILRT.

(2) Penetration isolated to reduce leakage during the ILRT.

(3) Penetration in service or in standby during the ILRT (or could not be isolated from a system in service or in standby).

(4) Penetration dedicated to ILRT functions.

TABLE 5.7

PLANT SPECIFIC DATA

A. Plant Information:

| | |
|---|---|
| Owner: | Middle South Energy, Inc. |
| Docket No: | 50 - 416 |
| Plant: | Grand Gulf Nuclear Station Unit 1 |
| Containment Type: | Conventionally Reinforced Concrete Mark III |
| NSSS Supplier, Type: | General Electric, BWR |
| Date Test Completed: | November 4, 1985 |

B. Technical Data

| | |
|---|---|
| Containment Free Air Volume: | 1,670,360 cubic feet |
| Calculated Loss of Coolant Accident Pressure: | 11.5 psig |
| Containment Design Pressure: | 15 psig |
| Containment Design Temperature: | 185°F |
| Test Pressure Limits: | 11.5 - 13.5 psig |
| Limits on Containment Air Temperature During Test: | 40 - 120°F |
| Maximum Allowable Leakage Rate, $L_a$: | 0.437wt.% of Contained Air Mass per Day (24 hrs). |
| Acceptance Leakage Rate as Determined During the Test: | The upper 95% confidence limit on calculated leakage rate plus local leakage rate additions shall be less than $0.75L_a$ = 0.328 wt.%/day |

## TABLE 5.8

## RETAINED TEST BACKUP DATA

1. Access control procedures that were established to limit ingress to containment during testing.

2. A listing of all containment penetrations, including penetration size, and function.

3. A listing of normal operating instrumentation used for the leakage rate test.

4. A system lineup (at time of test), showing required valve positions and status of piping systems.

5. A continuous, sequential log of events from initial survey of containment to restoration of all tested systems.

6. Documentation of instrumentation calibration and standards.

7. The Official Test Copy of the procedure which includes signature sign-off of procedural steps.

8. The procedure and all data that verifies completion of penetration local leakage testing (Type B&C tests).

9. Computer printouts of Integrated Leakage Rate Test Data.

10. A listing of all test exceptions including changes in containment system boundaries instituted to conclude successful testing.

11. Description of method of leak rate verification of instrument measuring system (superimposed leakage), with calibration information on flowmeters.

12. The P&IDs of pertinent systems penetrating the containment or affected by ILRT.

13. Calculation of containment and drywell volume fractions.

GRAND GULF NUCLEAR STATION 1985 ILRT
AIRMASS LBM X 1000 AND REGRESSION LINE

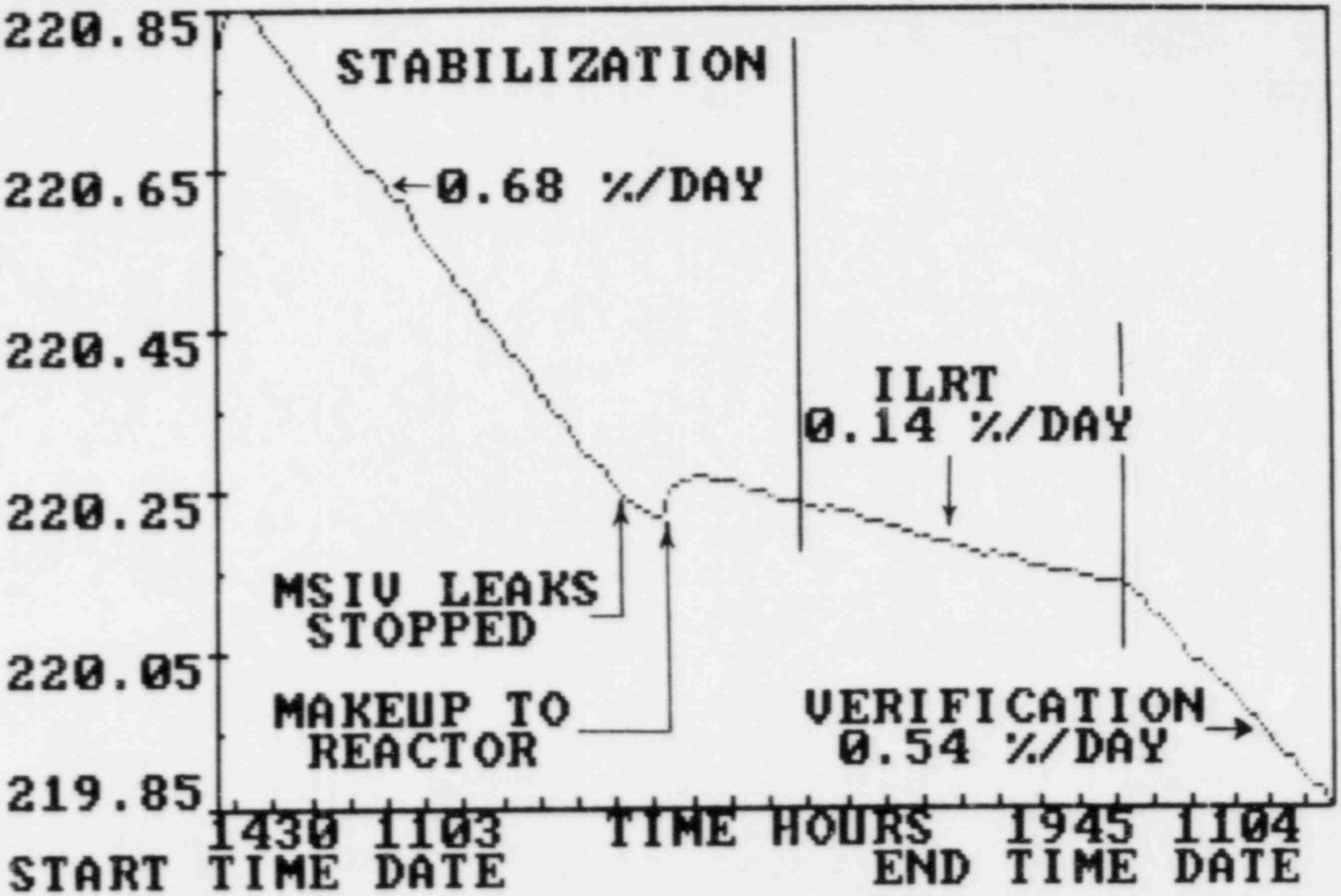
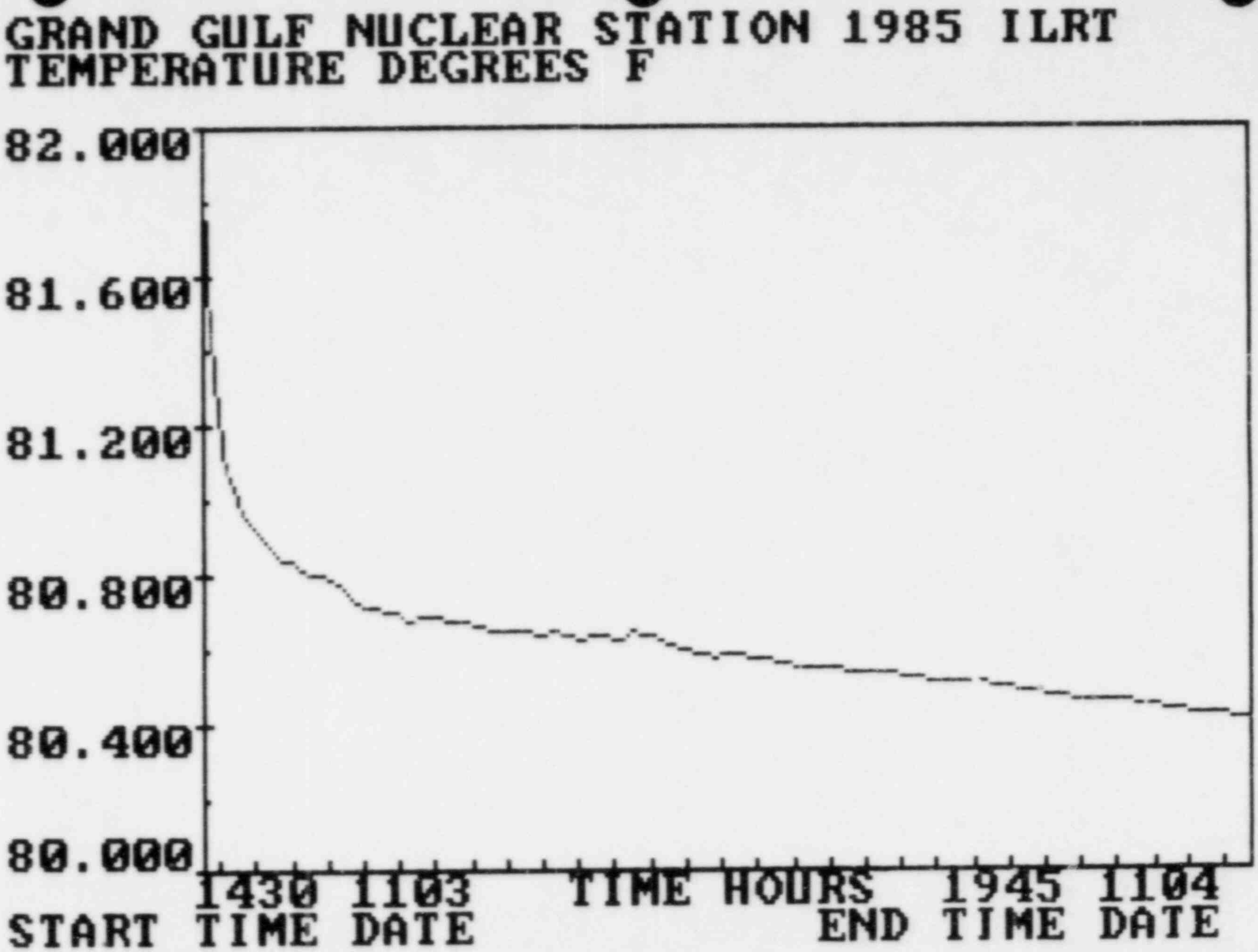



FIGURE 5.1




5.19

FIGURE 5.2

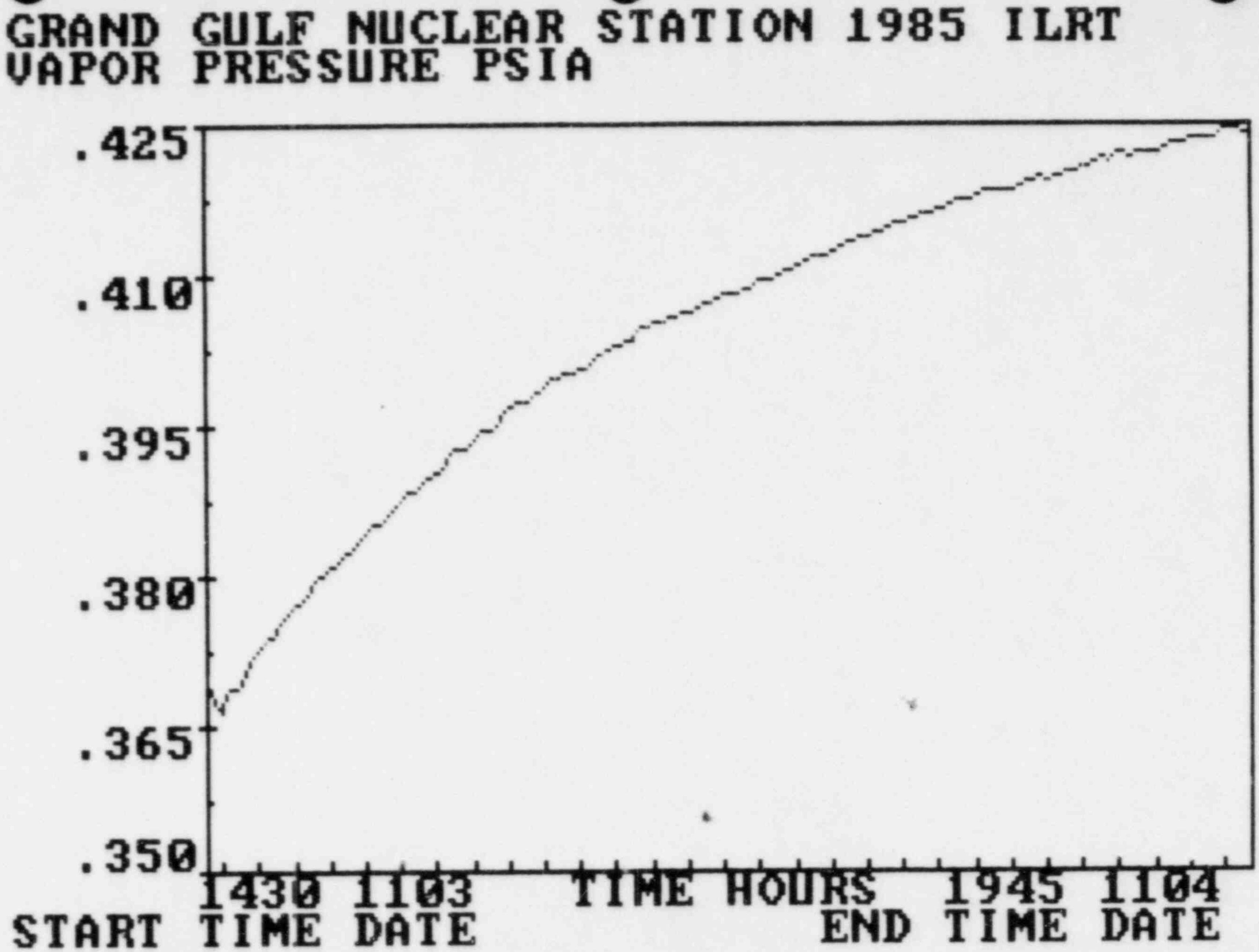

GRAND GULF NUCLEAR STATION 1985 ILRT
VAPOR PRESSURE PSIA
.425
.410
.395
.380
.365
.350
1430 1103
TIME HOURS
1945 1104
START TIME DATE
END TIME DATE

FIGURE 5.3

GRAND GULF NUCLEAR STATION 1985 ILRT
PRESSURE PSIA (DRY AIR)

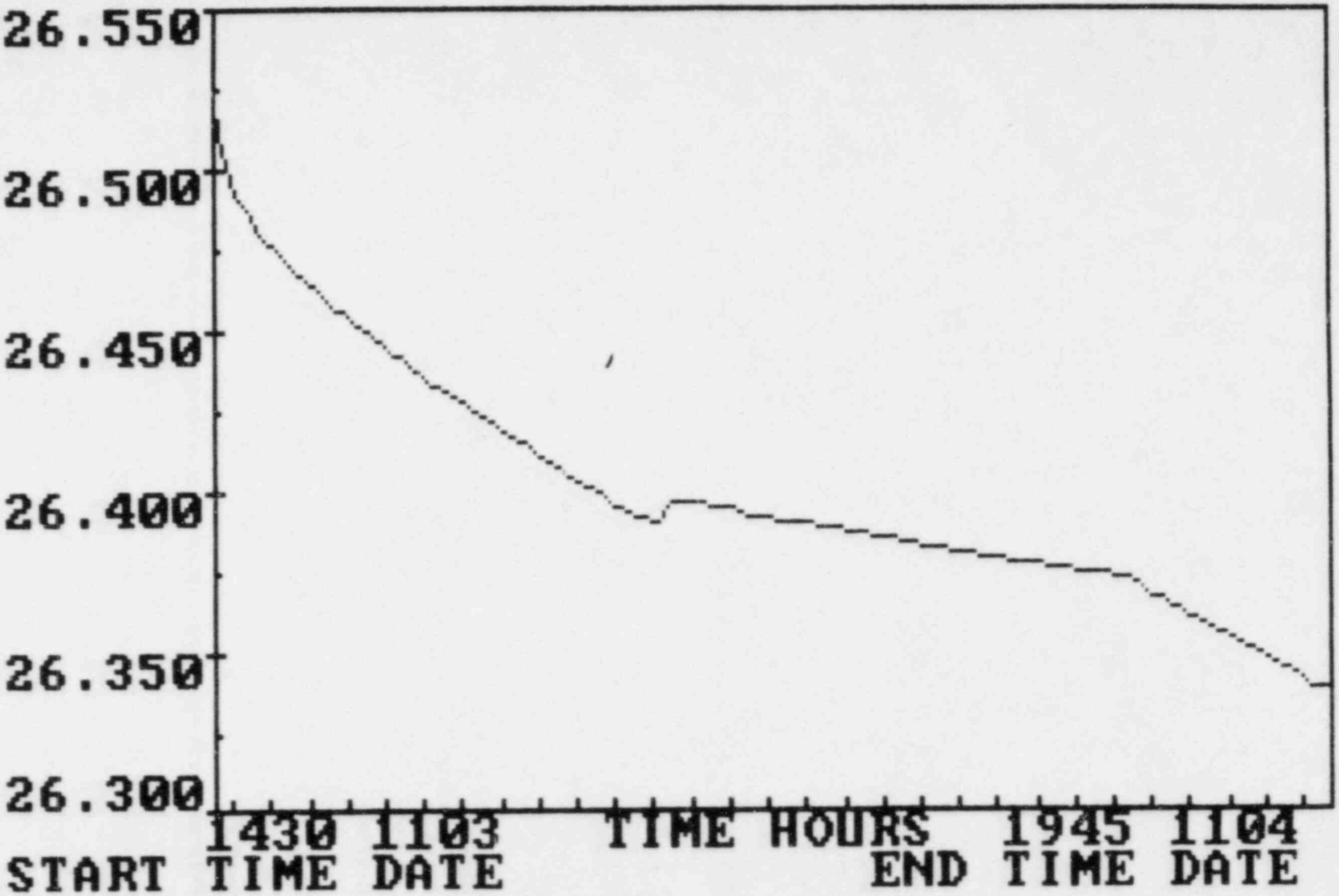



FIGURE 5.4

GRAND GULF NUCLEAR STATION 1985 ILRT
MASS POINT LEAKAGE RATE AND UCL - %/DAY

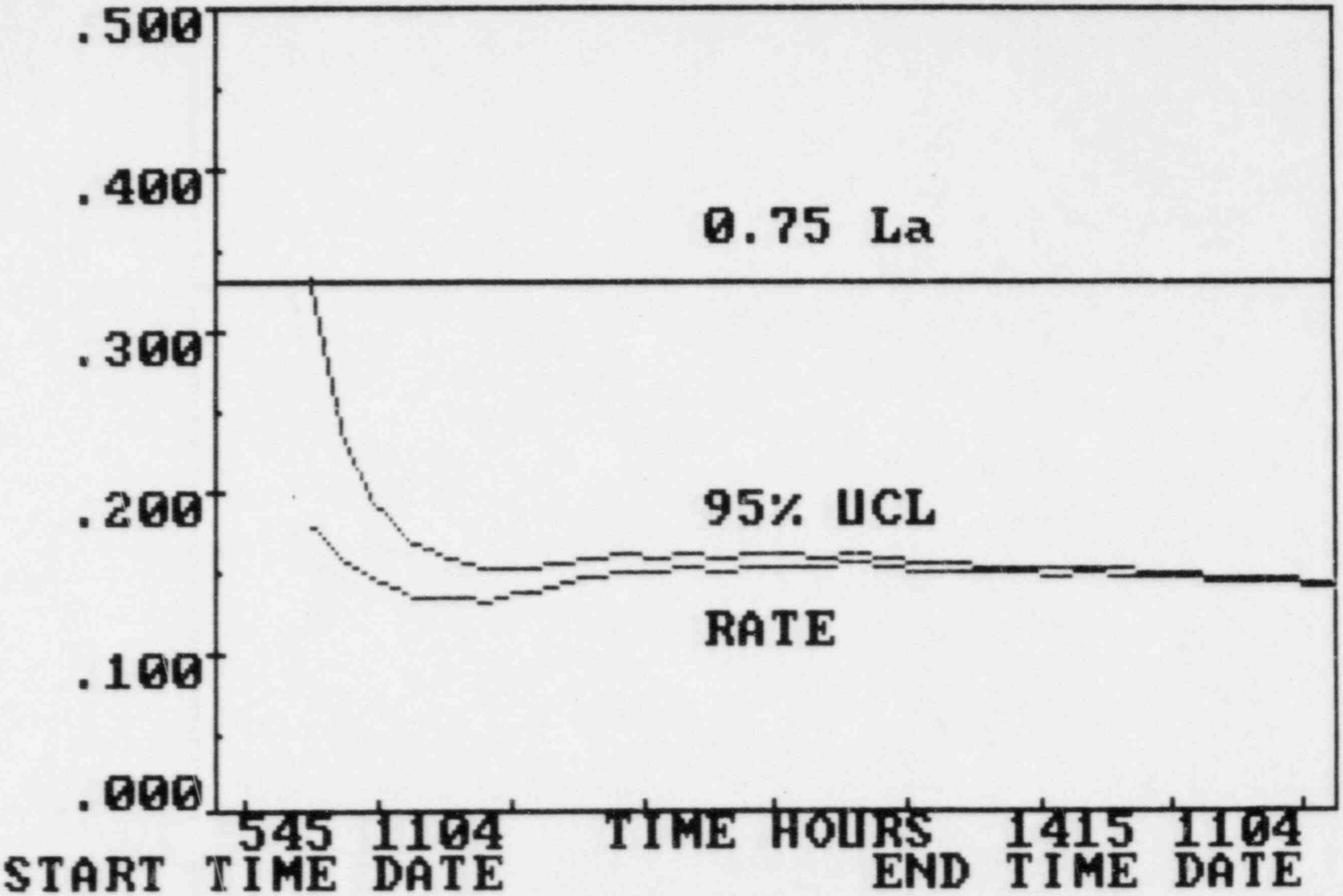



FIGURE 5.5

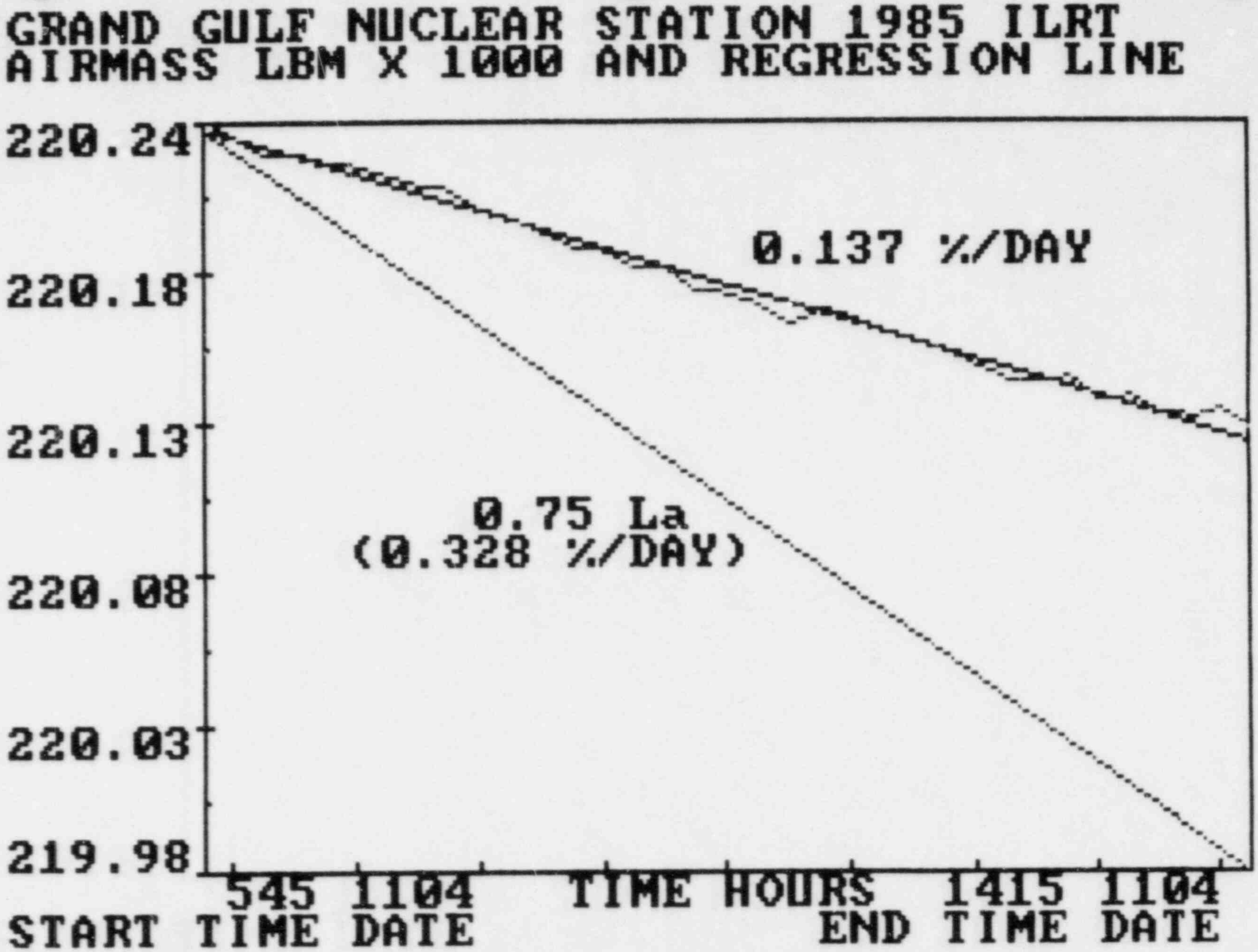

GRAND GULF NUCLEAR STATION 1985 ILRT
AIRMASS LBM X 1000 AND REGRESSION LINE
220.24
220.18
220.13
220.08
220.03
219.98
0.137 %/DAY
0.75 La
(0.328 %/DAY)
545 1104
TIME HOURS
1415 1104
START TIME DATE
END TIME DATE

FIGURE 5.6

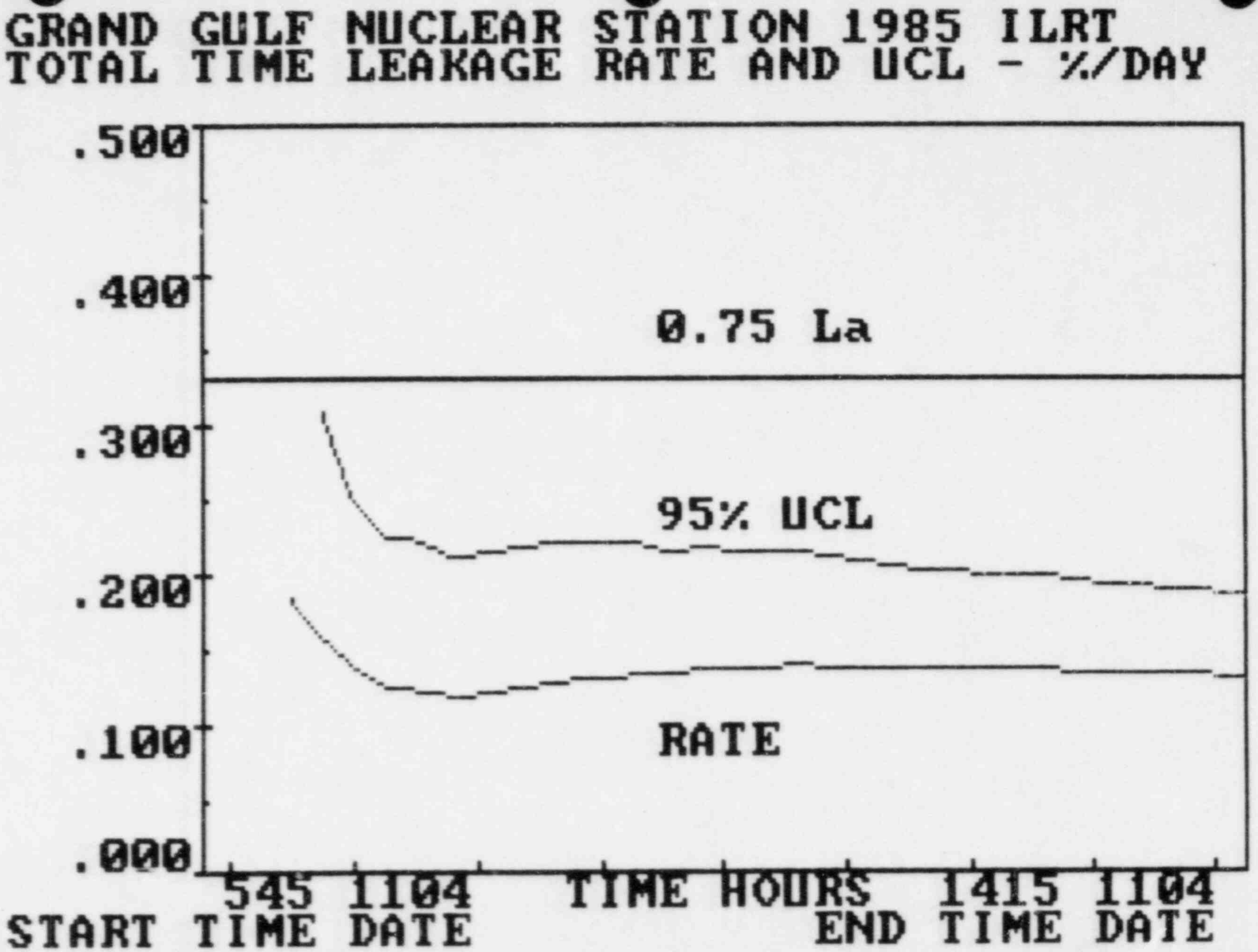

GRAND GULF NUCLEAR STATION 1985 ILRT
TOTAL TIME LEAKAGE RATE AND UCL - %/DAY
.500
.400
.300
.200
.100
.000
0.75 La
95% UCL
RATE
545 1104
TIME HOURS
1415 1104
START TIME DATE
END TIME DATE

FIGURE 5.7

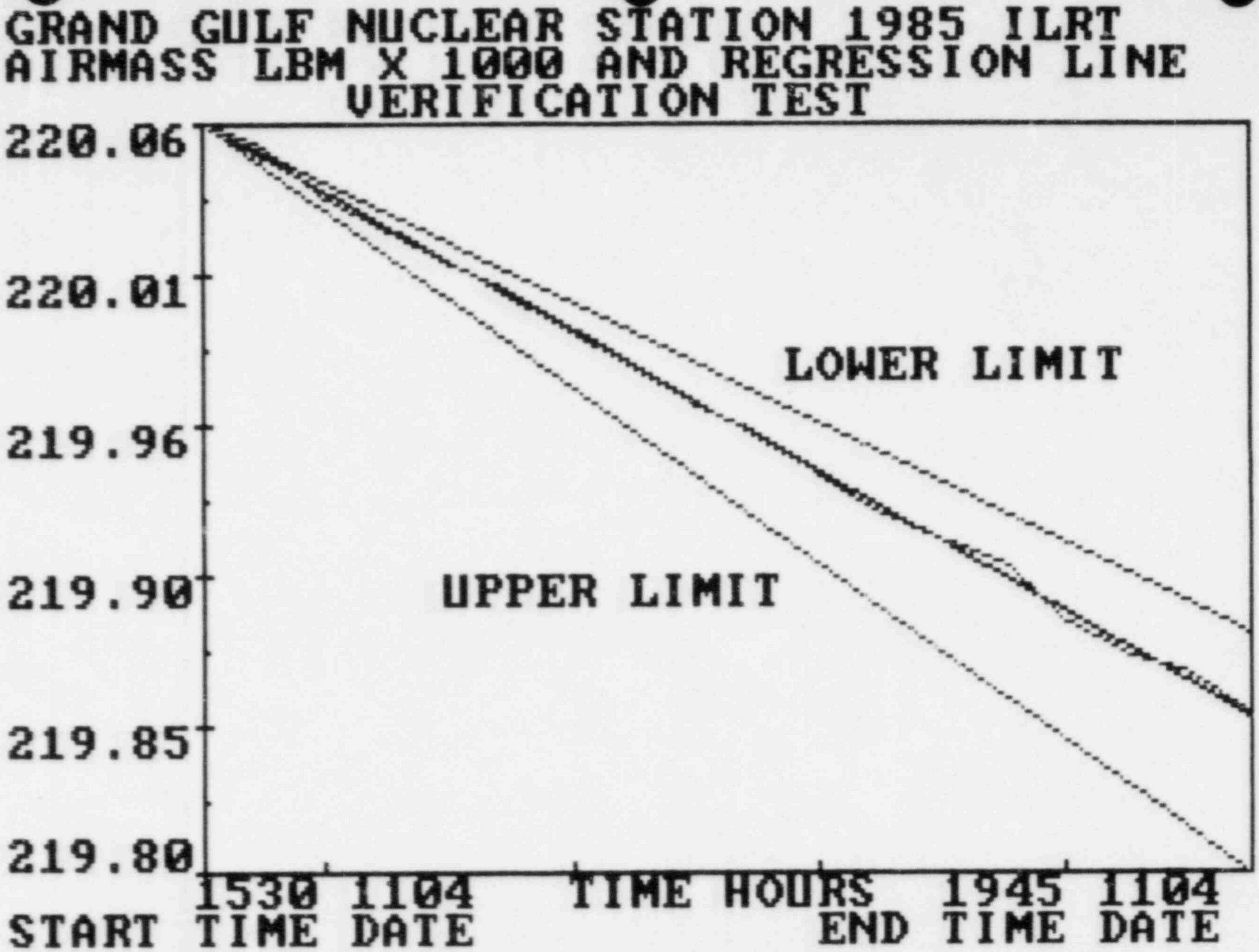

GRAND GULF NUCLEAR STATION 1985 ILRT
AIRMASS LBM X 1000 AND REGRESSION LINE
VERIFICATION TEST
220.06
220.01
219.96
219.90
219.85
219.80
LOWER LIMIT
UPPER LIMIT
1530 1104
TIME HOURS
1945 1104
START TIME DATE
END TIME DATE

FIGURE 5.8

## 6.0 REFERENCES

6.1 Grand Gulf Nuclear Station, Unit 1, Technical Specification 3/4.6.1.

6.2 Grand Gulf Nuclear Station, Surveillance Procedure 06-ME-1M10-0-0002, Containment Integrated Leak Rate Test, Revision 20.

6.3 Code of Federal Regulations, Title 10, Part 50, Appendix J - Primary Reactor Containment Leakage Testing for Water Cooled Power Reactors.

6.4 ANSI/ANS-56.8-1981, Containment System Leakage Testing Requirements.

6.5 Bechtel Topical Report BN-TOP-1, Revision 1, Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants.

6.6 ANSI N45.4 - 1972, Leakage Rate Testing of Containment Structures for Nuclear Reactors.

APPENDIX A

Description of Bechtel ILRT Computer Program

APPENDIX A

DESCRIPTION OF BECHTEL ILRT COMPUTER PROGRAM

A. Program and Report Description

1. The Bechtel ILRT computer program is used to determine the integrated leakage rate of a nuclear primary containment structure. The program is used to compute leakage rate based on input values of time, free air volume, containment atmosphere total pressure, drybulb temperature, and dewpoint temperature (water vapor pressure). Leakage rate is computed using the Absolute Method as defined in ANSI/ANS 56.8-1981, "Containment System Leakage Testing Requirements" and BN-TOP-1, Rev 1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants". The program is designed to allow the user to evaluate containment leakage rate test results at the jobsite during containment leakage testing. Current leakage rate values may be obtained at any time during the testing period using one of two computational methods, yielding three different report printouts.

2. In the first printout, the Total Time Report, leakage rate is computed from initial values of free air volume, containment atmosphere drybulb temperature and partial pressure of dry air, the latest values of the same parameters, and elapsed time. These individually computed leakage rates are statistically averaged using linear regression by the method of least squares. The Total Time Method is the computational technique upon which the short duration test criteria of BN-TOP-1, Rev 1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plant," are based.

3. The second printout is the Mass Point Report and is based on the Mass Point Analysis Technique described in ANSI/ANS 56.8-1981, "Containment System Leakage Testing Requirements." The mass of dry air in the containment is computed at each data point (time) using the Equation of State, from current values of containment atmosphere drybulb temperature and partial pressure of dry air. Contained mass is "plotted" versus time and a regression line is fit to the data using the method of least squares. Leakage rate is determined from the statistically derived slope and intercept of the regression line.

4. The third printout, the Trend Report, is a summary of leakage rate values based on Total time and Mass Point computations presented as a function of number of data points and elapsed time (test duration). The Trend Report provides all leakage rate values required for comparision to the acceptance criteria of BN-TOP-1 for conduct of a short duration test.

5. The program is written in a high level language and is designed for use on a micro-computer with direct data input from the data acquisition system. Brief descriptions of program use, formulae

used for leakage rate computations, and program logic are provided in the following paragraphs.

B. Explanation of Program

1. The Bechtel ILRT computer program is written, for use by experienced ILRT personnel, to determine containment integrated leakage rates based on the Absolute Method described in ANSI/ANS 56.8-1981 and BN-TOP-1.

2. Information loaded into the program prior to or at the start of the test:

   a. Number of containment atmosphere drybulb temperature sensors, dewpoint temperature (water vapor pressure) sensors and pressure gages to be used in leakage rate computations for the specific test

   b. Volume fractions assigned to each of the above sensors

   c. Calibration data for above sensors

   d. Test title

   e. Test pressure

   f. Maximum allowable leakage rate at test pressure

3. Data received from the data acquistion system during the test, and used to compute leakage rates:

   a. Time and date

   b. Containment atmosphere drybulb temperatures

   c. Containment atmosphere pressure(s)

   d. Containment atmosphere dewpoint temperatures

   e. Containment free air volume.

4. After all data at a given time are received , a Summary of Measured Data report (refer to "Program Logic," Paragraph D, "Data" option command) is printed.

5. If drybulb and dewpoint temperature sensors should fail during the test, the data from the sensor(s) are not used. The volume fractions for the remaining sensors are recomputed and reloaded into the program for use in ensuing leakage rate computations.

C. Leakage Rate Formulae

1. Computation using the Total Time Method:

a. Measured leakage rate, from data:

$$P_1V_1 = W_1RT_1 \qquad (1)$$

$$P_iV_i = W_iRT_i \qquad (2)$$

$$L_i = \frac{2400\,(W_1 - W_i)}{\Delta t_i\, W_1} \qquad (3)$$

Solving for $W_1$ and $W_i$ and substituting equations (1) and (2) into (3) yields:

$$L_i = \frac{2400}{\Delta t_i}\left(1 - \frac{T_1P_iV_i}{T_iP_1V_1}\right) \qquad (4)$$

where,

$W_1$, $W_i$ = Weight of contained mass of dry air at times $t_1$ and $t_i$ respectively, lbm.

$T_1$, $T_i$ = Containment atmosphere drybulb temperature at times $t_1$ and $t_i$ respectively, °R.

$P_1$, $P_i$ = Partial pressure of the dry air component of the containment atmosphere at times $t_1$ and $t_i$ respectively, psia.

$V_1$, $V_i$ = Containment free air volume at times $t_1$ and $t_i$ respectively, (constant or variable during the test), $ft^3$.

$t_1$, $t_i$ = Time at $1^{st}$ and $i^{th}$ data points respectively, hours.

$\Delta t_i$ = Elapsed time from $t_1$ to $t_i$, hours.

R = Specific gas constant for air = 53.35 ft.lbf/lbm.°R.

$L_i$ = Measured leakage rate computed during time interval $t_1$ to $t_i$, wt.%/day.

In order to reduce truncation error, the computer program uses the following equivalent formulation:

$$L_i = \frac{-2400}{\Delta t_i}\left(\frac{\Delta W_i}{W_1}\right)$$

where,

$$\frac{\Delta W_i}{W_1} = \frac{W_i - W_1}{W_1}$$

$$= \frac{\frac{\Delta P_i}{P_1} + \frac{\Delta V_i}{V_1} + \frac{\Delta P_i \Delta V_i}{P_1 V_1} - \frac{\Delta T_i}{T_1}}{1 + \frac{\Delta T_i}{T_1}}$$

$\Delta P_i = P_i - P_1$
$\Delta V_i = V_i - V_1$
$\Delta T_i = T_i - T_1$

b. Calculated leakage rate from regression analysis,

$$\overline{L} = a + b\,\Delta t_N \qquad (5)$$

where:

$\overline{L}$ = Calculated leakage rate, wt.%/day, as determined from the regression line.

$$a = (\Sigma L_i - b\Sigma\Delta t_i)/N \qquad (6)$$

$$b = \frac{N(\Sigma L_i \Delta t_i) - (\Sigma L_i)(\Sigma \Delta t_i)}{N(\Sigma \Delta t_i^2) - (\Sigma \Delta t_i)^2} \qquad (7)$$

N = Number of data points

$$\Sigma = \sum_{i=1}^{N}$$

c. Calculated leakage rate at the 95% confidence level.

$$\overline{L}_{95} = a + b\,\Delta t_N + S_{\overline{L}} \qquad (8)$$

where:

$\overline{L}_{95}$ = Calculated leakage rate at the 95% confidence level, wt.%/day, at elapsed time $\Delta t_N$.

For $\Delta t_N < 24$

$$S_{\overline{L}} = t_{0.025;N-2} \left[(\Sigma L_i^2 - a\Sigma L_i - b\Sigma L_i \Delta t_i)/(N-2)\right]^{1/2} \times \left[1 + \frac{1}{N} + (\Delta t_N - \overline{\Delta t})^2 / (\Sigma \Delta t_i^2 - (\Sigma \Delta t_i)^2/N)\right]^{1/2} \quad (9a)$$

where, $t_{0.025;N-2} = 1.95996 + \frac{2.37226}{N-2} + \frac{2.82250}{(N-2)^2}$ ;

For $\Delta t_N \geq 24$

$$S_{\overline{L}} = t_{0.025;N-2} \left[(\Sigma L_i^2 - a\Sigma L_i - b\Sigma L_i \Delta t_i)/(N-2)\right]^{1/2} \times \left[\frac{1}{N} + (\Delta t_N - \overline{\Delta t})^2 / (\Sigma \Delta t_i^2 - (\Sigma t_i)^2/N)\right]^{1/2} \quad (9b)$$

where, $t_{0.025;N-2} = \dfrac{1.6449(N-2)^2 + 3.5283(N-2) + 0.85602}{(N-2)^2 + 1.2209(N-2) - 1.5162}$

$\overline{L}_i$ = Calculated leakage rate computed using equation (5) at total elapsed time $\Delta t_i$, %/day.

$$\overline{\Delta t} = \frac{\Sigma \Delta t_i}{N}$$

2. Computation using the Mass Point Method

a. Contained mass of dry air from data:

$$W_i = 144 \frac{P_i V_i}{RT_i} \quad (10)$$

where:

All symbols are as previously defined.

b. Calculated leakage rate from regression analysis, $W = a + b\,\Delta t$

$$\overline{L} = -2400 \frac{b}{a} \quad (11)$$

where:

$\overline{L}$ = Calculated leakage rate, wt.%/day, as determined from the regression line.

$$a = (\Sigma W_i - b\Sigma\Delta t_i)/N \quad (12)$$

$$b = \frac{N(\Sigma W_i \Delta t_i) - (\Sigma W_i)(\Sigma\Delta t_i)}{N(\Sigma\Delta t_i^2) - (\Sigma\Delta t_i)^2} \quad (13)$$

$\Delta t_i$ = Total elapsed time at time of $i^{th}$ data point, hours

N = Number of data points

$W_i$ = Contained mass of dry air at $i^{th}$ data point, lbm, as computed from equation (10).

$$\Sigma = \sum_{i=1}^{N}$$

In order to reduce truncation error, the computer program uses the following equivalent formulation:

$$a = W_1 \left[ 1 + (\Sigma \frac{\Delta W_i}{W_1} - \frac{b}{W_1} \Sigma \Delta t_i)/N \right]$$

$$b = W_i \left[ \frac{N (\Sigma \frac{\Delta W_i}{W_i} \Delta t_i) - \Sigma \frac{\Delta W_i}{W_i} \Sigma \Delta t_i}{N(\Sigma\Delta t_i^2) - (\Sigma\Delta t_i)^2} \right]$$

where, $\frac{\Delta W_i}{W_1}$ is as previously defined.

c. Calculated leakage rate at the 95% confidence level.

$$\overline{L}_{95} = \frac{-2400}{a} (b - S_b) \quad (14)$$

where:

$\overline{L}_{95}$ = Calculated leakage rate at the 95% confidence level, wt.%/day.

$$S_b = t_{0.025;N-2} \frac{SN^{1/2}}{[N\Sigma\Delta t_i^2 - (\Sigma\Delta t_i)^2]^{1/2}} \qquad (15)$$

where, $t_{0.025;N-2} = \dfrac{1.6449(N-2)^2 + 3.5283\ (N-2)^2 + 0.85602}{(N-2)^2 + 1.2209\ (N-2) - 1.5162}$

$$S = \left\{\frac{\Sigma[W_i - (a + b\,\Delta t_i)]^2}{N-2}\right\}^{1/2}$$

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

D. Program Logic

1. The Bechtel ILRT computer program logic flow is controlled by a set of user options. The user options and a brief description of their associated function are presented below.

| OPTION COMMAND | FUNCTION |
| --- | --- |
| | After starting the program execution, the user either enters the name of the file containing previously entered data or initializes a new data file. |
| DATA | Enables user to enter raw data. When the system requests values of time, volume, temperature, pressure and vapor pressure, the user enters the appropriate data. After completing the data entry, a summary is printed out. The user then verifies that the data were entered correctly. If errors are detected, the user will then be given the opportunity to correct the errors. After the user verifies that the data were entered correctly, a Corrected Data Summary Report of time, data, average temperature, partial pressure of dry air, and water vapor pressure is printed. |
| TREND | A Trend Report is printed. |
| TOTAL | A Total Time Report is printed. |
| MASS | A Mass Point Report is printed. |
| TERM | Enables user to sign-off temporarily or permanently. All data is saved on a file for restarting. |
| CORR | Enables user to correct previously entered data. |
| LIST | A Summary Data Report is printed. |
| READ | Enables the computer to receive the next set of data from the data acquisition system directly. |
| PLOT | Enables user to plot summary data, individual sensor data or air mass versus time. |
| DELETE | Enables user to delete a data point. |
| INSERT | Enables user to reinstate a previously deleted data point. |
| VOLFRA | Enables user to change volume fractions. |

| OPTION COMMAND | FUNCTION |
|---|---|
| TIME | Enables the user to specify the time interval for a report or plot. |
| VERF | Enables the user to input imposed leakage rate and calculated ILRT leakage rates at start of verification test. |

E. COMPUTER REPORT AND DATA PRINTOUT

MASS POINT REPORT

The Mass Point Report presents leakage rate data (wt%/day) as determined by the Mass Point Method. The "Calculated Leakage Rate" is the value determined from the regression analysis. The "Containment Air Mass" values are the masses of dry air in the containment (lbm). These air masses, determined from the Equation of State, are used in the regression analysis.

TOTAL TIME REPORT

The Total Time Report presents data leakage rate (wt%/day) as determined by the Total Time Method. The "Calculated Leakage Rate" is the value determined from the regression analysis. The "Measured Leakage Rates" are the leakage rate values determined using Total Time calculations. These values of leakage rate are used in the regression analysis.

TREND REPORT

The Trend Report presents leakage rates as determined by the Mass Point and Total Time methods in percent of the initial contained mass of dry air per day (wt%/day), versus elapsed time (hours) and number of data points.

SUMMARY DATA REPORT

The Summary Data report presents the actual data used to calculate leakage rates by the various methods described in the "Computer Program" section of this report. The six column headings are TIME, DATE, TEMP, PRESSURE, VPRS, and VOLUME and contain data defined as follows:

1. TIME: Time in 24-hour notations (hours and minutes).
2. DATE: Calendar date (month and day).
3. TEMP: Containment weighted-average drybulb temperature in absolute units, degrees Rankine (°R).

4. PRESSURE: Partial pressure of the dry air component of the containment atmosphere in absolute units (psia).

5. VPRS: Partial pressure of water vapor of the containment atmosphere in absolute units (psia).

6. VOLUME: Containment free air volume (cu. ft.).

F. SUMMARY OF MEASURED DATA AND SUMMARY OF CORRECTED DATA

The Summary of Measured Data presents the individual containment atmosphere drybulb temperatures, dewpoint temperatures, absolute total pressure and free air volume measured at the time and date.

1. TEMP 1 through TEMP N are the drybulb temperatures, where N = No. of RTD's. The values in the right-hand column are temperatures (°F) as read from the data acquisition system (DAS). The values in the left-hand column are the corrected temperatures expressed in absolute units (°R).

2. PRES 1 through PRES N are the total pressures, absolute, where N = No. of pressure sensors. The right-hand value, in parentheses, is a number in counts as read from the DAS. This count value is converted to a value in psia by the computer via the instrument's calibration table, counts versus psia. The left-hand column is the absolute total pressure, psia.

3. VPRS 1 through VPRS N are the dewpoint temperatures (water vapor pressures), where N = No. of dewpoint sensors. The values in the right-hand column are temperatures (°F) as read from the DAS. The values in the lefthand column are the water vapor pressures (psia) from the steam tables for saturated steam corresponding to the dewpoint (saturation) temperatures in the center column.

The Summary of Corrected Data presents corrected temperature and pressure values and calculated air mass determined as follows:

1. TEMPERATURE (°R) is the volume weighted average containment atmosphere drybulb temperature derived from TEMP 1 through TEMP N.

2. CORRECTED PRESSURE (psia) is the partial pressure of the dry air component of the containment atmosphere in absolute units. The volume weighted average containment atmosphere water vapor pressure is subtracted from the volume weighted average total pressure, yielding the partial pressure of the dry air.

3. VAPOR PRESSURE (psia) is the volume weighted average containment atmosphere water vapor pressure, absolute derived from VPRS 1 through VPRS N.

4. VOLUME (cu. ft.) is the containment free air volume.

5. CONTAINMENT AIR MASS (lbm) is the calculated mass of dry air in the containment. The mass of dry air is calculated using the containment free air volume and the above TEMPERATURE and CORRRECTED PRESSURE of the dry air.

APPENDIX B

Instrument Error Analysis (ISG)

APPENDIX B

ISG CALCULATION
( ANSI/ANS 56.8 - 1981 )

CALIBRATION DATA

| | # OF SENSORS | SENSITIVITY(E) | REPEATABILITY(r) |
|---|---|---|---|
| TEMPERATURE(T) | 22 | 0.1000 deg. F | 0.0100 deg. F |
| PRESSURE(P) | 2 | 0.0003 psia | 0.0003 psia |
| VAPOR PRESS(Pv) | 6 | 0.1000 deg. F | 0.0100 deg. F |

Length of Test(t) 8.0 hrs

Test Pressure(P) 11.5 psig ==> 26.2 psia

From Steam Table 0.0124 psi/deg. F (at 70 deg. F)

La 0.4370 wt%/day

INSTRUMENT MEASUREMENT ERRORS

$$eT = [(ET)^2 + (rT)^2]^{1/2} / [\# \text{ of sensors}]^{1/2}$$

eT = 0.0214 deg. F

$$eP = [(EP)^2 + (rP)^2]^{1/2} / [\# \text{ of sensors}]^{1/2}$$

eP = 0.0003 psia

$$ePv = [(EPv)^2 + (rPv)^2]^{1/2} / [\# \text{ of sensors}]^{1/2}$$

ePv = 0.0005 psia

INSTRUMENT SELECTION GUIDE

$$ISG = 2400/t[\, 2(eP/P)^2 + 2(ePv/P)^2 + 2(eT/T)^2\,]^{1/2}$$

ISG = 0.0194 wt%/day

25% of La 0.1093 wt%/day

# APPENDIX C

## Local Leakage Rate Testing Results

## APPENDIX C

Local Leakage Test Summary Data
Type B Test Results

| Penetration | Description | Leakage, SCCM |
|---|---|---|
| 1 | Equipment Hatch | 0 ± 11 |
| 2 | Upper Personnel Lock | 116 ± 12 |
| 3 | Lower Personnel Lock | 294 ± 11 |
| 4 | Fuel Transfer Tube | 0 ± 11 |
| 201 | Reactor Protection System | 0 ± 0 |
| 202 | Low Voltage Power | 0 ± 0 |
| 203 | Instrumentation | 0 ± 0 |
| 204 | Instrumentation | 0 ± 0 |
| 205 | Neutron Monitoring | 0 ± 0 |
| 206 | Low Voltage Power and Control | 0 ± 0 |
| 207 | Control and Power | 0 ± 0 |
| 208 | Instrumentation | 0 ± 0 |
| 209 | Low Voltage Power | 0 ± 0 |
| 210 | Radiation Monitoring | 0 ± 0 |
| 211 | Control | 0 ± 0 |
| 212 | Instrumentation | 0 ± 0 |
| 213 | Rod Position Indication | 0 ± 0 |
| 214 | T. I. P. | 0 ± 0 |
| 215 | 6.9 Kv-Reactor Recirculation Pump A | 0 ± 0 |
| 216 | Test Systems and Communications | 0 ± 0 |
| 217 | Low Voltage Power and Control | 0 ± 0 |
| 218 | Neutron Monitoring | 0 ± 0 |
| 219 | Instrumentation | 0 ± 0 |
| 220 | Instrumentation | 0 ± 0 |
| 221 | Control | 0 ± 0 |
| 222 | Reactor Protection | 0 ± 0 |
| 223 | Low Voltage Power and Control | 0 ± 0 |
| 224 | Instrumentation | 0 ± 0 |
| 225 | Low Voltage Power | 0 ± 0 |
| 226 | Control | 0 ± 0 |
| 227 | Instrumentation | 0 ± 0 |
| 228 | Instrumentation | 0 ± 0 |
| 229 | Low Voltage Power and Control | 0 ± 0 |
| 230 | Reactor Protection | 0 ± 0 |
| 231 | Instrumentation | 0 ± 0 |
| 232 | Neutron Monitoring | 0 ± 0 |
| 233 | Rod Position Indication | 0 ± 0 |
| 234 | CRD Hydraulic System Power and Control | 0 ± 0 |
| 235 | Neutron Monitoring | 0 ± 0 |
| 237 | Instrumentation | 0 ± 0 |
| 238 | Reactor Protection System | 0 ± 0 |
| 239 | Control | 0 ± 0 |
| 240 | Instrumentation | 0 ± 0 |
| 241 | Low Voltage Power and Control | 0 ± 0 |
| 242 | Low Voltage Power and Control | 0 ± 0 |

## APPENDIX C (Cont'd)

### Local Leakage Test Summary Data
### Type B Test Results (Cont'd)

| Penetration | Description | Leakage, SCCM |
|---|---|---|
| 243 | Instrumentation | 0 ± 0 |
| 244 | Low Voltage Power | 0 ± 0 |
| 245 | Low Voltage Power and Control | 0 ± 0 |
| 246 | Radiation Monitoring | 0 ± 0 |
| 247 | 6.9 KV Reactor Recirculation Pump B | 0 ± 0 |
| 248 | Power | 0 ± 0 |
| 249 | Control | 0 ± 0 |
| * | ISI Inspection Ports | 0 ± 0 |
| | TOTAL = | 420 ± 23 |

* Twenty-two inspection ports on guard pipes, two each per penetration on eleven penetrations (5-10, 14, 17-19, & 87).

APPENDIX C (Cont'd)

Local Leakage Test Summary Data
Type C Test Results (Pneumatic)
(Maximum Pathway Leakage)

| Penetration | Description | Leakage, SCCM |
|---|---|---|
| 5 | Main Steam Line A | 7,174 ± 100 |
| 6 | Main Steam Line B | 30 ± 17 |
| 7 | Main Steam Line C | 0 ± 16 |
| 8 | Main Steam Line D | 588 ± 11 |
| 9 | Feedwater Line A | 11,011 ± 151 |
| 10 | Feedwater Line B | 2,552 ± 151 |
| 14 | RHR Shutdown Cooling Suction | 0 ± 17 |
| 17 | Steam Supply to RCIC Turbine and RHR Heat Exchangers | 0 ± 17 |
| 18 | RHR to RPV Head Spray | 0 ± 19 |
| 19 | Main Steam Drain to Condenser | 40 ± 19 |
| 20 | RHR A to LPCI | 393 ± 26 |
| 21 | RHR B to LPCI | 0 ± 27 |
| 22 | RHR C to LPCI | 1,472 ± 19 |
| 24* | RHR Pump C Test Return Line To Suppression Pool | 0 ± 20 |
| 26 | HPCS Pump Discharge to RPV | 20 ± 19 |
| 31 | LPCS Pump Discharge to RPV | 179 ± 16 |
| 32* | LPCS Pump Test Return Line to Suppression Pool | 0 ± 19 |
| 33 | CRD Pump Discharge | 0 ± 16 |
| 34 | Containment Purge Supply | 98 ± 16 |
| 35 | Containment Purge Exhaust | 49 ± 17 |
| 36 | Plant Service Water Return | 0 ± 11 |
| 37 | Plant Service Water Supply | 0 ± 16 |
| 38 | Chilled Water Supply | 180 ± 20 |
| 39 | Chilled Water Return | 0 ± 16 |
| 40 | ILRT Containment Pressurization/ Depressurization | 0 ± 11 |
| 41 | Plant Service Air | 0 ± 16 |
| 42 | Instrument Air | 450 ± 12 |
| 43 | RWCU to Main Condenser | 0 ± 16 |
| 44 | Component Cooling Water Supply | 0 ± 17 |
| 45 | Component Cooling Water Return | 0 ± 17 |
| 47 | Reactor Recirculation Post Accident Sample | 40 ± 12 |

* Penetrations 24 and 32 test return lines were extended into the Suppression Pool below the minimum drawdown level during the outage. Hydraulic local leakage test is specified by Tech Specs; however, pneumatic leakage test results are current, pneumatic testing is conservative, and results are included in Type B and C totals. The next scheduled leakage tests on these penetrations will be with water.

APPENDIX C (Cont'd)

Local Leakage Test Summary Data
Type C Test Results (Pneumatic)
(Maximum Pathway Leakage)

| Penetration | Description | Leakage, SCCM |
|---|---|---|
| 49 | RWCU Backwash Transfer Pump to Spent Resin Storage Tank | 40 ± 12 |
| 50 | DW & Containment Equipment Drain Sump Pumps Discharge to Auxiliary Building Transfer Tank | 150 ± 12 |
| 51 | DW & Containment Floor Drain Sump Pumps Discharge to Auxiliary Building Transfer Tank | 78 ± 11 |
| 54 | Upper Containment Pool to and from Refueling Water Storage Tank | 0 ± 11 |
| 56 | Condensate Makeup to Upper Containment Pool | 453 ± 11 |
| 57 | Discharge from Fuel Pool Cooling and C. U. System to Upper Containment Pool | 160 ± 17 |
| 58 | Inlet Upper Containment Pool Skimmer Tanks to Fuel Pool Cooling and C. U. System | 0 ± 10 |
| 60 | Auxiliary Building Floor and Equipment Drain Return | 0 ± 16 |
| 61 | Standby Liquid Control Mixing Tank (Future Use) | 30 ± 17 |
| 65 | Containment Normal Vent Supply and Combustible Gas Control | 150 ± 17 |
| 66 | Containment Normal Vent and Combustible Gas Control Purge Exhaust | 0 ± 17 |
| 70 | Automatic Depressurization System (Instrument Air) | 20 ± 12 |
| 73 | RHR Shutdown Relief Valve Discharge to Suppression Pool | 0 ± 12 |
| 75 | RCIC Pump Turbine Exhaust Vacuum Relief | 151 ± 12 |
| 76B | RHR Shutdown Suction Relief Valve Discharge to Suppression Pool | 0 ± 12 |
| 81 | Reactor Recirculation Post Accident Sample | 20 ± 12 |
| 82 | ILRT Drywell Pressurization/ Depressurization | 0 ± 11 |
| 83 | RWCU Line from Regenerative Heat Exchanger to Feedwater | 299 ± 12 |
| 84 | Drywell and Containment Chemical Waste | 0 ± 11 |
| 85 | Suppression Pool Cleanup Return | 304 ± 19 |
| 86 | Demineralized Water Supply to Containment | 0 ± 12 |
| 87 | RWCU Pump Suction from Recirculation Loops | 0 ± 17 |
| 88 | RWCU Pump Discharge to RWCU Heat Exchanger | 0 ± 17 |

APPENDIX C (Cont'd)

Local Leakage Test Summary Data
Type C Test Results (Pneumatic)
(Maximum Pathway Leakage)

| Penetration | Description | Leakage, SCCM |
|---|---|---|
| 101C | Drywell Pressure Instrumentation (Narrow Range) | 0 ± 11 |
| 101F | Drywell Pressure Instrumentation (Wide Range) | 30 ± 11 |
| 102D | Drywell Pressure Instrumentation (Wide Range) | 0 ± 11 |
| 103D | Containment Pressure Instrumentation (Wide Range) | 0 ± 12 |
| 104D | Containment Pressure Instrumentation (Wide Range) | 0 ± 12 |
| 105A | Containment Hydrogen Analyzer Sample | 0 ± 11 |
| 106A | Drywell Hydrogen Analyzer Sample | 0 ± 11 |
| 106B | Drywell Hydrogen Analyzer Sample Return | 0 ± 11 |
| 106E | Containment Hydrogen Analyzer Sample Return | 0 ± 11 |
| 107B | Containment Hydrogen Analyzer Sample Return | 0 ± 12 |
| 107D | Drywell Hydrogen Analyzer Sample | 0 ± 12 |
| 107E | Drywell Hydrogen Analyzer Sample | 0 ± 11 |
| 108A | Containment Hydrogen Analyzer Sample | 0 ± 11 |
| 109A | Drywell - Fission Product Monitor Sample | 0 ± 11 |
| 109B | Drywell - Fission Product Monitor Sample Return | 0 ± 12 |
| 109D | Containment Pressure Instrumentation (Narrow Range) | 0 ± 12 |
| 110A | ILRT Instrumentation (Drywell Pressure) | 0 ± 11 |
| 110C | ILRT Instrumentation (Verification Flow) | 0 ± 11 |
| 110F | ILRT Instrumentation (Containment Pressure) | 0 ± 11 |
| 114 | Suppression Pool Water Level Instrumentation | 0 ± 12 |
| 116 | Suppression Pool Water Level Instrumentation | 0 ± 12 |
| 118 | Suppression Pool Water Level Instrumentation | 0 ± 11 |
| 120 | Suppression Pool Water Level Instrumentation | 0 ± 11 |
| | TOTAL = | 26,734 ± 306 |

APPENDIX C (Cont'd)

Local Leakage Test Summary Data
Type C Test Results (Hydraulic)

| Penetration | Description | Leakage, Ml/Min |
|---|---|---|
| 11 | RHR Pump A Suction | 0 ± 0 |
| 12 | RHR Pump B Suction | 53 ± 1 |
| 13 | RHR Pump C Suction | 0 ± 0 |
| 23 | RHR A Pump Test Return Line to Suppression Pool | 0 ± 0 |
| 24* | RHR C Pump Test Return Line to Suppression Pool | N/A |
| 25 | HPCS Pump Suction | 0 ± 0 |
| 27 | HPCS Test Return Line to Suppression Pool | 0 ± 0 |
| 28 | RCIC Pump Suction | 0 ± 0 |
| 29 | RCIC Turbine Exhaust | 17 ± 1 |
| 30 | LPCS Pump Suction | 0 ± 0 |
| 32* | LPCS Test Return Line to Suppression Pool | N/A |
| 46 | RCIC Pump Discharge Minimum Flow Line | 0 ± 1 |
| 48 | RHR Heat Exchanger B Relief Valve Discharge To Suppression Pool | 157 ± 1 |
| 67 | RHR Pump B Test Return Line To Suppression Pool | 53 ± 1 |
| 69 | Refueling Water Transfer Pump Suction From Suppression Pool | 0 ± 0 |
| 71A | LPCS Relief Valve Discharge to Suppression Pool | 0 ± 0 |
| 71B | RHR "C" Relief Valve Discharge to Suppression Pool and Post-Accident Sample Return | 0 ± 0 |
| 77 | RHR Heat Exchanger A Relief Valve Discharge to Suppression Pool | 0 ± 1 |
| 89 | Standby Service Water Supply A | 0 ± 0 |
| 90 | Standby Service Water Return A | 0 ± 0 |
| 91 | Standby Service Water Supply B | 0 ± 0 |
| 92 | Standby Service Water Return B | 0 ± 0 |
| 113 | Suppression Pool Water Level Instrumentation | 0 ± 0 |
| 115 | Suppression Pool Water Level Instrumentation | 0 ± 0 |
| 117 | Suppression Pool Water Level Instrumentation | 0 ± 0 |
| 119 | Suppression Pool Water Level Instrumentation | 0 ± 0 |
| | TOTAL = | 280 ± 2.4 |

* Penetration 24 and 32 test return line were extended into the Suppression Pool below the minimum drawdown level during the outage. Hydraulic local leakage test is specified by Tech. Specs.; however, pneumatic leakage test results are current, pneumatic testing is conservative, and results are included in Type B and C totals. The next scheduled leakage tests on these penetrations will be with water.

# APPENDIX D

# SUMMARY OF MAJOR MODIFICATIONS

# AND COMPONENT REPLACEMENTS

# APPENDIX D

## Summary Of Major Modifications And Component Replacements

1. Carbon steel instrument air piping and valves through Penetration 70 were replaced with stainless steel components to prevent corrosion particles from contaminating the air supply to the Automatic Depressurization System. The following Type C tests were performed:

| Component | Date | Leakage (SCCM) |
|---|---|---|
| Penetration 70 pipe seal Weld to containment wall | 6-6-83 | 0 |
| Valve Q1P53F006 | 9-8-83 | 40 |
| Valve Q1P53F003 | 9-9-83 | 10 |
| Valve Q1P53F043 | 9-9-83 | 0 |

2. The carbon steel disk in Feedwater (Penetration 10) outboard isolation check valve Q1B21F032B was replaced with a stainless steel disk due to concerns about fracture toughness. At the time the work was completed, Type C testing of the feedwater check valves was not required by the GGNS local leak rate testing program. Work completed on 5-4-84.

3. A motor-operated 6-inch gate valve (Q1E12F394) was welded into the RPV head spray line to replace check valve Q1E51F066 as the inboard containment isolation valve on Penetration 17, due to the difficulty of performing Type C tests on Q1E51F066. The modification changed the containment isolation boundary so that 1-inch drain valve Q1E12F344, which was previously a containment isolation valve, is now outside the containment isolation boundary. After the new gate valve was connected electrically and stroke tested, a Type C test on 10-22-85 indicated no leakage.

4. The plugs on feedwater inboard isolation plug-check valves Q1B21F010A (Penetration 9) and Q1B21F010B (Penetration 10) were replaced with plugs with resilient seating surfaces to enable the valves to pass Type C tests. Prior to the replacements, the test volumes could not be pressurized to Type C test pressure. Type C tests performed after the replacements were as follows:

| Component | Date | Leakage (SCCM) |
|---|---|---|
| Q1B21F010A | 10-27-85 | 59 |
| Q1B21F010B | 10-25-85 | 814 |

5. Residual Heat Removal Loop C (Penetration 24) and Low Pressure Core

Spray (Penetration 32) pump test return pipes were extended down into the Suppression Pool to below the minimum drawdown level by welding spoolpieces (approximately 18 inches long) to each pipe. No Type B or C tests were performed because the previous Type B and C tests on the isolation valves are current. The penetrations now meet the requirements 10CFR50, Appendix J, Paragraph III.C.3 for valves sealed with fluid; hence, the next local leak rate tests of the isolation valves will be with water. Work was completed on Penetration 24 on 11-14-85 and on Penetration 32 on 11-25-85.

# APPENDIX E

## SUMMARY REPORT OF TYPE A, B, AND C TESTS WHICH FAILED TO MEET 10CFR50, APPENDIX J ACCEPTANCE CRITERIA

# APPENDIX E

Summary Report Of Type A, B, And C Tests Which
Failed To Meet 10CFR50, Appendix J, Acceptance Criteria

INTRODUCTION: This summary report provides details of Type B and C tests which failed to meet the acceptance criteria of 10CFR50, Appendix J, Paragraphs III.B.3 and III.C.3. The details of the Type A test which failed to meet the acceptance requirements of 10CFR50, Appendix J, Paragraph III.A.5.(b).(2), are described in the summary report to which this report is appended.

DISCUSSION: The following summary table provides details of Type B and C tests which were considered to have failed to meet the acceptance criteria of 10CFR50, Appendix J, Paragraphs III.B.3 and III.C.3. In each case, the actual leakage resulting from the test could not be measured.

The Type B test was conducted with a bubble column test apparatus which provides only two results: No leakage (no bubbles in the bubble column) or test failure (bubbles observed). While it is probable that the leakage would have been very low if it had been measured with a rotometer, this was not done; therefore, the leakage was conservatively considered infinite.

All of the Type C tests which failed were due to inability to pressurize the test volume to the required test pressure of 11.5 psig. The leakages were beyond the makeup capability of a 3/4-inch or 1-inch I. D. hose supplying air at approximately 90 psig to 110 psig. Due to the inability to pressurize the volumes as required to measure the leakages, each of the leakages was assumed to be infinite.

In each case where infinite leakage was determined, action was taken immediately to correct the problem and another Type B or C test was performed to verify that the corrective action was sufficient. The measured leakages were added to the combined Type B and C test totals. It should be noted that the combined Type B and C test totals at Grand Gulf have been determined conservatively by adding together the leakages from all of the components which are Type B or C tested. This method provides a significantly higher combined leakage than the Maximum Pathway Leakage method which is recommended in ANSI/ANS 56.8-1981.

## TYPE B AND C TESTS WHICH FAILED TO MEET 10CFR50, APPENDIX J, ACCEPTANCE CRITERIA

| COMPONENT NUMBER | COMPONENT DESCRIPTION | DATE OF TEST FAILURE | DESCRIPTION OF FAILURE | DESCRIPTION OF CORRECTIVE ACTION | RETEST DATA: TYPE OF TEST | RETEST DATA: DATE OF TEST | RETEST DATA: MEASURED LEAKAGE (SCCM) |
|---|---|---|---|---|---|---|---|
| Q1E12F041C | 12" Swing Check Valve | 1-20-84 | Test Volume could not be pressurized for Type C test | Lapped Seats | C | 1-23-84 | 0 |
| Q1E12D003C | Orifice plate with double-O-ring seals on 18" line | 1-20-84 | Bubbles Detected during Type B Test | Replaced orifice plate and O-rings | B | 2-8-84 | 0 |
| Q1G36F101 | 4" Air operated Gate Valve | 12-1-84 | Test volume could not be pressurized for Type C test | Replaced disk | C | 12-5-84 | 0 |
| Q1E12F028A | 18" Motor operated Gate Valve | 2-20-85 | Test volume could not be pressurized for Type C test | Adjusted valve closing torque switch setting | C | 2-20-85 | 1688 |
| Q1E12F064C | 4" Motor operated Gate Valve | 3-7-85 | Test volume could not be pressurized for Type C test during retest for electrical work | Replaced wedge disk | C | 3-8-85 | 0 |
| Q1B21F028D | 28" Air operated globe Valve with Poppet | 2-21-85 | Test volume could not be pressurized for Type C test | Replaced poppet | C | 3-9-85 | 0 |
| Q1E12F064C | 4" Motor operated Gate Valve | 10-24-85 | Test volume could not be pressurized for Type C test | Adjusted valve closing torque switch setting | C | 10-24-85 | 0 |
| Q1B21F010B | 24" Plug Check Valve | 10-19-85 | Test volume could not be pressurized for Type C test | Replaced plug with modified plug having resilient seat | C | 10-25-85 | 814 |
| Q1B21F010A | 24" Plug Check Valve | 10-17-85 | Test volume could not be pressurized for Type C test | Replaced plug with modified plug having resilient seat | C | 10-27-85 | 59 |

TYPE B AND C TESTS WHICH FAILED TO MEET
10CFR50, APPENDIX J, ACCEPTANCE CRITERIA

| COMPONENT NUMBER | COMPONENT DESCRIPTION | DATE OF TEST FAILURE | DESCRIPTION OF FAILURE | DESCRIPTION OF CORRECTIVE ACTION | RETEST DATA TYPE OF TEST | RETEST DATA DATE OF TEST | RETEST DATA MEASURED LEAKAGE (SCCM) |
|---|---|---|---|---|---|---|---|
| Q1E51F076 | 1" Motor operated Globe Valve | 10-29-85 | Test volume could not be pressurized for Type C test due to packing leak | Repacked valve | C | 11-2-85 | 101 |
| Q1B21F022C<br>Q1B21F028C | 28" Air operated Globe Valves with Poppets | 11-3-85<br><br>11-7-85 | Leakage from vent noted during Type A test preparation.<br>Test volume between valves could not be pressurized for Type C test. | Valves were determined to have been slow-closed prior to Type A test. Valves were opened and then fast-closed. | C | 11-7-85 | 4987 (Combined Leakage) |
| Q1B21F022D<br>Q1B21F028D | 28" Air-operated Globe Valves with Poppets | 11-3-85<br><br>11-7-85 | Leakage from vent noted during Type A test preparation.<br>Test volume between Q1B21F022D and F028D could not be pressurized for Type C test. | Valves were determined to have been slow-closed prior to Type A test. Valves were opened and then fast-closed. | C | 11-8-85 | 588 (Q1B21F022D only) |
| Q1B21F028D | 28" Air Operated Globe Valve with Poppet | 11-7-85 | Test volume could not be pressurized after Q1B21F022D and F028D were opened and fast-closed. | Replaced stem and lapped seat. | C | 12-15-85 | 436 |
| Q1C41F151 | 2" Manual Stop-check Valve | 11-3-85<br><br>11-7-85 | Leakage from vent noted during Type A test preparation.<br>Test volume could not be pressurized for Type C test. | Cleaned valve internals, lapped seat and disk. | C | 11-17-85 | 29 |

## TYPE B AND C TESTS WHICH FAILED TO MEET 10CFR50, APPENDIX J, ACCEPTANCE CRITERIA

| COMPONENT NUMBER | COMPONENT DESCRIPTION | DATE OF TEST FAILURE | DESCRIPTION OF FAILURE | DESCRIPTION OF CORRECTIVE ACTION | RETEST DATA: TYPE OF TEST | RETEST DATA: DATE OF TEST | RETEST DATA: MEASURED LEAKAGE (SCCM) |
|---|---|---|---|---|---|---|---|
| Q1E12F041C | 12" Swing Check Valve | 11-8-85 | Leakage of 10,000 sccm measured during Type C test. | Relapped disk and seat | C | 11-21-85 | 1472 |
| | | 11-17-85 | After initial lapping, test volume could not be pressurized for Type C retest. | | | | |
| Q1C41F150 | 3" Manual Gate Valve | 11-3-85 | Leakage from vent noted during Type A test preparation. Also, noted stem position indicated valve not fully closed. | Closed valve using valve wrench. Valve was very hard to close. | C | 11-7-85 | 65 |
| | | 11-7-85 | Test volume could not be pressurized for Type C test. | Disassembled valve, cleaned and lubricated stem and reassembled. | C | 11-29-85 | 30 |